THE CANADIAN FIELD-NATURALIST

Volume 89

1975

THE OTTAWA FIELD-NATURALISTS' CLUB

OTTAWA CANADA

Information Concerning Content of *The Canadian Field-Naturalist*

Articles

The Canadian Field-Naturalist is a medium for publication of research papers in all fields of natural history. If possible, major articles should be illustrated.

Notes

Short notes on natural history and related topics written by naturalists and scientists are welcome. Range extensions, interesting behavior, pollution data, and other kinds of natural history observations may be offered. It is hoped, however, that naturalists will also support local natural history publications.

Letters

Letters commenting on items appearing in this journal or on any developments or current events affecting natural history and environmental values are welcome. These should be brief, clear, pertinent, and of interest to a wide audience.

News and Comment

Informed naturalists, biologists, and others are invited to present documented narratives and commentaries upon current scientific and political events that affect Canadian natural history and the environment. Contributions should be as short as possible and to the point.

Book Reviews

Normally, only solicited reviews are published. Biologists and naturalists, however, are invited to submit lists of titles (complete with pertinent information regarding authors, publisher, date of publication, illustrations, number of pages and price) for listing under "New Titles."

Special Items

As *The Canadian Field-Naturalist* has a flexible publication policy, items not covered in the traditional sections can be given a special place provided they are judged suitable.

Reviewing Policy of *The Canadian Field-Naturalist*

Manuscripts submitted to *The Canadian Field-Naturalist* are normally sent to an Associate Editor and at least one other reviewer. If their comments concerning the scientific merit and suitability of the manuscript for publication are widely divergent or if an original referee's field of competence does not cover the entire contents of the manuscript, one or two additional referees are asked to review it. Referees are requested to complete their reviews within three weeks or to return the manuscript immediately and suggest an alternate reviewer. Reviews offering a general appraisal of the manuscript followed by specific comments and recommendations for revision are most useful to the Editor and author.

Most manuscripts with a content suitable for *The Canadian Field-Naturalist* must undergo revision — sometimes extensive revision. After resubmission, manuscripts that required major revision are usually returned to the original referees for re-evaluation. Some manuscripts must be rejected if they are scientifically unsound, unimportant (i.e. they do not contribute any worthwhile information), or are otherwise unsuitable for publication. The Editor makes the final decision on whether a manuscript is acceptable for publication and in so doing aims to maintain the scientific quality and overall high standards of the journal.

The CANADIAN FIELD-NATURALIST

Published by THE OTTAWA FIELD-NATURALISTS' CLUB, Ottawa, Canada

Volume 89, Number 1 January-March 1975

The Ottawa Field-Naturalists' Club

FOUNDED IN 1879

Patrons

Their Excellencies the Governor General and Madame Jules Léger

The objectives of this Club shall be to promote the appreciation, preservation and conservation of Canada's natural heritage; to encourage investigation and publish the results of research in all fields of natural history and to diffuse information on these fields as widely as possible; to support and co-operate with organizations engaged in preserving, maintaining or restoring environments of high quality for living things.

Correspondence: Address to The Ottawa Field-Naturalists' Club, Box 3264, Postal Station C, Ottawa, Canada K1Y 4J5

The Canadian Field-Naturalist

The Canadian Field-Naturalist is published quarterly by The Ottawa Field-Naturalists' Club with the assistance of contributions from the National Research Council of Canada and The Canadian National Sportsmen's Show. Opinions and ideas expressed in this journal are private and do not necessarily reflect those of The Ottawa Field-Naturalists' Club or any other agency.

Subscriptions and Membership

Subscription rates for individuals are $7.00 per calendar year. Libraries and other institutions may subscribe at the rate of $12.00 per year (volume). The annual membership fee of $7.00 includes club publications. Subscriptions, applications for membership, notices of changes of address, and undeliverable copies should be mailed to: The Ottawa Field-Naturalists' Club, Box 3264, Postal Station C, Ottawa, Canada K1Y 4J5.

Back Numbers

Most back numbers of this journal and its predecessors, *Transactions of The Ottawa Field-Naturalists' Club*, 1879-1886, and *The Ottawa Naturalist*, 1887-1919, may be purchased from the Business Manager.

All material intended for publication should be addressed to the Editor:

Dr. Lorraine C. Smith, Department of Biology, Carleton University, Ottawa, Ontario K1S 5B6

Cover Photograph: The Minnedosa pothole country where agriculture and duck nestings are often in opposition. Photograph supplied by Erik K. Fritzell. See article on page 21.

The Canadian Field-Naturalist

VOLUME 89, NUMBER 1 JANUARY-MARCH 1975

Looking Ahead

For many years *The Canadian Field-Naturalist* has been internationally recognized as an important national natural history publication and those of us currently responsible for it are dedicated to maintaining its position as a first-class scientific journal. We intend to continue publishing *The Canadian Field-Naturalist* to communicate new information to scientists and naturalists. The journal serves as an outlet not only for the work of scientists but also for that of amateur naturalists, people who have significant contributions to make to our understanding of many aspects of natural history. At the beginning of 1975, our 96th year of publication, with the change to a new printer and greatly increased printing costs because of inflation, it is essential to evaluate some aspects of the financial support of the journal, in particular with respect to its relation with its publisher, The Ottawa Field-Naturalists' Club.

Although The Ottawa Field-Naturalists' Club has several important objectives, the most significant and lasting of the many contributions that the club has made to society is the publication of *The Canadian Field-Naturalist*. Because, unfortunately, this fact has not always been clear to all local members of the club, from time to time controversies have arisen regarding the cost of publishing the journal relative to other uses of the club's funds. The two opposite positions are that publication of the journal is draining the club's financial resources excessively, and on the other hand, that the journal is financially straitened by subsidizing the club's other programs. What the controversy resolves into is the question "What proportion of our approximately 1300 members maintain their association with The Ottawa Field-Naturalists' Club entirely or mainly because they wish to receive (that is, subscribe to) *The Canadian Field-Naturalist*, in contrast to belonging in order to take part in or support the club's other activities?" In the past these discussions have been most unsatisfying and unscientific; although everyone had an answer, no one had any facts. The Publications Committee, therefore, decided to obtain some facts. Thus a questionnaire initiated by the committee formed part of the club's membership renewal form for 1974. Unfortunately, because of the considerable delay before the questionnaire was mailed, and the method used to circulate it, those members who had already paid their 1974 membership fees as well as all our Life and Honorary Members — perhaps 200 to 300 in all — did not receive the questionnaire — a fact we did not discover until it was too late to remedy it.

Although the questionnaire was carefully thought out so that it would be clear and straightforward, the printed version was different in some respects from that prepared by the committee. Part of the questionnaire received by the membership was unclear and one key sentence was omitted. One other unfortunate thing occurred. The Publications Committee received only the questionnaire portion of the returned renewal notices; all names and addresses had been removed. Thus although the anonymity of the respondents is assured, we can only say we are sorry to those who expected to hear from the club either because they offered their services, made suggestions, or asked questions. We had hoped to analyze the responses on a geographic basis (for instance to compare the replies from those in the Ottawa area, i.e. local members, with those from elsewhere). We know that many local members are club members in the full sense, but we also know that there are people in the Ottawa area who are members of the club only to receive *The Canadian Field-Naturalist*. Likewise we know that many non-local members are only 'subscribers' to the journal, while there are some from outside the Ottawa area who enjoy being members of the club. For the time being, however, the relative numbers in these categories are unknown.

Considerable useful information was provided by the 848 questionnaires returned; only 30 of these did not contain replies to our questions. The first asked members to mark *all* their reasons for being members of The Ottawa Field-Naturalists' Club and also to indicate their *major* reason. The answers to the first question follow.

	All reasons	Major reason
To attend the excursions and lectures of the club	43%	11%
To serve on Council or club committees	4%	1%
To receive *Trail & Landscape*	51%	10%
To receive *The Canadian Field-Naturalist*	75%	74% *
To support other club activities	19%	4%

* For 61% of the persons responding to this question, *The Canadian Field-Naturalist* was the *only* reason for their membership in the club.

The second series of questions was preceded by the statement that during the past two years 40% of all membership fees collected by The Ottawa Field-Naturalists' Club have been allocated to *The Canadian Field-Naturalist* and 60% to other club activities including *Trail & Landscape*. The sentence that originally followed and which might well have influenced the replies had it been present was omitted; this sentence stated that funds from subscriptions to *The Canadian Field-Naturalist* (currently available only to institutions and libraries) and to *Trail & Landscape* go directly to the publications. The questions and replies follow.

Do you think subscriptions to *The Canadian Field-Naturalist* should be available to individuals without club membership? Yes 58%; No 24%.

Do you think subscriptions to *Trail & Landscape* should be available to individuals without club membership? Yes 33%; No 41%.

Do you think fee schedules for club membership should be based on publications received by members? (At the present time *Trail & Landscape* is sent only to Ottawa area members, but is available to other members who request it.) Yes 50%; No 27%.

Comments on the questionnaire showed a strong concern for *The Canadian Field-Naturalist*. Several people who were not primarily interested in the journal understood its relevance and importance. The anonymous comment that perhaps best supports our own view was, "I am grateful to the club for maintaining what I regard as a national journal but I have only a slight interest in other club activities. I belong to clubs where I live. To have my name on your list inflates your real membership as defined as those with a definite interest in the club. I think it more realistic to sell me the journal and keep the club for those with an interest in the Ottawa area."

To the Publications Committee the opinions of the membership were unequivocal; most people are members because of *The Canadian Field-Naturalist*. Because only 40% of their membership fees are credited to the journal, these members are clearly subsidizing other club activities. In view of these quantitative results and the many comments on the questionnaires, the committee made two recommendations to improve the current inequitably low financial position of *The Canadian Field-Naturalist*. The first, to offer subscriptions to individuals at the same rate as membership in the club, was passed at the meeting of the Council of The Ottawa Field-Naturalists' Club on 18 November 1974. Although it was too late for this forward step to be implemented for those renewing their memberships in the club for 1975, we hope that a mechanism will be put into motion to advertise and accept subscriptions from new people during 1975. Present club members will be able, if they wish, to become subscribers for 1976, so that all their fees will then be available to publish the journal. The second recommendation, for a more equitable split of current membership fees (i.e., at least 60% should go to the journal) was to be directed to the Finance Committee in time for incorporation into the club's budget for 1975. Both these measures are consistent with the results of the questionnaire and should provide the extra funds to allow the journal to cope with the inflated publication costs ahead.

Other questions that have arisen lately include, "Is The Ottawa Field-Naturalists' Club still the most appropriate publisher for *The Canadian Field-Naturalist*?" and "Could *The Canadian Field-Naturalist* survive if it separated from the club and had to stand on its own?" On 19 February 1973 Anne Hanes, Editor of *Trail & Landscape*, wrote to the Council, "*The Canadian Field-Naturalist* . . . has become a business. The club, however, as a local natural history society is not a business, and should not be treated as one. A local natural history society devoted to resolving local problems and fulfilling local needs is vitally needed; *The Canadian Field-Naturalist* is performing another major function. . . . *The Canadian Field-Naturalist* staff can't make major changes in content, format or budget, however, without consulting the Council." Furthermore she felt that the club and the journal were "both suffering by the necessity to remain together."

Following Anne's letter, the interrelations of the club and the journal were debated in Council. A statement from A. J. Erskine, Recording Secretary, on 9 April 1973 said, "*The Canadian Field-Naturalist* is the only Canadian journal devoted strictly to natural science. This unique publication evolved initially from a local publication of The Ottawa Field-Naturalists' Club. Members of the club, more than 50 years ago, saw the need for a natural history publication of national scope and with this end *The Ottawa Naturalist* became *The Canadian Field-Naturalist.* I believe there are strong reasons why the club and the journal should continue their present association with at most minor change." The Editor's similar views were expressed at the same time. In addition she strongly recommended that "subscriptions to *The Canadian Field-Naturalist* be available to individuals without the obligation of becoming club members."

On 18 June 1973 a statement to the Council from Allan H. Reddoch, then Corresponding Secretary, said, "*The Canadian Field-Naturalist* is basically an archival journal to record original field observations. By maintaining high standards and accepting professional work, it assures itself a circulation and storage in major libraries. I strongly urge that *The Canadian Field-Naturalist* remain under the control of The Ottawa Field-Naturalists' Club." A statement from the Publications Committee on 14 May 1973 included the following, "*The Canadian Field-Naturalist* has presented and will continue to present papers on a variety of aspects of natural history and will thus retain its uniqueness. In doing this *The Canadian Field-Naturalist* will encourage amateur and professional naturalists, generalists and specialists, to become aware of the many facets of and many approaches to natural history. The committee is not going to suggest changes in the present relationship." The discussion helped to clarify the different roles of the club and the journal and the interrelations and we think there was general agreement that their separation is neither necessary nor desirable.

The possibility of the Canadian Nature Federation serving as an alternative to The Ottawa Field-Naturalists' Club as the publisher of *The Canadian Field-Naturalist* has been brought up from time to time and consistently rejected. If *The Canadian Field-Naturalist* were to become affiliated with the Canadian Nature Federation, it might well be slanted to become much more concerned with environmental or conservation issues than with recording the results of research and field observations in natural history, and we do not want to see this happen. Other publications should fill the former important niche and *The Canadian Field-Naturalist* should continue to play its own established role. Moreover, although we agree with the basic objectives of and give our support to the Canadian Nature Federation, we do not feel that this young organization is sufficiently 'mature' or 'financially sound' to be considered as a viable alternative to The Ottawa Field-Naturalists' Club as the publisher of our journal.

In conclusion, we think that The Ottawa Field-Naturalists' Club should be commended for providing an almost unique service for generations of naturalists and natural scientists in Canada and elsewhere by publishing *The Canadian Field-Naturalist* and its predecessors since 1880. Although we believe that *The Canadian Field-Naturalist* could, if necessary, survive on its own if it had a strong Board of Trustees, we think The Ottawa Field-Naturalists' Club is still the most appropriate publisher of the journal, especially when one considers the long history of close association between the club and the journal. We look ahead to future volumes of *The Canadian Field-Naturalist* being published by The Ottawa Field-Naturalists' Club and hope that our personal views expressed herein are supported by most of our readers.

LORRAINE C. SMITH and DONALD A. SMITH

Floristic Analysis of the Missouri River Bottomland Forests in North Dakota[1]

Warren R. Keammerer,[2] W. Carter Johnson,[3] and Robert L. Burgess[3]

Department of Botany, North Dakota State University, Fargo, North Dakota 58102

[2] Present address: Stoecker-Keammerer and Associates, Ecological Consultants, 395 30th Street, Boulder, Colorado 80303

[3] Present address: Environmental Sciences Division, Oak Ridge National Laboratory (operated by Union Carbide Corporation for the U.S. Atomic Energy Commission), Oak Ridge, Tennessee 37830

Keammerer, W. R., W. C. Johnson, and R. L. Burgess. 1975. Floristic analysis of the Missouri River bottomland forests in North Dakota. Canadian Field-Naturalist 89(1): 5–19.

Abstract. Much of the forest vegetation along the upper Missouri River has been inundated and destroyed by a series of large reservoirs. In North Dakota, the remnant forests fall readily into two classes, those dominated by *Populus deltoides* Marsh., and the more mesic forest of *Fraxinus pennsylvanica* Marsh., *Acer negundo* L., *Ulmus americana* L., and *Quercus macrocarpa* Michx. The vascular flora of these forests is comprised of 220 species, representing 54 families and 152 genera. Seven families (Compositae, Gramineae, Cyperaceae, Leguminosae, Labiatae, Rosaceae, and Ranunculaceae), all large families abundant in north-temperate regions, account for over half the total flora. Analysis of the Raunkiaer life-form in the flora of the bottomland forests shows the composition to be predominantly hemicryptophytic (53.2%). Phanerophytes and cryptophytes make up about 17% each, therophytes 11%, and only 1% of the flora is chamaephytic. Geographically, 73.2% of the species are North American, including arctic, subarctic, subarctic-temperate, and temperate distributions. Another 8% are circumpolar, while 18.6% are of European or Eurasian derivation. Many of the latter are widespread and well-known waifs, agricultural weeds, and other ruderal species. A complete checklist is given, including notes on local distribution and relative abundance.

Introduction

Ecosystems of restricted extent occurring in regions consisting overwhelmingly of another vegetation type stimulate scientific interest. For example, localized alpine tundra in New England has an appeal that diminishes in the broad expanses of tundra in the Canadian Arctic. Such is also the case with deciduous forests in North Dakota. Areas of deciduous forests in North Dakota are mostly restricted to the floodplains of the major river systems (Red River of the North, the Sheyenne, the James, and the Missouri Rivers). All of these except the James River have been intensively studied (Nelson 1964; Wanek 1967; Burgess et al. 1973).

The Missouri River Valley is situated in the west-central portion of North Dakota surrounded by gently rolling hills covered by agricultural lands and mixed grass prairie. The valley itself is clearly delimited by tall bluffs, particularly on the western side of the floodplain. The Missouri River at one time flowed unimpeded from its source in the highlands of Montana, through the grasslands of North and South Dakota, joining the Mississippi River near the present-day site of St. Louis, Missouri. The river now has high dams along most of its upper course. Reservoirs created by Gavins Point, Fort Randall, Big Bend, and Oahe dams have left little bottomland forest in South Dakota. Oahe Reservoir inundates bottomlands as far north as southern Burleigh County, North Dakota. Lake Sakakawea, created by Garrison Dam, has permanently flooded the bottomland in North Dakota from Riverdale to within a few miles of the Montana–North Dakota boundary. The diminishing extent of these forests prompted the initiation of an intensive study of the bottomland forests of the Missouri River in North Dakota of which this is a part.

[1] Contribution No. 182 from the Eastern Deciduous Forest Biome, US-IBP, and Publication No. 628, Environmental Sciences Division, Oak Ridge National Laboratory.

Description of the Study Area

Location

The study area (Figure 1) is bounded on the north by Garrison Dam (47°30′ N, 101° 27′30″ W) and on the south by the back-up waters of Oahe Reservoir which roughly approximate the southern boundary of Burleigh County (ca. 46°36′30″ N, 100°37′30″ W). Within this region, the river meanders for approximately 130 km in a southeasterly direc-

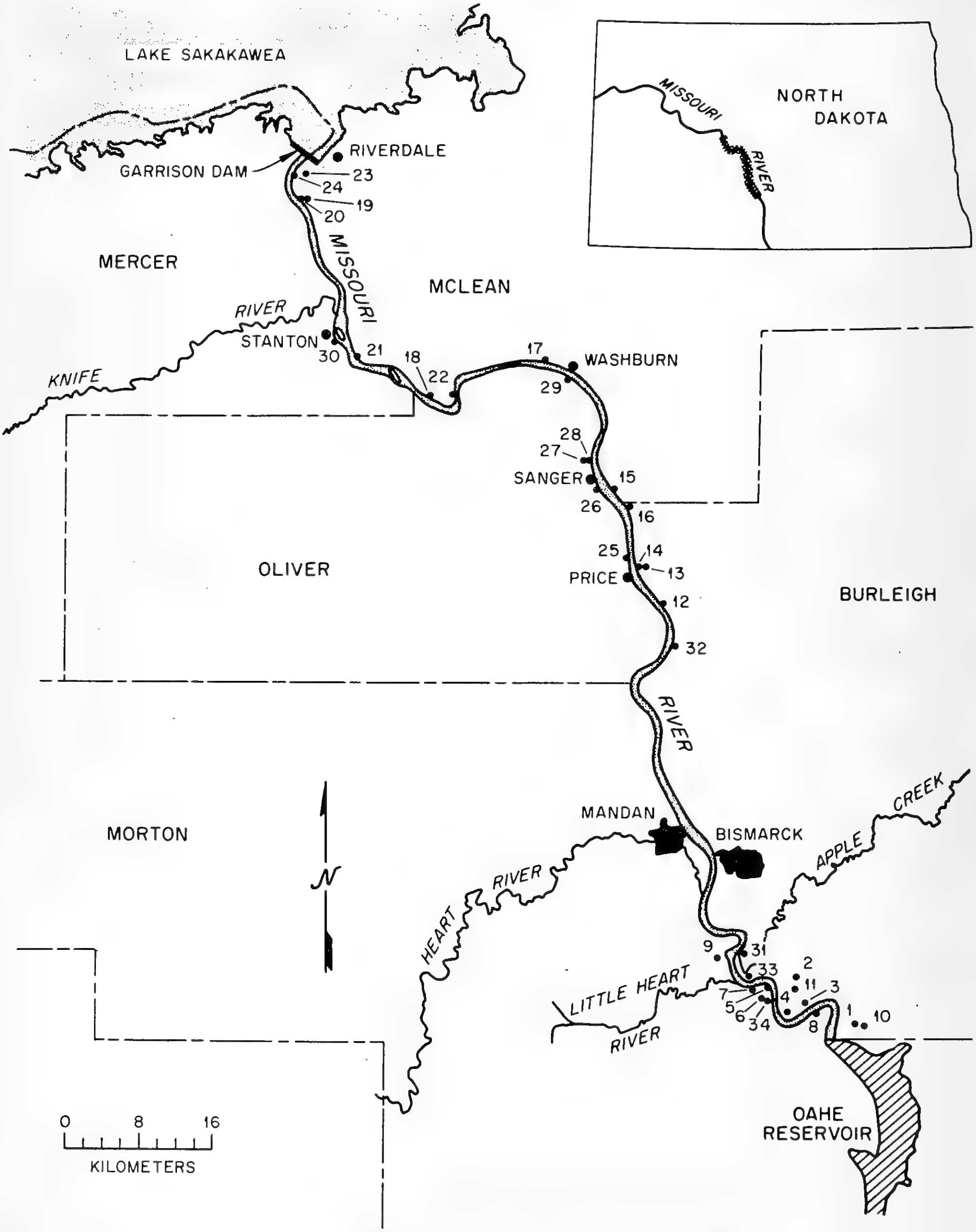


FIGURE 1. The location of the study area within North Dakota, and the general location of all intensively studied forest stands (numbered 1 through 34) on the Missouri River floodplain in North Dakota.

tion, representing a north–south airline distance of approximately 100 km. The floodplain on both sides of the river was included in the study area.

Climate

The Northern Great Plains region falls within a climatic regime described by Thornthwaite (1948) as Dry Subhumid Mesothermal (C_1B_1'). On an average annual basis, precipitation is substantially less than potential evapotranspiration, which generally restricts deciduous forest to low ground where soil moisture conditions are more amenable. This region is subject to great fluctuations in weather conditions (Borchert 1950; Coupland 1958).

The climate of Burleigh County is representative of the study area. The average January and July temperatures are —12.6 and 21.6°C, respectively, with extremes of 45.6 and —42.8°C (Kume and Hansen 1965). The average length of the growing season is 140 days, with the latest average date of killing frost about 10 May and the earliest in the fall approximately 27 September. The average precipitation is 47.9 cm for Burleigh County. Seventy percent of this falls during the growing season, with about 50% in May, June, and July.

Flooding History

One of the unique features of the study area is that even though it is a floodplain, it has not been subjected to flooding since the completion of Garrison Dam in 1954. Prior to 1954, flooding played a significant role in determining vegetation patterns. Information on the flooding history is scanty. In the period 1943–1953, five flood years were recorded (U.S. Army Corps of Engineers, personal communication). In 1943 and 1949, floods were caused by ice jams and flooded approximately 50,000 hectares. The 1952 flood was major, the worst recorded flood for the Missouri River, with an estimated 96,400 hectares inundated along the main stem of the river. In the Bismarck area, there also was considerable silt deposition ranging in thickness from a few centimeters to nearly 2 meters.

Physiography and Geology

West-central North Dakota is included in the Glaciated Missouri Plateau section of the Great Plains Province (Fenneman 1931). Kume and Hansen (1965) recognized four districts of the Plateau: (1) Glaciated Missouri Slope, (2) Coteau Slope, (3) Missouri Coteau, and (4) Missouri River Trench. The study was restricted to the floodplain of the Missouri River Trench district. The floodplain varies in width from less than 1.6 km near Garrison Dam to more than 11.0 km just south of Bismarck. Several major terraces occur. The lower terraces are alluvial in origin and were forested prior to settlement. The upper bedrock terraces, usually covered with grassland, were not included in the study. Different levels occur on forested terraces, forming a complex of land forms which differ in height above the river by as little as 1.0 m from one level to the next. An abundance of intermittent and ephemeral streams empty onto the floodplain along both sides of the river.

South of Bismarck, alluvium and outwash deposits average 30–35 m in depth. Layers of glacial till have been encountered in test drillings and indicate a possible period of glaciation in the valley in early (?) Wisconsin time (Kume and Hansen 1965). The valley is underlain by the Hell Creek and Fox Hills formations (Cretaceous), topped by the Tullock, Ludlow, Cannonball, and Tongue River formations of Tertiary age, which are exposed on the steep, dissected valley walls. Outlying patches of the Tongue River formation occur as buttes along both sides of the river, both north and south of Bismarck (Carlson 1969). These areas are similar in appearance to the badlands along the Little Missouri River in North Dakota, a similarity also reflected in the plant species found on these "outliers of the badlands."

Soils

The soils along the Missouri River are developed on recent alluvial deposits and are mostly medium-textured and calcareous (Omodt et al. 1968). Profile development is minimal with only A and C layers distinguishable. Flooding has played an important role in the development of soils along the Missouri

River. The initial point bar deposits are overwhelmingly sandy, and unless these deposits are subsequently flooded, and fine-grained sediments (silts and clays) deposited on top of them, the original texture will remain essentially unchanged. Also of considerable import is the burial of well-developed soil profiles during floods. This results in complexly layered profiles consisting of buried soils and intermixed lenses of sand, silt, and clay.

Present Vegetation

The present vegetation of the floodplain is a mosaic of aquatic, riparian, and terrestrial communities. Recent meander cut-offs have formed two large oxbow lakes (both adjacent to the river about 32 km north of Bismarck and 40 km north of Mandan). Several small ponds occur on the floodplain, but their origin is obscure. Marshes occur in partially filled oxbow lakes and in abandoned channels, usually dominated by cattail (*Typha latifolia*).

The riparian communities are found on sand bars and the river banks. These areas are usually colonized by sedges, horsetails, and shrubby willows. Coverage on the river banks is variable. In some areas the banks are quite similar to the sand bars, especially in aggraded areas; on cutbanks there is usually little or no plant cover.

Wind-blown sand dune communities, forests, and cultivated fields are characteristic terrestrial types. The sand dune areas, adjacent to the river's edge, are not common. Herbaceous cover is sparse. Young cottonwoods (*Populus deltoides*) and shrubby willows (*Salix* spp.) are alternately buried and exposed by the shifting sands.

Forests of differing composition are the most widespread of the natural communities, occurring on all floodplain terraces from the river's edge to the edge of floodplain (Figure 2). Forest dominants include cottonwood, green ash (*Fraxinus pennsylvanica* var. *subintegerrima*), box elder (*Acer negundo*), and American elm (*Ulmus americana*). Subdominants include peach-leaved willow (*Salix amygdaloides*) and bur oak (*Quercus macrocarpa*). The understory constituents of these forests are quite diverse. Common shrubs and woody vines include dogwood (*Cornus stolonifera*), wolfberry (*Symphoricarpos occidentalis*), poison ivy (*Rhus radicans*), chokecherry (*Prunus virginiana*), Juneberry (*Amelanchier alnifolia*), woodbine (*Parthenocissus inserta*), and fox grape (*Vitis vulpina*).

The forests differ considerably in physiognomy. Young cottonwood–willow forests exhibit large numbers of small trees (6–12 m tall) with few other woody species present. In older cottonwood forests, the trees are tall (18–24 m) and widely spaced with large, straight unbranched boles (61–91 cm in diameter) and little crown branching; thus, the canopy in these forests is never closed, and sufficient light is always available for shrub and herb development. These forests contain numerous species of tall shrubs and saplings which form a distinctive synusium. The more xeric nature of the open canopy cottonwood forests is reflected by the large number of prairie grasses and forbs in the understory. Forests of green ash, box elder, American elm, and bur oak exhibit relatively closed canopies resulting in a considerable decrease in the amount of light available to lower synusia. Thus, these forests lack the tall shrub and sapling layer characteristic of cottonwood forests. The ash – box elder – elm – oak forests at maturity rarely attain a height greater than 23 m, but in many of these stands a few old cottonwood trees approach 30 m in height, rising above the other members of the overstory. Soil fertility, available water capacity, and organic matter were generally highest in these forests; consequently they were considered the most mesic on the floodplain (Burgess et al. 1973).

Cultivated lands currently occupy the greatest area of the floodplain, and this area has been increasing since the completion of Garrison Dam. Without a threat of flooding, more land is being cleared and irrigated. Thus, the vegetation on the floodplain presently is in a state of flux, changing from natural diverse communities to cultivated monocultures. The once extensive forests are being reduced and, unless preventive measures are taken, will soon disappear.

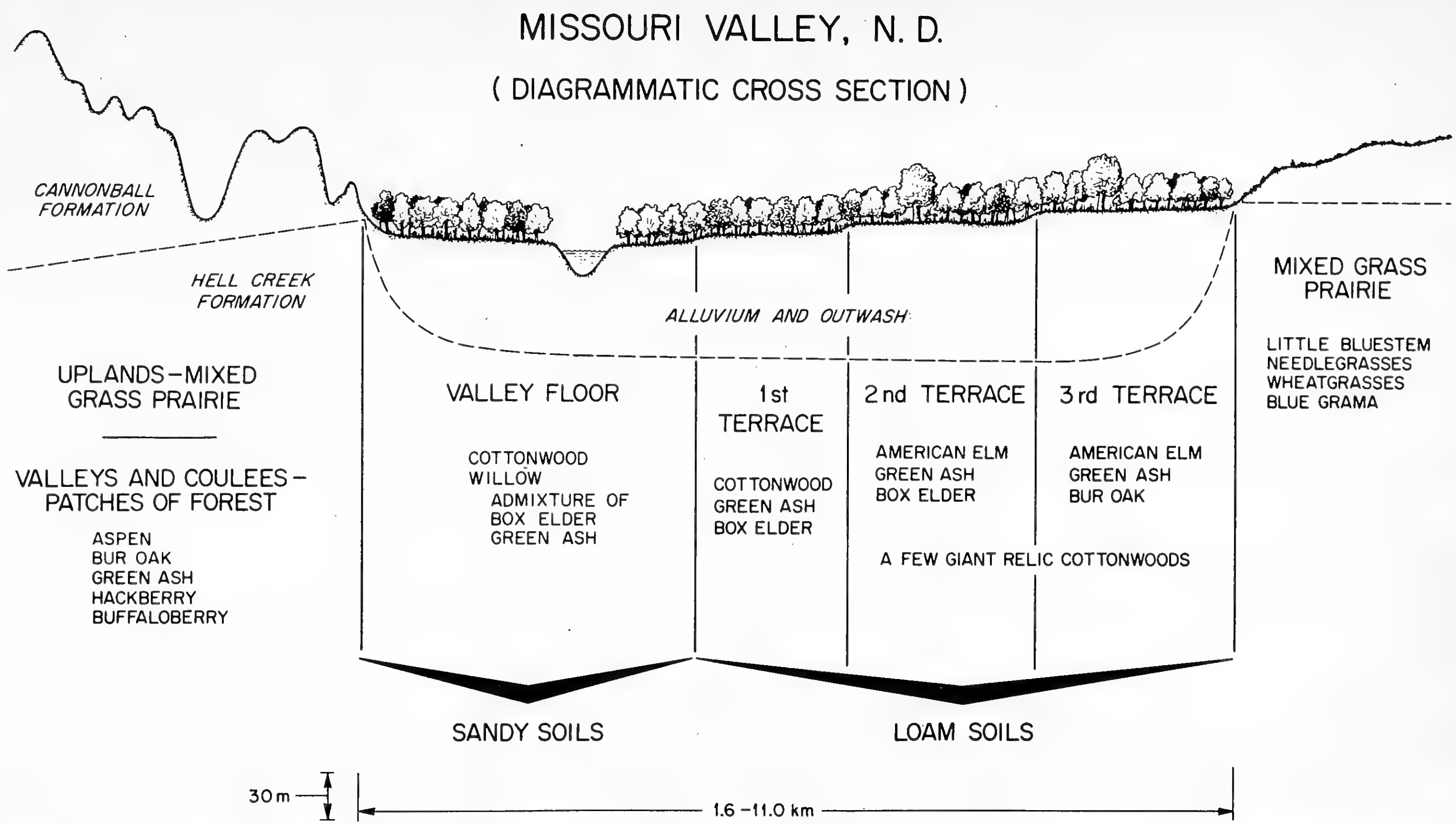


FIGURE 2. Diagrammatic cross-section of the portion of the Missouri Valley in North Dakota that formed the study area, showing the general distribution of vegetation and the surface and sub-surface geology.

Flora

The vascular flora of the bottomland forests along the Missouri River in North Dakota includes 220 species representing 4 divisions, 54 families, and 152 genera. Some of these species also occur in the adjacent prairie areas or in other habitats on the floodplain, but no attempt was made to document the entire floodplain flora. The list also includes a small number of aquatic species which are probably relicts of previous periods when some of the younger forests in which they occur were periodically flooded.

Comparison of the Missouri River forest flora with that of other forested areas within the state was difficult, since other investigators have used slightly different techniques. Since previous studies were not floristic in nature, usually only more common species were listed; however, an examination of the species lists from these studies is of interest. Many species of affinity with the eastern deciduous forest were encountered by Wanek (1967) in a study of the gallery forests along the Red River of the North (e.g., *Trillium cernuum, Arisaema atrorubens, Uvularia grandiflora*). Some of these extend as far westward as the Sheyenne River (Nelson 1964), but are lacking in the flora of the Missouri River forests. Consequently, the Missouri River forests almost completely lack a vernal flora so characteristic of many types of eastern deciduous forest.

The coniferous forests of western North Dakota (*Pinus ponderosa* and *Pinus flexilis*) are of limited extent and are floristically similar to the surrounding prairies because of their savanna-like nature (Potter and Green 1964a, b). Some of the more open cottonwood forests along the Missouri River also show a characteristic floral similarity to the mixed-grass prairie on the uplands above the floodplain.

The only previous report of the plants of the Missouri Valley in North Dakota was a brief survey conducted after it was learned that much of the valley would be flooded. In this study, Stevens (1945) reported 52 species of vascular plants. He stated that because of lack of time very few notes were made about herbs. Of the 52 species he listed, only 16 were not found in the floodplain forests in this study; and of those 16, 12 were noted on the bluffs of the floodplain or in areas adjacent to the forests.

In southeastern South Dakota, Wilson (1970) lists 43 species occurring in five cottonwood stands along the Missouri River. Thirty-one of these are also found in the forests along the Missouri in North Dakota. Johnson (1950), working in the same region, reported 51 species of vascular plants occurring in four sites. In bottomlands of the Missouri River in North Dakota only 25 of these species occur.

Of all these studies only the forests along the Red River show a greater floral richness than that of the forests along the Missouri River in North Dakota. This floral richness may well be a reflection of the area involved in each of the studies. Wanek (1967) surveyed 54 stands, 34 stands along the upper Missouri were included in our investigation, and only a few stands along the Missouri in South Dakota were studied. As the area increases, an increase in richness is anticipated.

An examination of the families represented in the flora reveals that the Compositae (36 species) has the most representatives; the Gramineae, represented by 26 species, is second. Five other families with 10 or more species in the flora, along with the number of species found in each, are as follows: Cyperaceae 14, Leguminosae 13, Labiatae 12, Rosaceae 11, and Ranunculaceae 10. Together these seven families account for 55.4% of the total flora. The angiosperms compose 97.3% of the flora; the conifers, 0.9%; the ferns, 0.5%; and the horsetails, 1.4%. Stevens (1963) lists 106 families, 519 genera, and 1,143 species as occurring in North Dakota. The flora of the bottomland forests thus includes 50.9% of the families, 29.3% of the genera, and 19.2% of the species found in North Dakota.

Life Forms

The life form classes used in this study are based on the position of the overwintering bud (Raunkiaer 1934). The life form of each species in the bottomland forests was determined from its growth habit. The subdivisions of life forms (Table 1) for the species were determined with the aid of MacDonald (1937).

TABLE 1 — Abbreviations of life forms of plants used in describing the flora of the bottomland forests along the Missouri River, North Dakota

Ph	Phanerophytes (perennating bud at least 0.25 m above soil surface)
MM	Mega- Meso-Phanerophytes (greater than 8 m in height)
M	Micro-Phanerophytes (2–8 m in height)
N	Nano-Phanerophytes (0.25–2.0 m in height)
	(Suffix "v" with any of the above symbols indicates a vine)
Ch	Chamaephytes (perennating bud between 0 and 0.25 m above soil surface)
H	Hemicryptophytes (perennating buds in soil surface)
Hp	Proto-Hemicryptophytes without runners (plant leafy throughout)
Hs	Semi-Rosette without runners (plant with large basal leaves and smaller cauline leaves)
Hr	Rosette without runners (plant with well-developed basal leaves and no cauline leaves)
Hpr	Proto-Hemicryptophytes with runners
Hsr	Semi-Rosette with runners
Hrr	Rosette with runners
	(Runner is here used for either hypogeal or epigeal shoot)
Cr	Cryptophytes (perennating buds covered by soil or water)
G	Geophytes (perennating buds covered by soil)
Grh	Rhizome
Gst	Stem-tuber
Grt	Root-tuber
Gb	Bulb
Gr	Root-bud
Gp	Root-parasite
HH	Helo-, Hydrophytes (perennating buds covered by water)
Th	Therophytes (annual plants, perennating buds contained in seed)
S	Stem Succulents (stems enlarged; serve as water storage organ)
E	Epiphytes (non-rooted plants growing on other plants)

Considering all species, the majority of them are hemicryptophytes (53.2%) (Tables 2 and 3), and the greatest number of these are semi-rosette plants without runners (Hs, 23.6%). Cryptophytes rank second in numbers of species and make up 17.6% of the flora. All of these are geophytes, with rhyzome geophytes being the most common (12.5%). Phanerophytes comprise 17.1% of the flora and are mostly microphanerophytes (9.2%). Therophytes comprise 10.6% of the flora, and chamaephytes are poorly represented with only 1.4% of the total flora. An examination of native species only (Table 2) reveals that phanerophytes, hemicryptophytes, and cryptophytes comprise a greater proportion, and chamaephytes and therophytes a smaller proportion, of the native flora than of the total flora because of the annual weedy nature of many of the introduced species (24.4% of which are therophytes).

The native flora of the bottomland forests can be characterized as a hemicryptophytic-cryptophytic flora on the basis of comparison with Raunkiaer's (1934) normal spectrum (Table 2). The percentage of hemicryptophytes is twice as great as that in the normal spectrum. Cryptophytes are about three times more abundant than in the normal spectrum. The other classes (phanerophytes, chamaephytes, and therophytes) are, respectively, 0.4, 1.1, and 0.5 times as abundant as in the normal spectrum. For the total flora the above values change to 2.0 for hemicryptophytes, 2.9 for cryptophytes, 0.4 for phanerophytes, 0.2 for chamaephytes, and 0.8 for therophytes.

Geographical Affinities

The geographical affinities of the flora of North Dakota have been examined by Stevens (1920) and Rudd (1951), with special references to the vegetation formation with which the species are most closely affiliated. Wanek and Burgess (1965), examining the sand prairies in southeastern North Dakota, found that the flora was predominantly of western derivation, (primarily Great Plains and Rocky Mountain floristic regions). Also of importance were species of tall- and mixed-grass prairie regions and especially species more or less

TABLE 2— Life form spectrum of species in Missouri River bottomland forests

Species	No. of species	Percentage distribution of species				
		Ph	Ch	H	Cr	Th
Native and introduced	216	17.1	1.4	53.2	17.6	10.6
Native in bottomland forests	175	18.3	1.1	54.3	18.8	7.4
Normal spectrum*		46.0	9.0	26.0	6.0	13.0

* After Raunkiaer (1934).

TABLE 3 — Spectrum of subdivisions of life forms of seed-bearing plants in the bottomland forests of the Missouri River in North Dakota. Values are percentages of the total flora

Ph (17.1)				Ch	H (53.2)						Cr (17.6)							Th
MM	MMv	M	N		Hp	Hs	Hr	Hpr	Hrs	Hrr	Grh	Gst	Grt	Gb	Gr	Gp	HH	
2.8	1.4	9.2	3.7	1.4	12.0	23.6	1.8	8.3	6.9	0.5	12.5	0.9	1.9	0.9	0.9	0.5	0	10.6

restricted to sand environments. Burgess and Disrud (1969) used a somewhat different approach in an analysis of the geographical affinities of wetland vegetation of the Turtle Mountain region in north-central North Dakota. The region of geographical affinity for each species was determined from Scoggan (1957). This analysis revealed that the flora in this region had components characteristic of six major distributional types: Circumpolar, North Temperate, North American, Amphi-Atlantic, European, and Eurasian. While various diverse sources are available for interpreting global distributions of plant species, Scoggan (1957) lists the vast majority of the species occurring in the Missouri Valley forests and consequently was used as the primary source for determining the geographical affinity of each species. For species not occurring in the flora of Manitoba, Fernald (1950) was used to determine the extent of a species range.

The species in the flora show four main categories of distribution patterns and five secondary groups (Table 4). The main categories are of two major types: latitudinal (Circumpolar) and longitudinal or continental (North American, European, and Eurasian). The same relationship can be seen in the secondary groups, which also show latitudinal (arctic, subarctic, and temperate) and longitudinal (eastern and western) separations.

TABLE 4 — Summary of the geographical distribution of the species present in the flora of the bottomland forests of the Missouri River, North Dakota

Geographical distribution	No. of species	% of flora
Circumpolar distributions		
Arctic circumpolar (Ca)	1	0.4
Arctic-subarctic circumpolar (Cas)	2	0.9
Subarctic circumpolar (Cs)	10	4.5
Subarctic-temperate circumpolar (Cst)	4	1.8
Temperate circumpolar (Ct)	1	0.4
Subtotal	18	8.0
American distributions		
Arctic American (Aa)	1	0.4
Subarctic American (As)	25	11.4
Western (Asw)	2	0.9
Subarctic-temperate American (Ast)	30	13.6
Western (Astw)	3	1.4
Temperate American (At)	47	21.4
Eastern (Ate)	25	11.4
Western (Atw)	28	12.7
Subtotal	161	73.2
Other distributions		
European (Ep)	24	10.9
Eurasian (Er)	17	7.7
Subtotal	41	18.6

Most of the species (73.2%) show characteristic North American distributions (Table 4). Forty-seven species from temperate North America comprise the largest subdivision (21.4%). An additional 53 species are distributed in the temperate American region, but these are restricted to either eastern (11.4) or western (12.7%) parts of the zone. Thus, even though a deciduous forest vegetation type exists along the Missouri River in North Dakota, the number of species centered in the temperate regions of western North America is greater than the number of species of eastern distribution. Many of these eastern species, however, would not be able to withstand the environmental conditions of the surrounding mixed-grass prairie and, therefore, would not be found in this region were it not for the ameliorating effects of the forest (e.g., *Circaea quadrisulcata*, *Polygonatum commutatum*, *Aquilegia canadensis*).

Subarctic-temperate American and subarctic American distributions account for 13.6% and 11.4% of the flora, respectively. Circumpolar distributions comprise only 8.0% of the flora. Subarctic circumpolar distribution includes 10 species (4.5%) and is the best represented of the circumpolar distributions. European and Eurasian distributions (Table 4), which correspond to the introduced species in the flora (18.6%), are represented by 24 species (10.9%) and 17 species (7.7%), respectively. The high percentage of introduced species in the forest flora may be the result of local disturbance. Some of the introduced weeds (e.g., *Lactuca serriola*, *Setaria viridis*, and *Arctium minus*) were found only on disturbed sites. Other introduced species (e.g., *Pastinaca sativa*, *Rorippa armoracia*, *Syringa vulgaris*, and *Lonicera tatarica*) are remnants of past cultivation, either in old gardens or ornamental plantings.

Format of the Annotated Flora

The list of flora (Table 5) incorporates as much information about each species as possible in a relatively small space. The scientific name of each species is presented along with its authority. Nomenclature follows Gleason and Cronquist (1963) except in cases where more recent revisions or monographs have shown other names to be correct. A species preceded by an "(I)" is an introduced species.

A key to the life-form abbreviations can be found in Table 1. Since Raunkiaer's (1934) system applies only to seed-bearing plants, no life form is given for horsetails or ferns; however, they may be considered cryptophytes. A key to the abbreviations for geographical affinity is given in Table 4.

Following the geographical affinity is a statement concerning the relative abundance of the species in the bottomland forests. Four categories of species abundance were selected: rare, scattered, common, and abundant (Burgess 1965). Gradations from one category to the next are indicated by the use of the modifiers "very" and "relatively." Thus a species that is very scattered is more abundant than a species that is relatively rare. A very rare species is one that might require weeks of searching to locate, whereas a very abundant species would be one seen upon entering almost any of the bottomland forests. Three habitats or forest categories are mentioned: cottonwood, mesic, and bottomland forests. If a species is found almost exclusively in either cottonwod or mesic (green ash – American elm – box elder) forests, the abundance statement is related to one of these two forest types. For example, *Agropyron repens* is listed as "rare, cottonwood forests," indicating that it is restricted to cottonwood forests and is not found in mesic forests. A statement which mentions the species abundance in relation to the "bottomland forest" implies that the species may be found in either cottonwood or mesic forests. The phrase "locally abundant" was employed to describe species which may be restricted to a certain habitat, but which proliferate in that habitat, e.g., *Circaea quadrisulcata*.

Acknowledgments

This research was supported in part by the North Dakota Water Resources Research Institute with funds provided by the Office of Water Resources Research, USDI, and in part by the Eastern Deciduous Forest Biome, US-IBP, funded by the National Science Foundation under Interagency Agreement BM569-01147 A09 with the Atomic Energy Commission–Oak Ridge National Laboratory.

TABLE 5 — Annotated vascular flora of the bottomland forests of the Missouri River in North Dakota

Taxon	Life form	Geographical distribution	Habitat and abundance
Division Arthrophyta			
Equisetaceae – Horsetail Family			
Equisetum arvense L.		Ca	Relatively common, cottonwood forests; rare, mesic forests
Equisetum hyemale L.		Ast	Scattered, cottonwood forests, but locally abundant
Equisetum laevigatum A. Br.		At	Rare, cottonwood forests
Division Pterophyta			
Ophioglossaceae – Adder's Tongue Family			
Botrychium virginianum (L.) Sw.		Ct	Scattered, mesic forests; rare, cottonwood forests
Division Coniferophyta			
Cupressaceae – Cypress Family			
Juniperus communis L. var. *depressa* (Pursh.)	N	Cst	Relatively rare, cottonwood forests
Juniperus scopulorum Sarg.	M	Atw	Relatively rare, cottonwood forests
Division Anthophyta			
Gramineae – Grass Family			
(I) *Agropyron repens* (L.) Beauv.	Grh	Er	Rare, cottonwood forests
Agropyron smithii Rydb.	Grh	Atw	Relatively scattered, cottonwood forests
Agrostis stolonifera L.	Hsr	Cs	Scattered, cottonwood and mesic forests
Andropogon gerardi Vitm.	Hs	At	Relatively rare, cottonwood forests
Bromus ciliatus L.	Hs	As	Very scattered, cottonwood forests
(I) *Bromus inermis* Leyss.	Hsr	Er	Relatively abundant, mesic forests; relatively common, cottonwood forests
(I) *Bromus tectorum* L.	Th	Ep	Very rare, cottonwood forests
Calamovilfa longifolia (Hook.) Scribn.	Grh	At	Scattered, cottonwood forests
Elymus canadensis L.	Hs	Ast	Common, cottonwood forests; scattered, mesic forests
Elymus virginicus L.	Hs	Ast	Abundant, mesic forests; relatively scattered, cottonwood forests
Muhlenbergia racemosa (Michx.) BSP	Hsr	At	Common, cottonwood forests; scattered, mesic forests
Oryzopsis hymenoides (R. & S.) Ricker.	Grh	Atw	Rare, cottonwood forests
Oryzopsis micrantha (Trin. and Rupr.) Thurb.	Grh	Atw	Rare, mesic forests
Panicum capillare L.	Th	At	Scattered, recently grazed bottomland forests
Panicum virgatum L.	Grh	At	Scattered, cottonwood forests, locally forming patches
Phalaris arundinacea L.	Grh	Cs	Scattered, mesic forests
(I) *Phleum pratense* L.	Hs	Er	Relatively rare, cottonwood forests
(I) *Poa compressa* L.	Hsr	Er	Scattered, mesic forests
Poa pratensis L.	Grh	Cas	Very abundant, mesic forests; abundant, cottonwood forests
(I) *Setaria glauca* (L.) Beauv.	Th	Er	Relatively scattered, disturbed sites within bottomland forests
(I) *Setaria viridis* (L.) Beauv.	Th	Er	Relatively scattered, disturbed sites within bottomland forests
Spartina pectinata Link.	Hsr	Ast	Scattered, cottonwood forests
Sphenopholis intermedia (Rydb.) Rydb.	Hs	Ast	Relatively scattered, mesic forests; scattered, cottonwood forests
Sphenopholis obtusata (Michx.) Scribn.	Hs	At	Rare, bottomland forests
Sporobolus cryptandrus (Torr.) Gray.	Hs	At	Relatively rare, cottonwood forests
Stipa viridula Trin.	Hs	Atw	Scattered, cottonwood forests
Cyperaceae – Sedge Family			
Carex aquatilis Wahl.	Grh	Cas	Rare, wet areas of bottomland forests
Carex aurea Nutt.	Grh	As	Rare, cottonwood forests
Carex brevior (Dewey) Mackenzie	Hs	At	Common, mesic forests; relatively common, cottonwood forests
Carex cristatella Britt.	Hs	Ate	Rare, mesic forests
Carex granularis Mihl.	Hs	Ate	Very scattered, mesic forests
Carex gravida Bailey.	Grh	Atw	Very scattered, mesic forests
Carex laeviconica Dewey.	Grh	Atw	Relatively common, bottomland forests
Carex pennsylvanica Lam.	Grh	At	Common, mesic forests; scattered, cottonwood forests
Carex saximontana Mackenzie.	Hs	Atw	Relatively rare, mesic forests
Carex sprengelii Dewey.	Grh	At	Relatively scattered, mesic forests
Carex vulpinoidea Michx.	Grh	Ast	Very rare, mesic forests
Eleocharis acicularis (L.) R. & S.	Grh	Cs	Very rare, mesic forests
Scirpus americanus Pers.	Grh	Cs	Very rare, young cottonwood forests
Scirpus acutus Muhl.	Grh	Ast	Very rare, young cottonwood forests
Commelinaceae – Spiderwort Family			
Tradescantia bracteata Small.	Hp	Atw	Very rare, cottonwood forests

TABLE 5 — Annotated vascular flora of the bottomland forests of the Missouri River in North Dakota

Taxon	Life form	Geographical distribution	Habitat and abundance
Juncaceae – Rush Family			
Juncus balticus Willd.	Grh	As	Very rare, young cottonwood forests
Liliaceae – Lily Family			
Allium stellatum Ker.	Gb	Atw	Very rare, mesic forests
(I) *Asparagus officinalis* L.	Grh	Ep	Scattered, cottonwood forests
Lilium philadelphicum L.	Gb	Ate	Very rare, mesic forests
Polygonatum commutatum (Schult. f.) A. Dietr.	Grh	Ate	Scattered, mesic forests
Smilacina stellata (L.) Desf.	Grh	As	Abundant, mesic forests; very common, cottonwood forests
Smilax herbacea L.	Hpr	At	Relatively scattered, mesic forests
Orchidaceae – Orchid Family			
Habenaria viridis (L.) R. Br. var. *bracteata* (Muhl.) Gray.	Grt	As	Very scattered, relatively undisturbed mesic forests
Salicaceae – Willow Family			
Populus deltoides Marsh.	MM	At	Abundant, bottomland forests
Salix amygdaloides Anderss.	MM	At	Relatively scattered, cottonwood forests
Salix interior Rowlee.	M	As	Very rare, young cottonwood forests
Salix lutea Nutt.	M	Astw	Scattered, cottonwood forests
Salix missouriensis Bebb.	M	Ate	Scattered, cottonwood forests
Betulaceae – Birch Family			
Corylus americana Walt.	M	Ate	Very rare, mesic forests
Fagaceae – Beech Family			
Quercus macrocarpa Michx.	MM	Ate	Relatively common, older mesic forests
Ulmaceae – Elm Family			
Ulmus americana L.	MM	Ate	Abundant, mesic forests; relatively scattered, cottonwood forests
(I) *Ulmus pumila* L.	M	Er	Very rare, open cottonwood forests
Moraceae – Mulberry Family			
Humulus lupulus L.	Grh	Cst	Scattered, mesic forests
Urticaceae – Nettle Family			
Parietaria pennsylvanica Muhl.	Th	Ast	Scattered, mesic forests
Urtica dioica L. var. *procera* (Muhl.)	Hpr	As	Relatively scattered, mesic forests
Polygonaceae – Smartweed Family			
(I) *Polygonum convolvulus* L.	Th	Ep	Relatively rare, mesic forests
(I) *Rumex crispus* L.	Hs	Ep	Very rare, mesic forests
Rumex venosus Pursh.	Hs	Atw	Very rare, cottonwood forests; locally abundant along sandy banks
Chenopodiaceae – Goosefoot Family			
(I) *Chenopodium album* L.	Th	Er	Common, disturbed sites in bottomland forests
Chenopodium hybridum L.	Th	As	Scattered, disturbed sites in bottomland forests
Nyctaginaceae – Four-o'clock Family			
Mirabilis nyctaginea (Michx.) MacM.	Grt	At	Relatively rare, cottonwood forests
Caryophyllaceae – Pink Family			
Arenaria lateriflora L.	Hpr	Cs	Relatively scattered, mesic forests
Stellaria longifolia Muhl.	Th	Cs	Very rare, mesic forests
Ranunculaceae – Crowfoot Family			
Actaea rubra (Ait.) Willd.	Grh	As	Relatively scattered, mesic forests
Anemone canadensis L.	Hs	Ast	Relatively abundant, bottomland forests
Anemone cylindrica Gray.	Hs	At	Rare, cottonwood forests
Anemone virginiana L.	Hs	Ate	Relatively common, bottomland forests
Aquilegia canadensis L.	Hs	Ate	Scattered, mesic forests
Clematis ligusticifolia Nutt.	Mv	Atw	Relatively common, cottonwood forests
Ranunculus abortivus L.	Hs	As	Relatively common, mesic forests
Ranunculus macounii Britt.	Hs	As	Very rare, cottonwood forests
Thalictrum dasycarpum Fisch. & Ave-Lall.	Hs	At	Relatively abundant, bottomland forests
Thalictrum venulosum Trel.	Hs	As	Common, mesic forests; relatively scattered, cottonwood forests
Cruciferae – Mustard Family			
Arabis holboellii Hornem.	Hs	As	Very scattered, cottonwood forests
Descurainia richardsonii (Sweet) O. E. Schultz.	Hs	As	Very rare, mesic forests

TABLE 5 — Annotated vascular flora of the bottomland forests of the Missouri River in North Dakota

Taxon	Life form	Geographical distribution	Habitat and abundance
(I) *Descurainia sophia* (L.) Webb.	Th	Ep	Rare, disturbed sites in mesic forests
(I) *Erysimum cheiranthoides* L.	Th	Er	Relatively scattered, bottomland forests
(I) *Hesperis matronalis* L.	Hs	Ep	Scattered but locally abundant, mesic forests
Lepidium densiflorum Schrader.	Hs	Ast	Rare, cottonwood forests
(I) *Rorippa armoracia* (L.) Hitchc.	Grt	Ep	Rare, mesic forests
Saxifragaceae – Saxifrage Family			
Ribes americanum Mill.	N	At	Common, mesic forests
Ribes missouriense Nutt.	N	Ate	Relatively common, mesic forests
Ribes odoratum Wendl.	N	Atw	Relatively rare, mesic forests
Rosaceae – Rose Family			
Agrimonia striata Michx.	Hpr	Ast	Scattered, mesic forests
Amelanchier alnifolia Nutt.	M	Asw	Common, bottomland forests
Crataegus rotundifolia Moench.	M	Ast	Scattered, bottomland forests
Fragaria vesca L.	Hrr	At	Scattered but locally abundant, mesic forests
Geum canadense Jacq.	Hs	Ate	Relatively rare but locally abundant, mesic forests
Geum aleppicum Jacq. var. *strictum* (Ait.)	Hs	Ast	Scattered, mesic forests
Potentilla norvegica L.	Hs	As	Relatively rare, mesic forests
Prunus americana Marsh.	M	At	Scattered, mesic forests
Prunus virginiana L.	M	Ast	Common, bottomland forests
Rosa woodsii Lindl.	N	Asw	Common, cottonwood forests; scattered, mesic forests
(I) *Rubus idaeus* L.	Hpr	Ep	Rare but locally abundant, mesic forests
Leguminosae – Bean Family			
Amorpha fruticosa L.	M	Atw	Very scattered, cottonwood forests
Amphicarpa bracteata (L.) Fern.	Hpr	Ate	Common, mesic forests
Astragalus canadensis L.	Hp	Ast	Scattered, mesic forests
Desmodium canadense (L.) DC.	Hp	Ate	Scattered, cottonwood forests
Glycyrrhiza lepidota Pursh.	Hp	Atw	Common, cottonwood forests
Lathyrus ochroleucus Hook.	Hp	As	Very rare, mesic forests
(I) *Medicago lupulina* L.	Th	Ep	Very common, cottonwood forests
(I) *Medicago sativa* L.	Hp	Er	Relatively rare, cottonwood forests
(I) *Melilotus alba* Desr.	Hs	Ep	Common to abundant, cottonwood forests
(I) *Melilotus officinalis* (L.) Desr.	Hs	Ep	Common to abundant, cottonwood forests
Psoralea lanceolata Pursh.	Hp	Atw	Relatively rare, cottonwood forests
(I) *Trifolium repens* L.	Hsr	Ep	Very rare, cottonwood forests
Vicia americana Muhl.	Hp	Ast	Common, cottonwood forests; relatively scattered, mesic forests
Oxalidaceae – Wood-sorrel Family			
Oxalis stricta L.	Hpr	At	Relatively common, bottomland forests
Linaceae – Flax Family			
Linum lewisii Pursh.	Hp	Aa	Very rare, cottonwood forests
Euphorbiaceae – Spurge Family			
(I) *Euphorbia esula* L.	Hpr	Ep	Scattered, bottomland forests
Anacardiaceae – Cashew Family			
Rhus radicans L. var. *rydbergii* (Small) Rehder.	N	At	Very abundant, bottomland forests
Rhus trilobata Nutt.	N	Atw	Very rare, bottomland forests
Celastraceae – Staff-tree Family			
Celastrus scandens L.	Mv	Ate	Common, bottomland forests
Aceraceae – Maple Family			
Acer negundo L.	MM	At	Abundant, mesic forests; relatively common, cottonwood forests
Rhamnaceae – Buckthorn Family			
(I) *Rhamnus catharticus* L.	M	Ep	Relatively scattered, mesic forests
Vitaceae – Grape Family			
Parthenocissus inserta (Kern) Fritsch.	MMv	At	Abundant, bottomland forests
Vitis vulpina L.	MMv	At	Abundant, bottomland forests
Violaceae – Violet Family			
Viola papilionacea Pursh.	Hr	Ate	Relatively common, bottomland forests
Viola rugulosa Greene.	Hr	Astw	Relatively common, mesic forests
Elaeagnaceae – Oleaster Family			
(I) *Elaeagnus angustifolia* L.	M	Er	Scattered, cottonwood forests
Shepherdia argentea Nutt.	M	Ate	Relatively common, cottonwood forests

TABLE 5 — Annotated vascular flora of the bottomland forests of the Missouri River in North Dakota

Taxon	Life form	Geographical distribution	Habitat and abundance
Onagraceae – Evening Primrose Family			
Circaea quadrisulcata (Maxim.) French. & Sav.	Grh	Ate	Rare but locally abundant, mesic forests
Oenothera strigosa (Rydb.) Mack. & Bush.	Hs	Ast	Scattered, bottomland forests
Umbelliferae – Parsley Family			
Cicuta maculata L.	Hs	As	Very scattered, mesic forests
Heracleum lanatum Michx.	Grt	As	Scattered, mesic forests
Osmorhiza longistylis (Torr.) DC.	Hs	At	Common, mesic forests
(I) *Pastinaca sativa* L.	Hs	Ep	Rare, bottomland forests (escaped from cultivation)
Sanicula marilandica L.	Hs	Ast	Common, mesic forests
Cornaceae – Dogwood Family			
Cornus stolonifera Michx.	M	As	Common, cottonwood forests, scattered elsewhere
Primulaceae – Primrose Family			
Lysimachia ciliata L.	Hpr	Ast	Very common, bottomland forests
Oleaceae – Olive Family			
Fraxinus pennsylvanica Marsh. var. *subintegerrima* (Vahl). Fern.	MM	At	Abundant, mesic forests; common cottonwood forests
(I) *Syringa vulgaris* L.	M	Ep	Very rare, bottomland forests (escaped from cultivation)
Apocynaceae – Dogbane Family			
Apocynum androsaemifolium L.	Hp	As	Rare, bottomland forests
Apocynum sibiricum Jacq.	Hp	Ate	Common, bottomland forests
Asclepiadaceae – Milkweed Family			
Asclepias ovalifolia Decne.	Hp	Atw	Relatively rare, cottonwood forests
Asclepias syriaca L.	Grh	Ate	Relatively abundant, bottomland forests
Asclepias verticillata L.	Hp	At	Scattered, cottonwood forests
Convolvulaceae – Morning-glory Family			
(1) *Convolvulus arvensis* L.	Gr	Er	Relatively scattered, bottomland forests
Convolvulus sepium L.	Hp	Cst	Relatively rare, bottomland forests
Cuscuta gronovii Willd.	Th	At	Scattered, bottomland forests
Cuscuta pentagona Engelm.	Th	At	Rare, bottomland forests
Boraginaceae – Borage Family			
Hackelia americana (A. Gray) Fern.	Hs	At	Scattered but locally abundant, mesic forests
Onosmodium molle Michx. var. *occidentale* (Mack.) Johnst.	Hs	At	Relatively rare, bottomland forests
Verbenaceae – Vervain Family			
Verbena hastata L.	Hp	At	Rare, bottomland forests
Verbena urticifolia L.	Hp	Ate	Rare, bottomland forests
Labiatae – Mint Family			
Agastache foeniculum (Pursh.) Kuntze.	Hs	Astw	Scattered, bottomland forests
(I) *Leonurus cardiaca* L.	Hp	Ep	Rare, bottomland forests
Lycopus americanus Muhl.	Hpr	Ast	Relatively scattered, bottomland forests
Lycopus asper Greene.	Hpr	Atw	Rare, bottomland forests
Mentha arvensis L.	Hpr	As	Scattered, mesic forests
Monarda fistulosa L.	Hpr	Ast	Very common, bottomland forests
(I) *Nepeta cataria* L.	Hp	Ep	Scattered, mesic forests
Physostegia parviflora Nutt.	Hp	Ast	Very rare, bottomland forests
Scutellaria galericulata L.	Hpr	As	Very scattered, mesic forests
Scutellaria lateriflora L.	Hpr	Ast	Scattered, mesic forests
Stachys palustris L.	Gst	As	Scattered, bottomland forests
Teucrium canadense L. var. *occidentale* (Gray) McClintock & Epling.	Hpr	At	Relatively common, bottomland forests
Solanaceae – Nightshade Family			
Physalis heterophylla Nees.	Grh	At	Common, cottonwood forests
(I) *Solanum nigrum* L.	Th	Ep	Very scattered, bottomland forests
Scrophulariaceae – Figwort Family			
Penstemon grandiflorus Nutt.	Hs	Atw	Very rare, cottonwood forests
Scrophularia lanceolata Pursh.	Hp	At	Very scattered, mesic forests
Orobanchaceae – Broom-rape Family			
Orobanche ludoviciana Nutt.	Gp	At	Very rare, cottonwood forests
Phrymaceae – Lopseed Family			
Phryma leptostachya L.	Hp	Ate	Common, bottomland forests

TABLE 5 — Annotated vascular flora of the bottomland forests of the Missouri River in North Dakota

Taxon	Life form	Geographical distribution	Habitat and abundance
Plantaginaceae – Plantain Family			
(I) *Plantago major* L.	Hr	Er	Rare, cottonwood forests
Rubiaceae – Madder Family			
Galium aparine L.	Th	Cst	Rare, bottomland forests
Galium boreale L.	Hpr	Cs	Common, mesic forests; scattered, cottonwood forests
Galium triforum Michx.	Hp	Cs	Abundant, mesic forests; relatively common, cottonwood forests
Caprifoliaceae – Honeysuckle Family			
(I) *Lonicera tatarica* L.	M	Er	Rare, mesic forests (escaped from cultivation)
Sambucus canadensis L.	M	Ate	Rare, bottomland forests
Symphoricarpos occidentalis Hook.	M	Ast	Very abundant, bottomland forests
Viburnum lentago L.	M	At	Relatively common, mesic forests
Cucurbitaceae – Gourd Family			
Echinocystis lobata (Michx.) T. & G.	Th	Ate	Scattered, bottomland forests
Compositae – Composite Family			
Achillea millefolium L. var. *lanulosa* (Nutt.) Piper.	Hsr	As	Relatively rare, bottomland forests
Ambrosia psilostachya DC.	Hpr	Atw	Relatively common, cottonwood forests
Ambrosia trifida L.	Th	At	Scattered, bottomland forests
Antennaria microphylla Greene.	Ch	Atw	Rare, young cottonwood forests
(I) *Arctium minus* Schk.	Hs	Er	Common, disturbed mesic forests
(I) *Artemisia absinthium* L.	Ch	Ep	Scattered, bottomland forests
Artemisia biennis Willd.	Hs	At	Rare, bottomland forests
Artemisia glauca Pall.	Hs	Atw	Relatively common, cottonwood forests
Artemisia ludoviciana Nutt.	Ch	At	Common, cottonwood forests; scattered elsewhere
Aster ericoides L.	Hsr	At	Relatively rare, cottonwood forests
Aster laevis L.	Hs	Ast	Common, bottomland forests
Aster simplex Willd.	Hsr	Ast	Common, bottomland forests
Bidens frondosa L.	Th	Ast	Relatively rare, mesic forests
Chrysopsis villosa (Pursh.) Nutt.	Hp	Atw	Very rare, cottonwood forests
(I) *Cirsium arvense* (L.) Scop.	Gr	Er	Common, bottomland forests
Cirsium undulatum (Nutt.) Spreng.	Hs	Atw	Scattered, cottonwood forests
(I) *Cirsium vulgare* (Savi) Tenore.	Hs	Ep	Very rare, bottomland forests
Conyza canadensis (L.) Cronq.	Th	Ast	Rare, bottomland forests
Conyza ramosissima Cronq.	Th	At	Rare, bottomland forests
Erigeron philadelphicus L.	Hsr	Ast	Common, bottomland forests
Erigeron strigosus Muhl.	Th	Ast	Scattered, cottonwood forests
Erigeron subtrinervis Rydb.	Hsr	Atw	Very rare, young cottonwood forests
Helianthus maximiliani Schrader.	Hp	Atw	Rare, cottonwood forests
Helianthus tuberosus L.	Gst	Ate	Common, bottomland forests
Hieracium canadense Michx.	Hp	Cs	Very scattered, bottomland forests
Lactuca canadensis L.	Hs	At	Scattered, bottomland forests
Lactuca pulchella (Pursh.) DC.	Hs	As	Common, bottomland forests
(I) *Lactuca serriola* L.	Th	Ep	Scattered, disturbed sites in bottomland forests
Ratibida columnifera (Nutt.) Woot & Standl.	Hs	Atw	Rare, cottonwood forests
Solidago altissima L.	Hsr	Ast	Common, bottomland forests
Solidago gigantea Ait.	Hsr	At	Common, bottomland forests
Solidago rigida L.	Hsr	At	Rare, cottonwood forests
(I) *Sonchus arvensis* L.	Hpr	Ep	Common, bottomland forests
(I) *Taraxacum officinale* Weber.	Hr	Er	Common, bottomland forests
(I) *Tragopogon dubius* Scob.	Hs	Ep	Common, bottomland forests
Vernonia fasciculata Michx.	Hp	At	Relatively rare, bottomland forests

Literature Cited

Borchert, J. R. 1950. The climate of the central North American grassland. Annals of the Association of American Geographers 40: 1–39.

Burgess, R. L. 1965. A checklist of the vascular flora of Tonto National Monument, Arizona. Journal of the Arizona Academy of Science 3(4): 213–223.

Burgess, R. L. and **D. T. Disrud.** 1969. Wetland vegetation of the Turtle Mountains, North Dakota. I. Analysis of the Flora. Prairie Naturalist 1(2): 19–30.

Burgess, R. L., W. C. Johnson, and **W. R. Keammerer.** 1973. Vegetation of the Missouri River floodplain in North Dakota. Research Project Technical Completion Report #WI-221-018-73. North Dakota Water Resources Research Institute, Fargo. 162 pp.

Carlson, C. G. 1969. Bedrock geologic map of North Dakota. North Dakota Geological Survey Miscellaneous Map No. 10.

Coupland, R. T. 1958. The effects of fluctuations in weather upon the grasslands of the Great Plains. Botanical Review 24: 273–317.

Fenneman, N. M. 1931. Physiography of western United States. McGraw-Hill, New York. 534 pp.
Fernald, M. L. 1950. Gray's manual of botany. 8th edition. American Book Co., New York. 1632 pp.
Gleason, H. A. and **A. Cronquist.** 1963. Manual of vascular plants of northeastern United States and adjacent Canada. D. Van Nostrand Co., Princeton, New Jersey. 810 pp.
Johnson, D. F. 1950. Plant succession on the Missouri River floodplain near Vermillion, South Dakota. M.A. thesis, University of South Dakota, Vermillion. 44 pp.
Kume, J. and **D. E. Hansen.** 1965. Geology and ground water resources of Burleigh County, North Dakota. Part I — Geology. North Dakota Geological Survey Bulletin 42. 111 pp.
MacDonald, E. S. 1937. The life forms of the flowering plants of Indiana. American Midland Naturalist 18: 687–773.
Nelson, P. W. 1964. The forests of the lower Sheyenne River Valley, North Dakota. M.Sc. thesis, North Dakota State University, Fargo. 148 pp.
Omodt, H. W., G. A. Johnsgard, D. D. Patterson, and **O. P. Olson.** 1968. The major soils of North Dakota. North Dakota Agricultural Experiment Station Bulletin 472. 60 pp.
Potter, L. D. and **D. L. Green.** 1964a. Ecology of ponderosa pine in western North Dakota. Ecology 45(1): 10–23.
Potter, L. D. and **D. L. Green.** 1964b. Ecology of a northeastern outlying stand of *Pinus flexilis*. Ecology 45(4): 866–868.
Raunkiaer, C. 1934. The life forms of plants and statistical plant geography, being collected papers of C. Raunkiaer. *Translated by* H. G. Carter, A. Fausboll, and A. G. Tansley. Clarendon Press, Oxford. 632 pp.
Rudd, V. E. 1951. Geographical affinities of the flora of North Dakota. American Midland Naturalist 45: 722–739.
Scoggan, J. J. 1957. Flora of Manitoba. National Museum of Canada Bulletin 140. 619 pp.
Stevens, O. A. 1920. The geographical distribution of North Dakota plants. American Journal of Botany 7: 231–242.
Stevens, O. A. 1945. Plant and animal populations of the Missouri River Valley in North Dakota. North Dakota Agricultural Experiment Station Bimonthly Bulletin 8(2): 20–25.
Stevens, O. A. 1963. Handbook of North Dakota plants (with revision appendix). North Dakota Institute for Regional Studies, Fargo. 324 pp.
Thornthwaite, C. W. 1948. An approach toward a rational classification of climate. Geographical Review 38(1): 55–94.
Wanek, W. J. 1967. The gallery forest vegetation of the Red River of the North. Ph.D. thesis, North Dakota State University, Fargo. 211 pp.
Wanek, W. J. and **R. L. Burgess.** 1965. Floristic composition of the sand prairies of southeastern North Dakota. Proceedings of the North Dakota Academy of Science 19: 26–40.
Wilson, R. E. 1970. Succession in stands of *Populus deltoides* along the Missouri River in southeastern South Dakota. American Midland Naturalist 83(2): 330–342.

Received 20 August 1974
Accepted 13 November 1974

Effects of Agricultural Burning on Nesting Waterfowl

E:IK K. FRITZELL*

Southern Illinois University, Carbondale, Illinois

* Present address: U.S. Bureau of Sport Fisheries and Wildlife, Northern Prairie Wildlife Research Center, Jamestown, North Dakota 58401

Fritzell, E. K. 1975. Effects of agricultural burning on nesting waterfowl. Canadian Field-Naturalist 89(1): 21–27.

Abstract. Agricultural burning in an intensively farmed region within Manitoba's pothole district is shown to affect the nesting activities of ground-nesting ducks. All species, except Blue-winged Teal (*Anas discors*), preferred unburned nest cover, although success was higher in burned areas, where predators may have exerted less influence. Attitudes of farmers, burning chronology, and nest destruction by fires are also reported.

Introduction

Attention has been given recently to the importance of adequate nest cover for the management of dabbling ducks, particularly with regard to man's use of the land (Martz 1967; Kirsch 1969; Dwyer 1970; Oetting and Cassel 1971; Jarvis and Harris 1971; Page and Cassel 1971). Agricultural practices in many instances are detrimental to the welfare of waterfowl. Just as drainage has reduced the number of wetlands available for waterfowl, farming operations such as grazing, mowing, and burning can also diminish the quantity and quality of upland cover available for ground-nesting ducks.

It is important to document the impact on upland nesting waterfowl of the frequent burning of fields, slough edges, fencerows, roadsides, and other waste areas. The objectives of this study, which was conducted during the spring and summer of 1970 and 1971, were to (1) determine the chronology and the amount of agricultural burning in the Minnedosa, Manitoba area, (2) investigate attitudes of farmers concerning burning as an agricultural practice, (3) evaluate areas burned in fall and spring as nest cover, and (4) compare nesting success in burned and unburned cover.

Study Area

The study area, located south of Minnedosa, Manitoba (part of a region where waterfowl studies have been conducted for over 20 years) consists of rolling terrain characterized by a mosaic of small wetlands, groves of aspen (*Populus* spp.) and oak (*Quercus* spp.), and cultivated fields. Cereal grain farming is the principal land use; cattle raising is of less importance. The upland vegetation consists primarily of smooth brome (*Bromus inermis*), slender wheatgrass (*Agropyron trachycaulum*), wolfberry (*Symphoricarpos occidentalis*), wild prairie rose (*Rosa arkansana*), and other grasses and forbs. Common wetland emergents are cattail (*Typha latifolia*), bulrush (*Scirpus* spp.) and whitetop (*Scolochloa festucacea*). Detailed descriptions of the area may be found in articles by Bird (1930) and Evans et al. (1952).

A 4-square-mile study area characteristic of the surrounding landscape was selected for intensive nest studies. On 1 May 1970, it included approximately 640 permanent, semi-permanent, and temporary potholes totalling over 300 acres of water. Narrow bands of upland vegetation surrounded these wetlands on which cultivation was impossible.

Only a few wetland areas were enclosed by upland cover totalling more than 1 acre. Mowing of slough edges and roadsides was insignificant throughout the duration of the study. Light grazing was observed only once. It occurred in early 1971 before the growing season began.

Methods

A 42-square-mile block was surveyed once each year in early spring to estimate the extent of fall burning done by farmers. It was subsequently surveyed at weekly intervals throughout the study to determine the amount of burning done in the spring. From the roads that criss-crossed the area, the acreage of each burn and the number of slough edges involved were described and estimated.

During the two-year study, farmers were interviewed informally to determine the justification and techniques they used for burning cropland, slough edges, and waste areas. Questionnaires relating to burning, agricultural techniques, and wildlife values were sent to 100 farmers during the fall of 1970.

Two censuses of breeding pairs and brood beat-outs (Blankenship et al. 1953) were conducted each year along a transect (⅛ × 8 miles) adjacent to roads throughout the study area. The data collected gave insight into breeding populations and served as a check on production data obtained from nest studies.

When burning occurred on the 4-square-mile area, all burned vegetation, except stubble, was searched for burned nests. Destroyed nests were extremely difficult to locate because most of the burning was done in the afternoon when laying hens were off their nests and the eggs were covered with vegetation. Consequently, the number of burned nests discovered represents a fraction of those actually present. Burned areas off the study area were searched occasionally.

Potential duck nesting cover was measured by the use of aerial photos and a Bryan Modified Acreage Grid, as well as by personal observations and estimates.

Searches for active nests were made daily between 0700 and 1300 hours through a portion of the study area. All potential cover, except cultivated fields and stubble, was traversed by individuals thrashing vegetation with sticks or dragging a rope strung with tin cans between them. A Chesapeake Bay Retriever usually accompanied one of the field workers and aided in flushing hens and finding hatched or destroyed nests. Areas burned during each nesting season or during the previous fall were searched more regularly than unburned areas to insure complete coverage.

Each nest was marked by attaching surveyor's flagging to vegetation or by placing stakes 10 to 20 feet from the site. All nests were examined to determine location, species, number of eggs, stage of incubation, cover type, cover condition, and distance to water. The calculated hatching date being used as a guide, nests were reexamined to determine their fate.

Small mammal populations, as an indicator of prey density, were surveyed in burned and unburned areas from May through July 1971. From 35 to 50 mousetraps were set 3 or 4 nights a week in comparable burned and unburned cover. The number and species of the catch were recorded.

Results and Discussion

Amount of Burning

The survey of 42 square miles showed that approximately 2,928 and 577 acres of cropland, roadsides, fencerows, slough edges, and miscellaneous areas were burned during the springs of 1970 and 1971 respectively. Approximately 275 slough edges were burned in 1970 compared with 230 in 1971. The reduction in the total amount of burning done in spring 1971 was due to extremely wet weather in late May and June. In addition, a late fall in 1970 permitted farmers to burn an estimated 3,225 acres, including 581 slough edges. Comparable data were not collected on the 42 square miles in the fall of 1969; however, a substantial increase in fall burning was observed during the two years. Data from the 4-square-mile study area indicated 220 acres and 31 slough edges were burned in the fall of 1969, while 550 acres and 97 slough edges were burned in the fall of 1970.

Three hundred acres of the 4-square-mile study area indicated 220 acres and 31 slough and 700 acres burned in the springs of 1970 and 1971 respectively, 50 acres were idle. Similar proportions of idle to cultivated land and burned to unburned land were present in the surrounding area.

Chronology of Burning

The timing of burning and of nest initiation for an early-nesting species, the Mallard (*Anas platyrhynchos*), and a late-nesting species, the Blue-winged Teal (*Anas discors*), in 1970 are compared in Figure 1. The extremely late spring in 1970 delayed breeding as well as burning activity. Comparable data for 1971 are presented in Figure 2.

During the study, most burning occurred after the peak of first nest initiation by Mallards and Pintails (*Anas acuta*), and before most Blue-winged Teal nesting activity. It appears that early-nesting ducks are more susceptible to destruction of nests by fire than later-nesting species. Mallards often prefer heavy, rank growth as nest sites, and Pintails often nest in stubble fields (Milonski 1958). Because

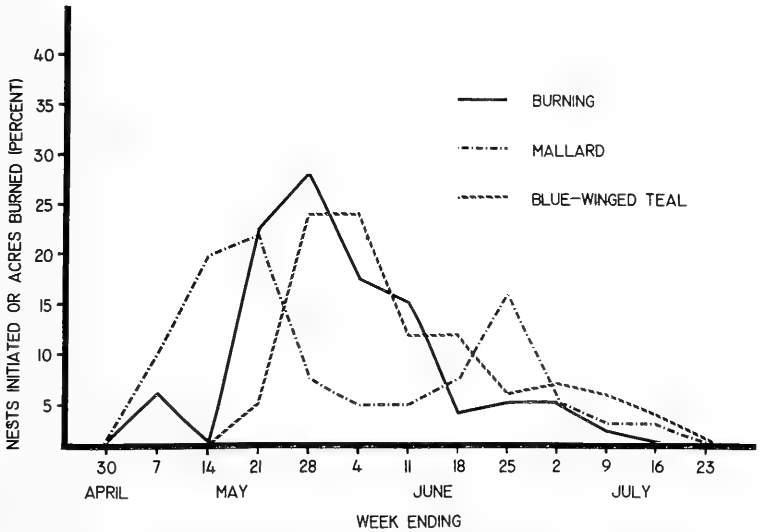


FIGURE 1. Chronology of burning and nest initiation of Mallards and Blue-winged Teal, 1970.

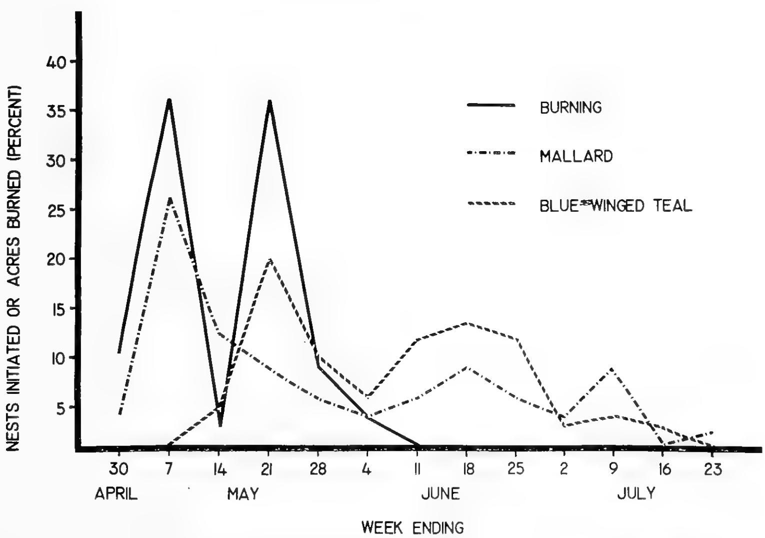


FIGURE 2. Chronology of burning and nest initiation of Mallards and Blue-winged Teal, 1971.

both of these types of cover are subject to heavy burning, Mallard and Pintail nests are highly susceptible to fire destruction. Blue-winged Teal are capable of, perhaps even prefer, nesting in short, often sparse vegetation (Glover 1956; Burgess et al. 1965). Such scant cover is not intentionally ignited as often as heavy cover. As a result, the nests of the late-nesting teal are less subject to fire destruction.

Attitudes of Farmers

Informal interviews and questionnaires indicate that the attitudes of the farmers in the Minnedosa area vary considerably concerning burning as an agricultural technique. Some farmers were strongly opposed to burning, while others ignited fields and idle lands whenever conditions were favorable. Most farmers, however, burned some stubble and associated upland cover during the year. Slough edges were burned whenever possible where cattle-raising created a demand for hay.

The farmers indicated that they use burning to control wild oats, willow (*Salix* spp.), aspen, and weeds; for clearing brush; for removing old bottom from a potential hay crop, stubble, and roadside vegetation; to dry out fields in spring; to increase hay production; and "because my father did it." The local agricultural extension agent appraised the prevalent burning practices as the farmers' "inability to cope" with modern farming methods.

Dixon (unpublished report on file at Manitoba Department of Mines, Resources and Environmental Management) found that the majority of 40 farmers questioned on a township southwest of Minnedosa believed sloughs should be burned. The reasons they had for burning were for control of willow, aspen, and weeds; generation of new growth of hay; and elimination of old bottom. In addition, most farmers believed fields should be burned in the fall. Spring burning was believed to be necessary if weather or time did not permit fall burning.

Breeding Populations

The most common ducks using the study area were Blue-winged Teal and Mallards with 36 and 10 pairs per square mile respectively. Data compiled by Stoudt (1967) showed a shift in species composition had occurred in the Minnedosa area from the period 1949–1955 to 1964–1967. Mallards were the most abundant breeders during the former period, while Blue-winged Teal were the most numerous during the latter. During this study, teal continued to flourish while Mallard populations remained low. One explanation (Stoudt 1967) is that the impact of increased hunting pressure and intensive farming operations has been greater on the Mallard than on the teal population. Sellers' (1973) results for the same area suggest that a lack of cover had affected breeding Mallard populations more than hunting pressure had. Moyle (1964, p. 16) showed that Mallards were more successful than Blue-winged Teal in areas where agricultural activity was light, and the reverse was true where agricultural activity was intense.

Comparative surveys of breeding populations on unburned and burned areas were not made. Noticeably fewer Mallard pairs, however, used a 1-square-mile portion of the study area containing twice as much burned acreage, and having limited mowing and grazing, than used sections with less burned area. Cover conditions and land usage may limit the species of duck capable of successfully utilizing a particular area for breeding activities.

Nest Destruction by Fire

Approximately 38.0 acres of potential nesting cover, excluding stubble, were burned in the spring of 1970. The figure was approximately 26.0 acres in 1971. Fifteen burned nests were found in 1970, but only four were located in 1971. A Green-winged Teal (*Anas crecca*) removed one badly charred egg from a burned nest and laid at least four additional eggs. The clutch of five charred and at least four fresh eggs was later flooded and deserted. Similar behavior of hens continuing to nest after fires has been reported by Leedy (1950), Sowls (1955, p. 96), and Moyle (1964).

Five additional burned nests were found off the study area in 1970. One of these was a Canvasback (*Aythya valisineria*) nest destroyed by a fire that swept over emergent vegetation. It was located 25 feet from dry land in 24 inches of water.

Nest Densities

Uncultivated nest cover contained 0.19 nest per acre on burned areas and 0.49 nest per acre on unburned areas (Table 1). These densities differ significantly ($P < 0.01$) when tested against an expected 50:50 ratio by *chi*-square methods. Other studies have shown limited duck nesting in burned cover (Glover 1956; Keith 1961, p. 51; Ward 1968). Page and Cassel (1971) found no nests in burned railroad rights-of-way.

TABLE 1 — Densities of duck nests in burned and unburned idle nesting cover, 1970–1971

Cover type	Acreage	Number of nests found	Nest/acre
Burned			
1970	50	4	0.08
1971	50	15	0.30
Total or average	100	19	0.19
Unburned			
1970	250	80	0.32
1971	250	166	0.66
Total or average	500	246	0.49

Sixteen of 19 nests found in burned areas were Blue-winged Teal nests. Teal did not show a significant preference for either burned or unburned cover. All other species combined, however, significantly preferred ($P < 0.05$) unburned nest cover. Martz (1967) found Blue-winged Teal nesting in mowed meadows on a North Dakota refuge significantly more than expected. Page and Cassel (1971) and Oetting and Cassel (1971) found unmowed areas were preferred by all upland nesting ducks. Kirsch (1969) found more nests of all species on ungrazed upland cover than on grazed areas.

Nest Success

The hatching success of 246 dabbling duck nests, which had not been abandoned because of my disturbance, was 15.0% in unburned cover. Five of 13 nests (38.5%) in burned cover were successful (Table 2).[1] Most duck nesting-land use studies have found success higher in idle undisturbed areas with adequate residual growth than in disturbed areas with sparse cover (Moyle 1964, p. 17; Martz 1967; Kirsch 1969; Page and Cassel 1971; Oetting and Cassel 1971). Glover (1956) found that Blue-winged Teal nests located in light to sparse cover were more successful than those in heavier cover. Burgess et al. (1965) found the nest success of Blue-winged Teal was 47% on grazed areas and 14% on ungrazed areas. Kirsch (1969), however, reported that the Burgess et al. study was conducted where ungrazed cover consisted of narrow strips or small clumps of vegetation, rendering duck nests especially vulnerable to predators. Moyle (1964, p. 16) found poor duck nesting success in areas where the only idle cover consisted of strips and clumps associated with intensive agriculture.

Idle land in the Minnedosa area is also limited to small strips and clumps. Eighty-three percent of all nests located in the study were found in narrow bands of cover, slough edges, fencerows, and roadsides. Sixty-nine percent were located less than 50 feet from water. Keith (1961, p. 62) and Page and Cassel (1971) found that nesting success was reduced, possibly because of increased predator activity, when nest-to-water distance was decreased. The present study further illustrates that predators are extremely effective where cover consists of narrow bands of vegetation.

The difference in hatching success between burned and unburned cover suggests a reduction of predator activity in the burned areas. Predators searching for food may find it less available in sparse, green new growth than in undisturbed areas with residual growth.

Trap success for all small mammals was approximately equal. It averaged 10.8% in burned cover and 12.6% in unburned cover. No meadow voles (*Microtus pennsylvanicus*) were caught during 1,474 trap-nights in burned cover. Fifty were taken during 961 trap-nights in unburned areas. The absence of voles was due primarily to the lack of residual vegetation necessary for surface runways. Cook (1959) and Schramm (1968) also found *Microtus* spp. populations severely decreased by burning of grassland vegetation.

[1] Excludes six nests deserted by laying hens.

TABLE 2 — Fates of 265 dabbling duck nests in burned and unburned idle nesting cover, 1970–1971.

	Number of nests	Deserted	Hatched	Destroyed			
				Predators	Flood	Fire	Farming operations
1970							
Unburned	80	9	11(15.5)[a]	45(63.4)	—	15(21.1)	—
Burned	4	1	2(66.7)	1(33.3)	—	—	—
1971							
Unburned	166	17	22(14.8)	118(79.2)	6(4.0)	3(2.0)	—
Burned	15	5	3(30.0)	5(50.0)	—	—	2(20.0)

[a] Figures in parentheses are percentages.

Meadow voles are a preferred food for some carnivorous mammals. Scott (1947) reported that red foxes (*Vulpes vulpes*) favored voles over deer mice (*Peromyscus maniculatus*). Errington (1967, p. 30) said that foxes "relished" voles. Most fox food-habits studies indicate a high consumption of voles. Red foxes, and perhaps other important nest predators in the Minnedosa area, such as raccoons (*Procyon lotor*) and striped skunks (*Mephitis mephitis*), may avoid burned areas when hunting. They may concentrate their activity on undisturbed areas that contain more voles and duck nests, and that perhaps afford more concealment. Keith (1961, p. 62) and Milonski (1958) found that heavy cover is traversed extensively by striped skunks, and suggest that concealment is an important influence in their movements.

Conclusion

Relatively thick cover with adequate residual vegetation is necessary for the successful nesting of most dabbling ducks. Idle land, described by Duebbert (1969), in the Cropland Adjustment Program demonstrates the effectiveness of predator-proof nesting cover. Such cover is essential for increased duck production in agricultural areas where the only available cover occurs in narrow strips easily and efficiently searched by predators.

Controlled burning is an efficient tool in wildlife habitat management. The aspen parklands of Canada are ecotonal in nature and have been subject to periodic burning for centuries. Natural events, including fire, controlled the fluctuations of the forest-prairie edge (Bird 1930). Indiscriminate annual burning, however, reduces the quantity and quality of suitable nesting cover for adequate duck production. The isolated islands of upland cover remaining around sloughs and other waste areas should be left undisturbed for several years where high quality nest cover is reduced by agricultural practices.

Acknowledgments

I acknowledge the assistance of H. A. Hochbaum and R. E. Jones of the Delta Waterfowl Research Station, the agency sponsoring this research. I thank J. N. Krull, Southern Illinois University, for encouragement and guidance; J. Stoudt, U.S. Fish and Wildlife Service for advice during fieldwork; and K. A. West for field assistance in 1971.

Literature Cited

Bird, R. H. 1930. Biotic communities of the aspen parkland of central Canada. Ecology 11(2): 356–443.

Blankenship, L. H., C. D. Evans, M. H. Hammond, and **A. S. Hawkins.** 1953. Techniques for brood production studies. Contribution for the Mississippi Flyway Council Technical Committee. Mimeograph. 14 pp.

Burgess, H. H., H. H. Prince, and **D. L. Trauger.** 1965. Blue-winged Teal nesting success as related to land use. Journal of Wildlife Management 29(1): 89–95.

Cook, S. F., Jr. 1959. The effects of a fire on a population of small rodents. Ecology 40(1): 102–108.

Duebbert, H. F. 1969. High nest density and hatching success of ducks on South Dakota CAP land. Transactions of the North American Wildlife and Natural Resource Conference 34: 218–228.

Dwyer, T. J. 1970. Waterfowl breeding habitat in agricultural and non-agricultural land in Manitoba. Journal of Wildlife Management 34(1): 130–136.

Errington, P. L. 1967. Of predation and life. Iowa State University Press, Ames. 277 pp.

Evans, C. D., A. S. Hawkins, and **W. H. Marshall.** 1952. Movements of waterfowl broods in Manitoba. United States Fish and Wildlife Service, Special Scientific Report, Wildlife, Number 16. 47 pp.

Glover, F. A. 1956. Nesting and production of the Blue-winged Teal (*Anas discors* Linnaeus) in northeast Iowa. Journal of Wildlife Management 20(1): 28–46.

Jarvis, R. L. and **S. W. Harris.** 1971. Land-use patterns and duck production at Malheur National Wildlife Refuge. Journal of Wildlife Management 35(4): 767–773.

Keith, L. B. 1961. A study of waterfowl ecology on small impoundments in southeastern Alberta. Wildlife Monograph 6. 88 pp.

Kirsch, L. M. 1969. Waterfowl production in relation to grazing. Journal of Wildlife Management 33(4): 821–828.

Leedy, D. L. 1950. Ducks continue to nest after brush fire at Castalia, Ohio. Auk 67(2): 234.

Martz, G. F. 1967. Effects of nesting cover removal on breeding puddle ducks. Journal of Wildlife Management 31(2): 236–247.

Milonski, M. 1958. The significance of farmland for waterfowl nesting and techniques for reducing losses due to agricultural practices. Transactions of the North American Wildlife Conference 23: 215–227.

Moyle, J. B. 1964. Ducks and land use in Minnesota. Minnesota Department of Conservation Technical Bulletin 8. 140 pp.

Oetting, R. B. and **J. F. Cassel.** 1971. Waterfowl nesting on interstate highway right-of-way in North Dakota. Dakota. Journal of Wildlife Management 35(4): 774–781.

Page, R. D. and **J. F. Cassel.** 1971. Waterfowl nesting on a railroad right-of-way in North Dakota. Journal of Wildlife Management 35(3): 544–550.

Scott, T. G. 1947. Comparative analysis of red fox feeding trends on two central Iowa areas. Iowa Agricultural Experiment Station Bulletin 353: 427–487.

Sellers, R. A. 1973. Mallard releases in understocked prairie pothole habitat. Journal of Wildlife Management 37(1): 10–22.

Schramm, P. 1968. Effects of fire on small mammal populations in a restored tall-grass prairie. *In* Proceedings of a Symposium on Prairie and Prairie Restoration. *Edited by* P. Schramm. Knox College, Galesburg, Illinois. pp. 39–41.

Sowls, L. K. 1955. Prairie ducks, a study of their behaviour, ecology and management. Stackpole Company, Harrisburg, Pennsylvania. 193 pp.

Stoudt, J. H. 1967. A preliminary report on the status of mallard populations in the pothole region of Manitoba, Saskatchewan and the Dakotas. A paper presented at Waterfowl Seminar, Delta Waterfowl Research Station, Delta, Manitoba, August 17–18, 1967. Mimeograph. 12 pp.

Ward, P. 1968. Fire in relation to waterfowl habitat of the Delta Marshes. Proceedings of the Tall Timbers Fire Ecology Conference, Tallahassee, Florida 8: 255–267.

Received 7 May 1974
Accepted 14 September 1974

Comments on the Distribution and Natural History of Some Mammals in Minnesota

LAWRENCE R. HEANEY and ELMER C. BIRNEY

Bell Museum of Natural History, University of Minnesota, Minneapolis, Minnesota, U.S.A. 55455

Heaney, L. R. and E. C. Birney. 1975. Comments on the distribution and natural history of some mammals in Minnesota. Canadian Field-Naturalist 89(1): 29–34.

Abstract. Data on the distribution and natural history of 18 species of Minnesota mammals are presented in an attempt to update information available in the last comprehensive account of the state's mammalian fauna, which was published more than 20 years ago. New information is given for four insectivores, three bats, one lagomorph, nine rodents, and one carnivore.

In the more than 20 years since the last comprehensive report on the mammals of Minnesota appeared (Gunderson and Beer 1953), much information on the distribution and natural history of mammals in the state has been gathered. Important papers include those by Beer (1953) on *Clethrionomys gapperi* and *Napaeozapus insignis*, Beer and MacLeod (1955) on *Reithrodontomys megalotis*, Birney (1974) on *Gulo gulo*, Bue and Stenlund (1953) on *Felis concolor*, Clough (1959) on *Napaeozapus insignis*, Davis and Ernst (1971) on *Zapus hudsonius*, Dickerman and Tester (1957) on *Onychomys leucogaster*, Erickson and Bue (1954) on *Odocoileus hemionus*, Ernst and Ernst (1972) on *Tamias striatus*, Gunderson (1955) on *Myocastor coypus* and (1965) on *Martes americana*, Handley (1954) on *Phenacomys intermedius* and *Microtus chrotorrhinus*, Hibbard (1970) on *Didelphis virginiana*, Hibbard and Beer (1960) on *Perognathus flavescens*, Mech (1973) on *Lynx canadensis*, Robins (1971) on *Spermophilus franklinii*, and Timm (1974) on *Microtus chrotrorhinus*.

The purposes of this paper are to bring together unpublished distributional records of small mammals within the state and to provide information on reproduction and natural history where it is appropriate. We hope that this information, together with citations to recent literature on Minnesota mammals, will serve students of the state's mammalian fauna as a supplement to Gunderson and Beer's (1953) *The Mammals of Minnesota* until such time as that work can be more thoroughly updated.

Specimens referred to, unless otherwise noted, are housed in the mammal collection of the James Ford Bell Museum of Natural History; catalogue numbers refer to this collection.

Species Accounts

Sorex arcticus. Three specimens (12743–12745) of the arctic shrew from Carver County (1 mi N, 2 mi W of Victoria) taken on 20 January (2) and 5 February 1973 (1) constitute the southernmost records for the species in the state. An additional specimen (11615) from a southwestern marginal locality (Dassel, Meeker County) was taken on 20 April 1969. Arctic shrews were second in abundance only to meadow voles (*Microtus pennsylvanicus*) in a grass-sedge meadow in Anoka County (Carlos Avery Game Management Area, 5½ mi N, 1 mi W of Lino Lakes) in the summer of 1973. Later that summer they were found to be abundant near the edges of a large cattail marsh further south, also in Anoka County (Blaine). These observations, together with the discovery of a population in Carver County, lead us to believe the species is fairly widely distributed and not uncommon in suitable habitat along the southern boundary of its range in Minnesota.

Microsorex hoyi. The pygmy shrew has been reported from eight counties in the state. Bailey (1929) reported 14 specimens from Elk River, Sherburne County; there is an additional specimen, collected in 1927 from Elk River, in the Museum of Natural History, University of Kansas. Cahn (1937) stated that several shrews of this species were taken at Ely, St. Louis County, but cited no preserved specimens. Quimby (1943) trapped one specimen in Itasca State Park, Clearwater County. Rom (1940, p. 30) reported three specimens from Kekekabic Lake, Lake County,

TABLE 1 — Data on selected specimens of *Microsorex hoyi* from Minnesota

MMNH Specimen number	Date	Total length	Tail	Weight, g	Sex	Reproductive information	Habitat
2926	13 July 1950	91	30	—	♀	6 embryos (3 L, 3 R), crown–rump = 8 mm	—
12749	28 Aug. 1972	99	29	4.7	♀	Nulliparous	—
21749	28 Aug. 1972	99	29	4.7	♀	Placental scars visible	—
7587	30 Oct. 1966	84	29	2.4	♀	Nulliparous	Dry cornfield, seeded 2 years before
7588	29 Dec. 1966	87	28	4.2	♀	—	Moist area (heavy moss) near drainage ditch
12750	31 Dec. 1966	89	30	5.6	?	—	Tamarack swamp

with the statement that "the average measurements in millimeters were 112–39–11–2.5 (total length, tail, hind foot, ear), which is a good indication that it was this species, rather than *Sorex cinereus*." Actually, these measurements are more like those of *Sorex* than of *Microsorex* (cf., Table 1). Additionally, no specimens were kept, no examination of the dentition was reported, and no *Sorex cinereus*, usually abundant in this area, were recorded. We doubt the specimens were identified correctly. Gunderson (1950) trapped one pygmy shrew on the Cedar Creek Natural History Area, Anoka County, and Gunderson and Beer (1953) noted additional specimens from Koochiching, Lake of the Woods, Pine, Dakota, and Steele Counties. The specimen from Steele County was not preserved; it, as with Rom's specimens, should be viewed with skepticism. We are unable to locate the specimen from Pine County, and we have uncovered no source for their Dakota County record. Additional specimens are now available from Anoka County (Cedar Creek Natural History Area, 2926), Beltrami County (13 mi N, 5 mi W of Fourtown, 7588), Clearwater County (8 mi N, 2½ mi W of Berner, 8908), Hubbard County (LaSalle Creek, Itasca State Park, 12746, 12747), Isanti County (5 mi S, 2 mi E of Isanti, 12748, 12749), and Wadena County (2 mi S, 4 mi W of Nimrod, 7587, 12750).

The two specimens from Hubbard County were live-trapped by P. A. Rutter on 19 and 20 September 1972. They lived in captivity until 20 October 1972 and 12 January 1973, respectively. Miscellaneous information on the natural history of *Microsorex hoyi* in Minnesota is summarized in Table 1.

Partial skulls of two pygmy shrews were removed from the stomachs of owls and given to the Museum by R. J. Oehlenschlager. One (12751) was in a Barred Owl (*Strix varia*) taken 8 October 1972 at 2½ mi N, 1 mi E of Oylen, Wadena County, and the other (12752) was in a Great Gray Owl (*Strix nebulosa*) killed at 1½ mi N of Oylen, Wadena County (date unknown). Long (1972) mentioned only a hawk (*Buteo*) and a garter snake (*Thamnophis*) as documented predators of *Microsorex hoyi*.

Scalopus aquaticus. Gunderson and Beer (1953) indicated that the eastern mole is common in the southern portions of Minnesota, but recorded having seen specimens from only four eastern counties (Hennepin, Houston, Ramsey, and Sherburne). Their "other records" (i.e., specimens not seen) were from Clearwater, Dakota, and Winona Counties. The Clearwater County record is based on Swanson's (1943, p. 44) observations of the "characteristic runs" of *Scalopus* in Itasca State Park. Despite frequent collecting in the area, no specimens have been procured. The star-nosed mole (*Condylura cristata*), a common species in that area, sometimes makes similar runs, and perhaps was responsible for the runs seen by Swanson. For these reasons it seems unlikely that *Scalopus* occurs there.

Three specimens in the Bell Museum constitute new documented distributional records for *S. aquaticus*; one of these, from 10 mi SW of Onamia, Mille Lacs County (11934), is the northernmost record for the species, previously documented from no farther north than Elk River, Sherburne County (Bailey 1929). Field notes accompanying specimens from the other localities (Nobles County, 1½ mi S, 5½ mi W of Kinbrae, 7930; and Renville County, 1½ mi N of Morton, 12324) indicate that *Scalopus* is common in suitable habitat in southwestern Minnesota.

Condylura cristata. Gunderson and Beer (1953, p. 36) recorded a possible occurrence of *Condylura* from Olmstead County; records in the Bell Museum indicate that the source was an amateur who found what he believed to be a star-nosed mole dead on the road near Rochester. Until specimens are secured from that part of the state, this record should be viewed skeptically. Gunderson and Beer's southernmost documented locality is in Chisago County. Eight specimens have been acquired since 1962 from the Carlos Avery Game Management Area, Anoka County (5½ mi N, 1 mi W of Lino Lakes). This locality is south of Elk River, previously the southernmost locality for which specimens were available (Bailey 1929). Most of the eight were found dead along dirt roads or captured in live-traps set for *Microtus* in a grass-sedge meadow. This species is probably more abundant in the southern part of its range than was believed by Gunderson and Beer (1953).

Lasionycteris noctivagans. Gunderson and Beer (1953) summarized the available county records of silver-haired bats in Minnesota. Timm (The mammals of Cook County, Minnesota. Uncompleted M.Sc. thesis, University of Minnesota) examined one from Cook County, and we have five from three other counties; these are Hennepin County, no specific locality, 3394, and Minneapolis, 4942, 12790; Wadena County, N of Oylen, 8041; Wright County, 5 mi N of Maple Lake, 5057. The specimen from Wadena County, taken on 24 June 1968, carried two embryos 20 mm in crown-rump length (1L, 1R) and the one from Wright County is a subadult. Specimens have been collected in Minnesota from 24 April through 29 August.

Lasiurus borealis. In addition to the localities plotted by Gunderson and Beer (1953), the red bat is known from Cook (Timm, manuscript), Itasca (Cahn 1921), and Benton (Swanson 1945) Counties. We now have additional specimens from Carver (Camden, 1567–1569), Clearwater (Preacher's Grove, Itasca State Park, 12756), Aitkin (no specific locality, 12754), Hubbard (Itasca State Park, 12755), Houston (4 mi S of Reno, 5120), and Lincoln (Lake Hendricks, 12757) Counties, indicating that the species is probably state-wide and fairly common. The earliest date on which a specimen was taken in the state is 29 May, and the latest date is 30 September. The female taken on 29 May carried two embryos; our collection includes four juveniles, all captured in July.

Lasiurus cinereus. Since the publication of *The Mammals of Minnesota* (Gunderson and Beer 1953), Beer (1954) reported a hoary bat from a cave in St. Paul, Ramsey County, and Timm (manuscript) obtained another in Cook County. We have specimens from five additional counties, all in northern Minnesota: Hubbard County, Itasca State Park, 12758; Koochiching County, ½ mi N, 4½ mi E of Pelland, 7629; Norman County, Ada, 4088; Polk County, 2 mi S of Fertile, 12759; St. Louis County, Lake Burntside, 7631. The specimen from Hubbard County, taken on 23 July 1963, is a large subadult, but the others are fully adult. All were taken between 30 May and 3 September.

Lepus americanus. The snowshoe hare, although abundant and widespread in the northern part of the state, has a spotty and poorly defined distribution in the southern and central parts. Bailey (1929, p. 163) reported them "fairly abundant until about the close of the nineteenth century" and rare afterwards in Sherburne County. Swanson (1945) doubted that they extended as far south as Minneapolis-St. Paul. Gunderson and Beer (1953) listed Mille Lacs County as the southernmost verified record in the state and Houston County as having a possible occurrence. De Vos (1964, p. 218) stated that *Lepus americanus* was "once present in all forested portions of Minnesota . . . [but] . . . now usually survives along the southern boundary of its range in swampy woodlots largely covered by conifers . . . ." Trapping on the northern fringe of Minneapolis-St. Paul has yielded 16 specimens from four localities. Two localities, East Bethel, Anoka County, 12761–12762, and 4 mi S, 4½ E of Isanti, Isanti County, 12763, 12773–12775, are similar to the conifer swamps described by de Vos, but the other (Blaine, Anoka County, 12760, 12764–12772) is a series of loosely connected willow-aspen marshes wholly lacking in coniferous vegetation.

Spermophilus richardsonii. Richardson's ground squirrel has been reported from Kittson, Lac Qui Parle, Lincoln, Norman, Polk, and Traverse Counties (Swanson 1945), all on the Dakota border of the state. Gunderson and Beer (1953) noted possible records from Lyon and Polk Counties. Specimens now are available from another border county (Rock County, 14 mi NW of Luverne, 8035, and 5 mi N, 2 mi E of Luverne, 12779), and from two more easterly localities: Jackson County, Round Lake Waterfowl Station, 12778, and Ottertail County, E of Fergus Falls, 6541.

Glaucomys volans. The distribution of the southern flying squirrel in Minnesota is uncertain. Swanson (1945) reported specimens from Aitkin, Anoka, Hennepin, Ramsey, Sherburne, Stearns, and Steele Counties. In addition, Gunderson and Beer (1953) claimed specimens from St. Louis and Washington Counties and listed Clearwater County as having an "authentic record," but they neglected to mention Swanson's (1945) record from Stearns County. We are unable to locate a source for the "authentic record" from Clearwater County and consider it questionable. Frequent collecting over many years in Itasca State Park, Clearwater County, has yielded many specimens of the northern flying squirrel, *Glaucomys sabrinus*, but none of *G. volans*. The record from St. Louis County is also questionable and once again we are unable to locate its source. It possibly was a subadult *G. sabrinus*, which is common there and easily could be confused with *G. volans*. The northernmost verifiable record of *Glaucomys volans* in Minnesota, therefore, is Howell's (1918) report of a specimen from Aitkin, Aitkin County. We have three specimens that further define the range of *G. volans* in Minnesota. These are from Crow Wing County, Upper Long Lake, 7877; Mille Lacs County, Wahkon (= Waukon) Bay, Mille Lacs Lake, 8164; and Renville County, 2 mi N, ½ mi E of Morton, 12830. It is possible that *G. volans* occurs farther north and west than these records indicate, but acceptable evidence for such an argument does not exist.

Onychomys leucogaster. Dickerman and Tester (1957) discussed the seven specimens of the northern grasshopper mouse previously known from Minnesota. Since that time, 11 additional specimens have been collected from the western portion of Minnesota: Clay County, Baker, 12780; Grant County, Hwy. 29, 1 mi E of Herman, 5492; Jackson County, ½ mi S of Alpha, 8982, 8983; Kandiyohi County, 2 mi W of Willmar, 6068; Lyon County, 6 mi N of Tracy, 8984; Murray County, 6 mi N, 2 mi E of Currie, 8107; Nobles County, 2 mi N, 1½ mi W of Wilmont, 7611, 8985, 8986; Stevens County, 1 mi S of Morris, 8106. Specimens from Jackson and Kandiyohi Counties provide the easternmost records for the species.

Available reproductive information follows. Testes lengths: 11 June, 22 mm; 9 August, 9 mm; 29 August, 8 × 3 mm; 31 August, 11 × 7 mm; 10 September, 6.5 mm; 10 September, 8 mm; 13 September, 7 mm; 16 September, 5 mm. Uterine activity: 22 August, 3 placental scars; 13 September, no embryos and no placental scars.

Clethrionomys gapperi. The red-backed vole, although common in the northern two-thirds of the state (see Powell 1972), is rarely encountered in the southern third, having been reported only from Nicollet County (Beer 1953). Bowles (1975) discussed the status and history of the several known populations of this species in Iowa. He commented on the degree and duration of isolation of these populations, previously thought to be about 80 miles SSE of the nearest populations in Minnesota. Specimens from intermediate localities are now available from Minnesota. A single specimen was taken 27 August 1967, 2 mi N, 4 mi W of Wanamingo, Goodhue County (8692). Two were taken ½ mi W of Owatonna, 1146 ft, Steele County, one each of 8 and 22 October 1972 (11988, 11989). These, the southernmost records for the state, are from the Kaplan Woods State Park, the only large (⅓ square mile), undisturbed deciduous forest in this part of the state. This finding seems to support Bowles' contention that red-backed voles were once more widespread along the southern portion of their range in Minnesota and Iowa, and that the Iowa populations probably have been isolated there for much less than the 8,000–3,000 years postulated by Blagen (1967). Red-backed voles probably will be found in the southeastern corner of the state, wherever large stands of deciduous forest remain undisturbed.

Microtus ochrogaster. The prairie vole is widespread and at times may be locally abundant in southern and west-central Minnesota, but populations are encountered only rarely and the distribution limits in the state have remained poorly known since Swanson (1945) summarized the records available to him. Allen (1936) commented on the status of the species in Houston County. Our collection contains additional specimens from Pipestone (4½ mi N, 8 mi W of Holland, 8060) and Wadena (5 mi SE of Nimrod, 7440, 7712–7728) Counties.

Swanson (1945) commented on a north–south cline in external dimensions in the species, giving 156–38–20 mm as mean dimensions for total length, tail length, and length of hind foot, respectively, for seven prairie voles from Fairport, Iowa, 147–36–19 as means of four specimens from Houston and Winona Counties, Minnesota, and 128–30–16 as means of 51 voles from Sherburne County. Our sample of 18 specimens from Wadena County has mean dimensions of 115.6–25.5–15.7; the largest individual was 127–27–16. The average weight for this sample is 16.2 g; the heaviest vole weighed 20.6 g. All appear to be in adult pelage. The only reproductively active female had 10 placental scars (5 L, 5 R).

Microtus pinetorum. Since Hatfield (1939) reported a specimen (skin only, 3267) of the pine vole taken on 21 March 1935 from Caledonia, Houston County, collecting efforts have produced only a single additional specimen (5564), taken on 1 September 1961 in an apple orchard in La Crescent, Houston County.

Synaptomys borealis. The northern bog lemming has been reported from only two localities in Minnesota. Wetzel and Gunderson (1949) reported a specimen from Williams, Lake of the Woods County (951), and another (2552) from Warroad, Roseau County. Subsequently, a third specimen (11687) was taken 10 mi S of Big Falls, in central Koochiching County, on 28 May 1971. This adult male represents an extension of the known range of this species in the central United States approximately 50 miles to the south.

Synaptomys cooperi. In addition to localities reported by Gunderson and Beer (1953), southern bog lemmings have been captured in Roseau (Swanson 1945) and Cook (Timm, manuscript) Counties. Additional records now are available from Hubbard (Itasca State Park, 5118), Itasca (2 mi S, 4 mi W of Bergville, 7605), Koochiching (10 mi S of Big Falls, 12781), Wadena (10 mi N of Nimrod, 8038), Counties, all in the northern half of the state. Pregnant females have been taken on 23 June (four embryos, 2 L, 2 R), 14 September (three embryos 4 mm in crown–rump length, 1 L, 2 R), and 25 September (three embryos, 4 mm in crown–rump length, 1 L, 2 R). Testes measured 7 mm on 4 July, 8 mm on 28 July, 4 mm on 19 August, and 6 mm on 14 September. Subadults have been taken on 12 June, 22 July, and 17 September.

Erethizon dorsatum. Swanson (1945) reported that the "southernmost recent record of the porcupine in Minnesota is from Mille Lacs County." Gunderson and Beer (1953) reported having seen specimens only from Carlton, Lake, and St. Louis Counties, all part of the northern coniferous forest. This apparently was a result of the decline of porcupines within the deciduous forest after 1890 and 1929, when specimens were taken in Elk River, Sherburne County (Bailey 1929, and University of Kansas collection). Records now available to us indicate that the porcupine again has become common in the deciduous forest south to Minneapolis. Specimens collected since 1953 are available from: Anoka County, 1 mi N of Fish Lake, 12787, and 2 mi SE of Fish Lake, 5696; Aitkin County, 24 mi N, 3 mi E of Aitkin, 11979, and 8 mi E of Hill City, 5502; Carlton County, 6.7 mi S of Cloquet, 4868; Clearwater County, NW side of Itasca State Park, 4969; Mille Lacs County, 2 mi NE of Page, 7993; Pine County, 1½ mi S, 4 mi E of Cloverdale, 12788.

Martes pennanti. As Gunderson and Beer (1953) noted, the fisher once was a common mammal throughout the wooded portions of the state, but by 1880 it probably persisted only in small populations in such places as St. Louis and Pennington Counties. In a recent discussion of the status of the fisher, de Vos (1964, p. 216) concluded that the species had "spread somewhat in northeastern Minnesota." Our records indicate that fishers probably persisted in the northern portions of the state, and, partly as a result of nearly complete protection by the state, are now abundant in Cook, Koochiching, Lake, and St. Louis Counties. They apparently are fairly common in Beltrami and Lake of the Woods Counties as well.

In addition to the 20 specimens from Cook County obtained by Timm (manuscript), 13 have become available since 1953 from the following localities: Beltrami County, 5 mi N, 11 mi W of Kelliher, 12389; Koochiching County, Pine Island, 4479, and Ray, 5643, 5668, 5669, 5676–5678; Lake County, (near) Ely, 5662, and 10 mi NW of Finland, 3986; St. Louis County, Lake Vermillion, 4376, 12789, and Hibbing, 5673.

Acknowledgments

We acknowledge the donation of valuable specimens by L. J. Anderson, P. A. Rutter, R. J. Oehlenschlager, and O. T. Kalin. R. M. Timm read the manuscript and assisted us throughout its preparation. Partial support of field work came from a research grant to Birney from the Graduate School, University of Minnesota.

Literature Cited

Allen, P. F. 1936. *Microtus ochrogaster* in Minnesota. Journal of Mammalogy 17: 291.

Bailey, B. 1929. Mammals of Sherburne County, Minnesota. Journal of Mammalogy 10: 153–164.

Beer, J. R. 1953. Two new locality records for mammals in Minnesota. Journal of Mammalogy 34: 384–385.

Beer, J. R. 1954. A record of a hoary bat from a cave. Journal of Mammalogy 35: 116.

Beer, J. R. and **C. F. MacLeod.** 1955. The harvest mouse in Dakota County. Flicker 27: 176.

Birney, E. C. 1974. Twentieth century records of wolverine in Minnesota. Loon 46: 78–81.

Blagen, W. S. 1967. Habitat ecology of a relict red-backed vole population in Iowa. Ph.D. thesis, Iowa State University, Ames, Iowa, 230 pp.

Bowles, J. B. 1975. Distribution and biogeography of mammals of Iowa. Texas Tech University, The Museum, Special Publications. (*In press.*)

Bue, G. T. and **M. H. Stenlund.** 1953. Recent records of the mountain lion, *Felis concolor,* in Minnesota. Journal of Mammalogy 34: 390–391.

Cahn, A. R. 1921. The mammals of Itasca County, Minnesota. Journal of Mammalogy 2: 68–74.

Cahn, A. R. 1937. The mammals of Quetico Provincial Park of Ontario. Journal of Mammalogy 18: 19–30.

Clough, G. C. 1959. Extension of range of the woodland jumping mouse. Journal of Mammalogy 40: 449.

Davis, W. H. and **C. H. Ernst.** 1971. The taxonomic status of *Zapus* in northwestern Minnesota. American Midland Naturalist 85: 265–267.

de Vos, A. 1964. Range changes of mammals in the Great Lakes region. American Midland Naturalist 71: 210–231.

Dickerman, R. W. and **J. Tester.** 1957. *Onychomys leucogaster* in Kittson County, Minnesota. Journal of Mammalogy 38: 269.

Erickson, A. B. and **G. T. Bue.** Additional mule deer records for Minnesota. Journal of Mammalogy 35: 457–458.

Ernst, C. H. and **E. M. Ernst.** 1972. The eastern chipmunk, *Tamias striatus,* in southwestern Minnesota, U.S.A. Canadian Field-Naturalist 86: 377.

Gunderson, H. L. 1950. A study of some small mammal populations at Cedar Creek Forest, Anoka County, Minnesota. Minnesota Museum of Natural History, Occasional Paper 4: vii+1–49.

Gunderson, H. L. 1955. Nutria, *Myocastor copyus,* in Minnesota. Journal of Mammalogy 36: 465.

Gunderson, H. L. 1965. Marten records for Minnesota. Journal of Mammalogy 46: 688.

Gunderson, H. L. and **J. R. Beer.** 1953. The mammals of Minnesota. Minnesota Museum of Natural History, Occasional Paper 6: xii+1–190.

Handley, C. O., Jr. 1954. *Phenacomys* in Minnesota. Journal of Mammalogy 35: 260.

Hatfield, D. M. 1939. Northern pine mouse in Minnesota. Journal of Mammalogy 20: 376.

Hibbard, E. A. 1970. Additional Minnesota opossum records. Loon 42: 77–78.

Hibbard, E. A. and **J. R. Beer.** 1960. The plains pocket mouse in Minnesota. Flicker 32: 89–94.

Howell, A. H. 1918. Revision of the American flying squirrels. North American Fauna 44: 1–64.

Long, C. A. 1972. Notes on habitat preference and reproduction in pigmy shrews, *Microsorex.* Canadian Field-Naturalist 86: 155–160.

Mech, L. D. 1973. Canadian lynx invasion of Minnesota. Biological Conservation 5(2): 151–152.

Powell, R. A. 1972. A comparison of populations of boreal red-backed vole (*Clethrionomys gapperi*) in tornado blowdown and standing forest. Canadian Field-Naturalist 86: 377–379.

Quimby, D. 1943. Notes on the long-tailed shrews in Minnesota. Journal of Mammalogy 24: 261–262.

Robins, J. D. 1971. Movement of Franklin's ground squirrel into northeastern Minnesota. Journal of the Minnesota Academy of Science 37: 30–31.

Rom, W. N. 1940. Small mammals of northeastern Lake County, Minnesota. Flicker 12: 29–32.

Swanson, G. A. 1943. Wildlife of Itasca Park — The mammals. Flicker 15: 41–49.

Swanson, G. A. 1945. A systematic catalog of the mammals of Minnesota. *In* The mammals of Minnesota. *Edited by* G. A. Swanson, T. Surber, and T. S. Roberts. Minnesota Department of Conservation, Technical Bulletin 2. pp. 52–102.

Timm, R. M. 1974. Rediscovery of the rock vole (*Microtus chrotorrhintus*) in Minnesota. Canadian Field-Naturalist 88: 82.

Wetzel, R. M. and **H. L. Gunderson.** 1949. The lemming vole, *Synaptomys borealis,* in northern Minnesota. Journal of Mammalogy 30: 437.

Received 19 June 1974
Accepted 7 November 1974

Behavior of a Young Bald Eagle at a Southern Ontario Nest

Florence M. Weekes

Box 11398, Postal Station "H", Ottawa, Ontario K2H 7V1.

Weekes, F. M. 1975. Behavior of a young Bald Eagle at a southern Ontario nest. Canadian Field-Naturalist 89: 35–40.

Abstract. A series of observations at a southern Ontario nest of the Bald Eagle (*Haliaeetus leucocephalus*) disclosed some points in the development of an eaglet and in its adjustment to life off the nest. The question is raised as to how well birds of prey can adapt to human interference and lack of wilderness conditions, particularly during the learning period.

In 1973, a sequence of observations of behavior was made at a nest in Essex County, Ontario, where a pair of Bald Eagles (*Haliaeetus leucocephalus*) raised one young. The nest was chosen for study after it became evident that it was possibly the only 1973 nest holding an eaglet in southern Ontario – an area where the Bald Eagle, once common, appeared in 1973 to be on the verge of extinction (Weekes 1974).

Methods

During April and May the nest was visited eight times (total observation time 25 hours). From 31 May to 22 June the nest was visited daily (total observation time 250 hours). Watches started as early as 4:20 a.m., and ended as late as 9:25 p.m., E.S.T., and lasted from 1 to 16 hours.

The nest tree was not climbed nor the nest measured. The nest was estimated to be about 7 feet across and was in the dying crown of a shagbark hickory. This was one of three hickories standing after the surrounding land had been cleared for agriculture. The tree was almost 1 mile north of Lake Erie and ¾ mile north of the road and main farm buildings. About ¾ mile north of the nest a creek up to 500 feet wide flowed in an east-west direction, with several marshes extending from it. The land around these waters was wooded, with the result that the open area north of the nest was bordered by an irregular line of trees, the closest being about 1800 feet away. Area crops included beans, corn, wheat, and market vegetables.

While the eaglet was on the nest many observations were made with a telescope (15×, 30×, 45×, 60×) set up in a barn 500 feet west of the tree. Other observations, and almost all those after the eaglet flew, were made on foot in the field, woods, marsh, and creek areas, usually with 7× or 12× binoculars. The barn was dilapidated and not in current use except for storage. Positioning of the telescope was limited by the uncertain condition of the floor, by the presence of much old equipment, and by the necessity for sighting through one of many narrow gaps in the walls. A position was found about the middle of the barn where the telescope was protected from all but the most driving rains, and from which a good view of the nest, but not the peripheral side areas, was possible.

Identification of the adults was not always possible because sexual dimorphism was slight and because they were absent from the nest increasingly. Age of the young was surmised by comparisons with other area nesting dates, by the landowner's observations of earliest nest occupancy, and by the author's observations. Incubation was expected to take 34–35 days (Herrick 1932), and nest life after hatching 10–13 weeks (Herrick 1933).

Observations

The farmer reported 26 February 1973 as the date when the eagles began staying at the nest. The eaglet was first seen by the author 18 April. During a 2½-hour period it stood once for a few seconds and staggered about 18 inches across the nest.

Sham Fighting and Feeding

On 5 May the eaglet made a sham attack on one of the parent birds. At 7:14 p.m., the eaglet was settled low when the adult began pecking at it, twice lifting the young's wing in its beak. The adult frequently shook small light feathers from its beak. The eaglet stood up and twice took a "fighting" stance, wings out and beak pecking at the adult. It settled back down. The adult picked up several sticks in succession, proferring them toward the eaglet. The eaglet pecked at two and then resettled. The whole process lasted about 7 min.

A few minutes earlier the adult helped the eaglet eat a long piece of intestine. The adult offered the eaglet one end of some thin dripping red (and probably slippery) entrail. The eaglet took the end in its mouth. The adult then grasped the entrail about 12 inches from the eaglet's mouth. While the eaglet gulped and swallowed, opening and closing its beak, the adult held the entrail taut, leaving always about 12 inches between them. The adult also opened and closed its beak as it regulated the flow from the prey to the eaglet. Finally, the adult moved its beak toward that of the young bird and let the final about 6 inches go. The eaglet finished swallowing it.

On 11 May an adult gave the eaglet one end of a piece of fresh intestine about 12 inches long. As soon as the eaglet took it the adult let go. The eaglet gulped and grabbed a few times, without losing the food, and swallowed it.

On 21 May the eaglet ate four to six small whole fish, swallowing them headfirst and whole. The last one was so large the eaglet had to open its beak wide and make swallowing motions for several seconds before the tail disappeared and it could close its beak. The eaglet then stood with its head bent well down for about 1 min. Its body jerked hard twice but nothing was cast. At no time did I see any casting by any of these eagles.

Fish were the main food seen at the nest, and were usually brought in from the north. One particular area of the nest, on the north side, seemed to serve as a pantry. Both storage and feeding generally took place there or from there. When the eaglet grew strong enough sometimes to carry its food around in its beak it still tended to return to the habitual place for prolonged feeding. Of 39 feedings recorded as to place, 27 were in this north area, 9 were on the south side, and 3 were in the center. Feedings at the south or center were generally of short duration, sometimes just a few seconds, while feedings on the north side lasted up to about 20 min.

As the dark plumage grew, the eaglet discarded many down feathers while preening. Usually it would just open its beak and the feather would blow away. When a feather stuck on the tongue or mandible the eaglet would open its beak wide, waggling its tongue and shaking its head vigorously, or vary this procedure with rapid biting motions. During one 20-min preening period on 9 June, the eaglet five times spent several seconds in fits of violent throat clearing in apparent efforts to dislodge feathers. The bird's *hawwr hawwr* sounds were clearly audible in the barn.

On 12 June a second session of sham fighting was seen. An adult returned to the nest with food. The eaglet flapped its wings and twisted its head down and around to present its beak to the parent's for feeding. The adult remained where it had landed on the nest edge and chittered quietly. The chick flapped about, banging the adult with its wings. The adult walked to nest center. The chick climbed to the nest rim, flapped its wings about six times and leaped up and landed with its talons spread on the adult's back. It jumped back to the nest rim and repeated the whole manoeuvre, eliciting no response from the adult. The chick then jumped down and fed itself. The adult watched for about 2 min and flew to a perch off the nest.

Disturbances

The only birds that harassed the eagles near the nest were gulls. A noisy flock of them often chased an adult coming to the nest. They would circle and call over one or both adults perched near the nest, diving to within about 7 feet of them. The eaglet would flatten itself on the nest. The harassed adult might squeal or squawk, but never chased the gulls. Only once was a gull seen to dive at a bird on the nest. On 12 June the eaglet was alone practicing flying when one gull dived a few times toward it, calling once. The eaglet showed no reaction. The only bird seen chased away was a Red-tailed Hawk (*Buteo jamaicensis*), which flew over 21 May when both adults were at the nest. The male gave chase. Crows rarely came near the nest, but occasionally harassed an adult flying over the woods.

At first any walking around by this observer provoked both adults into circling and calling, and would result in the eaglet's getting down out of sight. They seemed undisturbed when I was inside the barn or sitting quietly just outside it. They soon began to ignore my walking about near the barn during the day, but almost any movement at twilight when they seemed settled for the night would provoke calling and circling. By 8 June I was able, by careful approach, to walk to within 200 feet of the nest tree and sit in the open watching it for periods of up to 1½ hours without exciting the female. On this day the male flew away at first, but after about 3½ hours he returned and became very agitated. The male's reaction to my approach to any of his regular perch trees at the field/woods edge or in the marsh was sometimes as vocal and restive as was his reaction to my approach to the nest. Actions that seemed to disturb the eagles or change their behavior were avoided as much as possible.

Fledging

There were many convenient branches over and around the nest, but up to 14 June all the eaglet's practice flights were over or across the nest with landings back on the nest proper. Practice flying was only occasional. On 14 June the eaglet stood for one period of 4½ hours without lifting its wings, and during another period of almost 3 hours it flapped a total of seven times without becoming airborne. At the end of this second period, at 7:02 p.m., the eaglet suddenly started running across the nest. This was the first time it was seen to run. It picked up a small stick and shook it vigorously, displaying unusual energy. Then it took off in a vertical flight and landed on a branch almost overhanging the nest, about 3 feet above it. The female, perched nearby, seemed to pay no attention. The male was absent. The eaglet executed the off-nest perching three times. At 7:10 p.m. it was quiet on the nest again.

At 7:24 p.m., the male returned, dropped a small fish in the nest and perched near the female. Both were on perches they often used for the night. Twice when I started moving slowly near the barn the male began calling. At 7:56 p.m., I sat down and he settled on a branch about 6 feet above the nest. At 7:57 p.m., the eaglet squealed loudly and flew, once, up to its new perch and back down again. Neither adult showed reaction. The weather was clear and warm. Sunset was 8:05 p.m. They all seemed settled for the night. I did not move. At 8:10 p.m., the male flew away in a fast, direct, climbing flight to the west-northwest, a direction they had taken before for only a few short flights. At 8:12 p.m., the female followed him. Neither called. They flew out of sight. I walked around and then went about 100 feet directly toward the nest and back. The adults did not return. Night fell. At 9:25 p.m., the eaglet was still standing on the nest. With the exception of 3 June and 6 June, when evening checks were not made, one or both adults were observed at the nest at every sundown or near-sundown check from 31 May to 13 June, inclusive, and would be found on the same perches if I arrived early the next morning.

On 15 June at 4:20 a.m. (sunrise 4:45 a.m.) the eaglet was alone on the nest. At 5 a.m., it jumped once to its new perch and back. It was strong enough to complete the manoeuvre with wings spread but not flapping. It did no more practicing. It disappeared between 5:35 a.m. and 5:40 a.m., while I was walking around not more than 400 feet from the nest. I neither saw nor heard it leave and did not see or hear the adults, although I glanced from time to time around the horizon. I had earlier clocked the adults from nest to woods in as few as 20 s.

Post-fledging Observations

The eaglet did not return to the nest during this study. Shortly after 8 p.m., 15 June, one of the adults was at the nest eating a fish. The bird's head jerked from side to side about every 1 to 4 s, so violently that blood and bits of flesh were flung in all directions. The frequent head turnings of the eagles, which Herrick (1933) calls "that index of circumspection," were common at all times to the adults but not to the eaglet. No eagles roosted at the nest the night of 15 June.

There were no eagles around at dawn 16 June. At 6:25 a.m., several starlings and grackles entered the nest and began feeding. Such smaller birds had flown around and over the nest before, but had not landed on top.

When first found off the nest, 16 June, the immature was perched near the marsh with the adults nearby. Even though I called out it stood silent and still, not even twitching its head, as I stood within 60 feet of it. It was facing in my direction. After I had walked away the immature was noted to have turned about 180 degrees to be again facing in my direction, but while I watched and called out it again remained still and silent.

On 17 June, 2:30 p.m., one of the adults carried a large piece of fish from the nest to the woods where the young had been shortly before. Both adults roosted by the nest 17 June.

On 18 June one adult roosted at the nest. None of the birds was subsequently seen near the nest.

On 19 June the three eagles were seen briefly soaring over the woods. Otherwise the immature exhibited a pattern of low flights and a tendency to remain near cover of the trees. It frequently would fly into the foliage where its dull plumage gave it effective camouflage.

The morning of 20 June, the immature and an adult were perched in a tree on the south bank of the creek when someone came along in a boat. The birds flew away. In the afternoon of 20 June the three eagles were in a marsh north of the creek. At one point the immature stood on the ground with about 50 seagulls wheeling noisily about 100 feet over it. An adult was perched near. Neither bird seemed to react, but the immature flew when two dogs ran toward it. All three eagles were constantly harassed, both flying and perching, by Red-winged Blackbirds (*Agelaius phoeniceus*). The latter had been common around the eagle nest but had not interacted with them there. In this new area the adults still flew if approached, but I walked openly to within 60 feet of the immature. For about 4½ min it remained silent and still. Then it flew to join the adults.

One adult was seen on the north side of the creek early 21 June, but for the rest of 21 June and 22 June none of the birds was sighted there or in any of the usual areas to the south of the creek. There had been, and continued to be, a steady increase in the amount of human activity in the fields (mainly farming, some people out walking) and along the creek (fishing and boating).

Discussion

For purposes of this study it was assumed the egg was laid on or about 26 February 1973, and hatched 1 or 2 April. February 26, 1973, was the date of first noted occupancy of another Bald Eagle nest (unsuccessful) in southwestern Ontario. Development milestones of the Essex eaglet seem consistent with its having hatched 34–35 days from that approximate date. It would thus have flown at 10 weeks and 4 ± 1 days.

The eagles were active later in the day than had been anticipated. Herrick (1924a) arranged nest watches from 5 a.m. to 7 p.m., as he considered this the entire period of daily activity for Bald Eagles in his study area. His work was done at Ohio nests less than 1 degree south and less than 1 degree east of the Essex nest. Bird activities dictated by day length would be expected to be timed about the same in either locality.

When there are two or three eaglets in one nest, play or practice fighting would be expected among them (Herrick 1924d). For the single eaglet here recorded, sham fighting with the parent may have taken the place of some of this.

Herrick (1933) provides the only information that seems available on the problem young eagles might have in learning to feed on intestine. He reports a pair of Bald Eagles each twice offered their two young long pieces of intestine, but the eaglets (age unspecified) refused the food every time and the parents finally ate it themselves.

Gerrard (1973) reports that food-begging calls can be heard from young Bald Eagles when they are otherwise hidden among trees after leaving the nest. Although this observer never happened to hear the Essex eaglet calling after it left the nest, it is possible the adult seen carrying food to the woods on 17 June was taking it to the young.

Of the many other birds in the vicinity of southern Ontario Bald Eagle nests, crows, gulls, and hawks seem to be the main birds with which the eagles interact, and the interaction seems to be mainly chasing or harassing without contact. In June 1969, in Elgin County, I watched a tiercel Bald Eagle chase a Red-tailed Hawk from over a nest containing an eaglet. At a Middlesex County nest, in March 1971, before there were any signs of incubation, a male chased away a Red-tailed Hawk that was harassing the female in flight. Later, with the male absent, the female was harassed for a short time by a crow, again both in flight. Less beligerent behavior can be expected when nesting is not a factor.

It is probable that 14 June 1973 was the first night the Essex eaglet was left alone. The change in the adults' behavior followed so closely on the eaglet's being seen perched off the nest that it seemed as if the eaglet's behavior might have triggered their response. The eaglet might have just flown away on its own on 15 June, but it is possible one or both adults appeared briefly over the woods and that the eaglet flew to them. Herrick (1933) notes an eaglet making a mile on its first flight.

Behavior as generally reported (Herrick 1924b, c; Retfalvi 1965) indicates that before leaving the nest eaglets can be expected to make many practice flights to nearby perches, and that after leaving the nest they can be expected to make frequent return visits to perch or feed during a period of up to several weeks. The Essex eaglet's abrupt and complete nest-leaving might have been partly attributable to the constant presence of a human observer, and was probably influenced by the fact that the nest was in a very exposed position compared to the perches near the feeding grounds.

Where a nest tree is in a fairly open area there is an apparent regular tendency for Bald Eagles to move with their young to areas affording better cover, after the young can fly. This seems to have occurred in 1971, when an eaglet fledged from the Essex nest was reported by local observers to have "just disappeared" within a few days of flying. The same was true of a Bald Eagle fledged in Elgin County in 1969, where the nest was in an open area with thicker woods nearby. These nests, as in the cases of at least some others found in exposed positions, were built when the nest trees were still part of woodlots. At one southwestern Ontario nest which was situated in a well-wooded and seldom-visited area, two eaglets hatched in 1971 were still to be seen with the adults as late as September of that year. When the Ontario Department of Lands and Forests cleared woods for a camping area near a Bald Eagle nest in the District of Algoma, northern Ontario, in 1961, the eagles used the nest to raise a young, but moved back as soon as the eaglet could fly (L. G. Larose, report from the Royal Canadian Mounted Police to the Canadian Audubon Society).

The Essex eaglet off the nest exhibited a pattern that included stillness, silence, and some camouflage. Survival might be enhanced by these factors, but might be hindered by the young bird's lack of alertness or irritability. At another southwestern Ontario nest, in 1974, an eaglet perched about 5 feet above its nest while the author sat in full view about 100 feet away for 3¼ hours. The adults were absent. The bird only occasionally turned its head, and during periods of up to 1¾ hours the only movement noted was that of the nictitating membrane, which blinked about every 1 to 3 s. Full-grown eaglets, on and off the nest, have often been noted to turn to face this observer, but whether this is from wariness or curiosity is difficult to determine.

Human disturbance and lack of cover trees may be important factors in timing of complete nest-leaving and in some areas might mean a crucial shortening of the time needed for an eaglet, or any bird of prey, to learn survival techniques. Such factors should be kept in mind in assessing reasons for species disappearance or in attempting species preservation. Brown and Amadon (1968) note that the great majority of birds of prey die in their first year, and that larger ones are more likely to be shot.

Literature Cited

Brown, L. and **D. Amadon.** 1968. Eagles, hawks and owls of the world. Volume 1. Hamlyn Publishing Group, Middlesex. 414 pp.

Gerrard, J. M. 1973. The Bald Eagles in Canada's northern forests. Nature Canada 2(3): 10–13.

Herrick, F. H. 1924a. An eagle observatory. Auk 41(1): 89–105.

Herrick, F. H. 1924b. Nests and nesting habits of the American Eagle. Auk 41(2): 213–231.

Herrick, F. H. 1924c. The daily life of the American Eagle: late phase. Auk 41(3): 389–422.

Herrick, F. H. 1924d. The daily life of the American Eagle: late phase (concluded). Auk 41(4): 517–541.

Herrick, F. H. 1932. Daily life of the American Eagle: early phase. Auk 49(3): 307–323.

Herrick, F. H. 1933. Daily life of the American Eagle: early phase (concluded). Auk 50(1): 35–53.

Retfalvi, L. 1965. Breeding behaviour and feeding habits of the Bald Eagle (*Haliaeetus leucocephalus*) on San Juan Island, Washington. M.Sc. thesis, University of British Columbia, Vancouver, B. C. 180 pp.

Weekes, F. M. 1974. A survey of Bald Eagle nesting attempts in southern Ontario, 1969–1973. Canadian Field-Naturalist 88(4): 415–419.

Received 24 May 1974
Accepted 19 November 1974

Comparative Concentrations of Twelve Elements in Substrates and Leaves of *Scirpus validus* and Other Aquatic Plant Species in a Sewage Lagoon and in Unpolluted Habitats

ERNEST SMALL[1] and JOHN D. GAYNOR[2]

[1] Biosystematics Research Institute, Agriculture Canada, Ottawa, Ontario
[2] Soil Research Institute, Agriculture Canada, Ottawa, Ontario
Current address: Research Station, Agriculture Canada, Harrow, Ontario

Small, E. and J. D. Gaynor. 1975. Comparative concentration of twelve elements in substrates and leaves of *Scirpus validus* and other aquatic plant species in a sewage lagoon and in unpolluted habitats. Canadian Field-Naturalist 89: 41–45.

Abstract. Concentrations of 12 elements were examined in vegetation and associated soils and water of 12 rooted aquatic plant species growing in the lagoon of a sewage treatment plant, and elsewhere in unpolluted habitats. Near the point of discharge of effluent into the lagoon, the substrate accumulated sludge, with very high concentrations of chlorine, zinc, and copper, and also notably high concentrations of phosphorus, iron, and calcium. The only rooted aquatic plant species successfully colonizing this area was *Scirpus validus* (the common bulrush), which accumulated significantly higher concentrations, in the leaves, of phosphorus, iron, chlorine, nitrogen, sodium, and magnesium, compared with the same species in non-sludge areas of the lagoon, and in unpolluted habitats. Eleven additional aquatic plant species were found in the lagoon, rooted in sandy sediment adjacent to the sludge area. These species appeared excluded from the sludge area. Concentrations of the 12 elements examined in substrates and leaves of these species growing just outside the sludge area did not differ notably in comparison with concentrations in unpolluted habitats.

Introduction

Effluent from sewage treatment plants is often channelled into lagoons, where "polishing" occurs through the action of sunlight, waves, oxygen, and bacteria, resulting in less harmful ultimate discharge into a river system. The effects of such discharge on natural aquatic vegetation in the immediate path of the effluent have been little studied from the point of view of element uptake (see review of subject area by Antonovics et al. (1971)). This paper reports a brief investigation of element concentration in plants and substrates of a sewage lagoon, in comparison with unpolluted sites.

Site Description

The Watts Creek sewage treatment plant of Ottawa directs its effluent, via Watts Creek, into Shirleys Bay of the Ottawa River, where berms extend 1 km out from the mainland to form a large lagoon, less than a metre deep in late summer, which is continuous with the river. A simplified diagram of the sewage lagoon is presented in Figure 1. The sewage plant was constructed in 1961, with a design capacity of 1.5 million gallons per day, and was enlarged in 1972 to a total capacity of 8 million gallons per day. The plant provides primary and secondary treatment to the sewage prior to discharge, removing perhaps 90% of solid material, and presently treats effluent at a rate of about 300 lb chlorine per day. The conductivity of the water at the discharge point of Watts Creek into the lagoon in August of 1973 was about 200 μMHO/cm, and this gradually tapered off to about 50 μMHO/cm 1 km toward the center of the river. About 20 m from the discharge point of Watts Creek into the sewage lagoon, a large growth of the very common bulrush *Scirpus validus* Vahl. begins, and extends almost continuously for about 500 m away from the discharge area

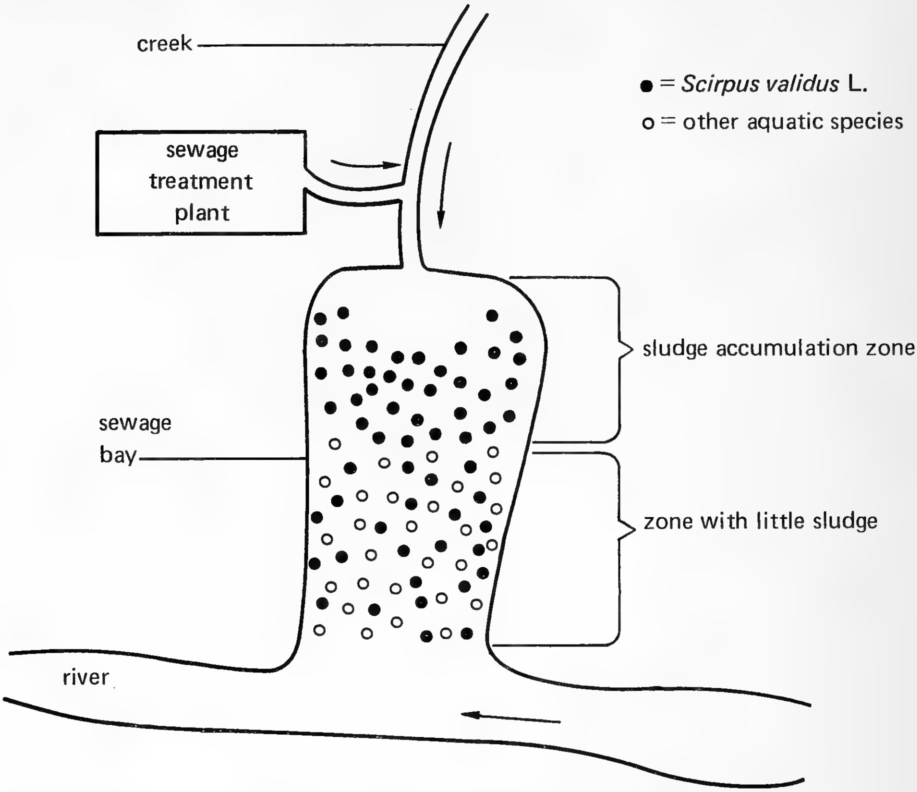


FIGURE 1. Highly simplified diagram illustrating basic topographical relationships discussed in text.

toward the river, with scattered patches of this species occurring for a further kilometre towards the center of the river. For a distance of about 75 m from the discharge point of Watts Creek, *Scirpus validus* is essentially the only rooted aquatic plant found. (Floating duckweeds, *Lemna minor* L. and *Spirodela polyrhiza* (L) Schleiden, also grow profusely in this area, as do microscopic algae.) The substrate of this region is an oozy sewage deposit, hereafter termed "sludge." At the limits of this zone, the substrate changes very noticeably to a sandy sediment, and several other rooted higher aquatic plant species are found in addition to *S. validus*. These include the emergent aquatic species *Typha latifolia* L., *Sparganium eurycarpum* Engelm., *Pontederia cordata* L., *Sagittaria rigida* Pursh, and *Sagittaria latifolia* Willd., the floating-leaved *Nymphaea odorata* Ait., and the submersed species *Ceratophyllum demersum* L., *Anacharis canadensis* (Michx.) Rich. *Heteranthera dubia* (Jacq.) Macm., *Potamogeton perfoliatus* L., and *Vallisneria americana* Michx.

Methods

Samples of sediments and leaves were collected August 20–24, 1973. Sampled plants of *Scirpus validus* were consistently chosen growing in water less than a metre in depth, and extending at least a metre out of the water. The top 50 cm of leaves, well out of the water, were collected. Massed collections of about 100 leaves were made at 32 sites, and at each site a sample of soil representing the top 15 cm of substrate, was collected. Thirteen sites in the heavily-polluted sludge zone, where only *Scirpus validus* is found, were sampled. An additional 19 sites of growth of *S. validus*, representing less-polluted areas of the lagoon, the Ottawa River, and other sites in the Ottawa district, were sampled. Single massed samples of soil and leaves from each of the other 11 rooted aquatics listed in the previous paragraph, from the areas bordering the sludge zone, and from a control unpolluted area outside the lagoon, were also collected. All samples were air-dried at 35°C prior to analysis. Two litres of water were collected from the most polluted area occupied by *S. validus*, and from an unpolluted site occupied by this species about 2 km away toward the center of the river. The water was filtered through a 0.45-micron membrane filter on collection.

Leaf tissue analyses were conducted as follows. Nitrogen was determined by the Kjeldahl method as described by Horowitz (1965); Cl as described by Ward and Johnston (1962); P by the molybdo-vanadate method (Parks and Dunn 1963); Mg by atomic absorption (Hackman 1967); and Ca, K, Fe, Ni, Zn, Na, Cu, and Mn also by atomic absorption (Macbride 1967; Jones 1969).

For soil samples, phosphorus was extracted with $NaHCO_3$ and determined colorimetrically by the method of Watanabe and Olsen (1965). Ammonium and nitrate nitrogen were extracted by shaking ½ hour with 2 N NaCl, and analyzed with an autoanalyzer (Keay and Menage 1970). A water-saturated soil paste was equilibrated 1 hour, filtered, and chloride determined by titration with $Hg(NO_3)_2$ (Teloh 1956). Exchangeable metals were extracted ½ hour with one part soil to two parts 0.05 M ethylenediaminetetraacetic acid (EDTA) in 0.01 M $CaCl_2$ and 0.1 M triethanolamine (TEA), at pH 7.3. Analysis was by atomic absorption.

Water samples were analyzed for trace metals by atomic absorption. Ammonium and nitrate nitrogen and phosphorus were analyzed by autoanalyzer (Keay and Menage 1970; Sowden 1972).

Observations

Concentrations of the elements in *Scirpus validus* in the sewage lagoon proved to depend strongly on whether the plants were growing in the sludge deposit area or elsewhere. Just outside the sludge zone, element concentrations in soils and plants of *S. validus* are fairly comparable to levels completely outside the lagoon. Accordingly samples taken from the sludge area were treated as a group, and compared with all other collected samples. Element concentrations of the additional 11 aquatic species examined just outside the sludge-area also proved to be roughly comparable to concentrations in the same species growing outside the sewage lagoon, and these results are not reported.

Means and standard errors of the means for element concentrations, and the results of tests for each element in soils and in plants between the sludge group and the other samples, are presented in Table 1. Phosphorus, Fe, and Cl were present in significantly higher concentrations in both soil and plant samples of the sludge area compared to other areas. Calcium, Zn, and Cu were present in significantly higher concentrations in the sludge soil samples, and N, Na, and Mg were present in significantly higher concentrations in the sludge-zone plant samples. Correlation coefficients between element levels in soils and plants, for all 32 sites examined, are also given in Table 1, simply as an indication of trends. The levels of chloride in soils and plants were highly correlated ($r = 0.76$).

Dissolved element levels for several elements in the water over the sludge area and in the adjacent river are given in Table 2. Levels of dissolved P, N, Mg, and K are much higher in the sewage lagoon.

Discussion

The sewage lagoon examined proved to be distinctly structured. Near the point of discharge into the lagoon, the substrate had accumulated a great deal of sludge. The only rooted aquatic plant successfully colonizing this area was the bulrush *Scirpus validus*. The notably high concentrations of Cl, Zn, and Cu in the sludge zone may be responsible for the exclusion of other rooted aquatics here (perhaps by altering the competitive relationships of the other plant species in comparison with *S. validus*). Concentrations of six of the 12 elements examined were significantly higher in the plants of *S. validus* of this region, compared to concentrations in more peripheral areas of the sewage lagoon and in unpolluted sites, indicating altered ion availability in the sludge

TABLE 1 — Mean content and standard errors (S.E.) of 12 elements in leaves of *Scirpus validus* and corresponding substrates in sludge of sewage lagoon, and in other substrates. r = correlation coefficients between plants and soils for contents of elements. For s'udge samples, n = 13; for others, n = 19. * = significantly higher, $P = 0.05$; ** = $P = 0.01$; *** = $P = 0.001$.

Element	Plants (ppm dry matter)				Substrates (ppm air-dry soil)				
	Sewage sludge		Other sediments		Sewage sludge		O her sediments		
	mean	S.E.	mean	S.E.	mean	S.E.	mean	S.E.	r
P	3190 ***	70	2440	110	81.7**	21.1	27.0	3.2	0.38*
Fe	505.5*	100.4	241.6	19.1	457.4**	41.6	259.6	41.6	0.03
Cl	16200 ***	700	11600	400	214.4***	46.5	26.3	3.1	0.76***
$N(NH_3)$					39.4	12.8	19.4	2.5	—
$N(NO_3)$					1.39	0.39	1.35	0.65	—
N(Total)	33200 ***	1000	27000	1300	—	—	—	—	—
Na	2640 ***	160	1100	130	—	—	—	—	—
Mg	1780 *	320	1470	80	21.2	1.9	16.6	3.1	0.09
Ca	5190	120	5940	360	28.62**	2.14	19.02	1.81	0.00
Zn	17.8	1.5	16.9	1.6	50.9*	16.5	15.6	2.9	0.42*
Cu	7.25	0.57	7.36	0.70	12.32**	2.28	2.90	0.78	0.01
Mn	207.8	15.1	360.1	87.8	25.6	5.3	60.7*	13.2	0.48**
K	16600	500	17700	600	57.3	7.8	50.4	3.3	0.40*
Ni	—[1]	—	—[1]	—	1.43	0.15	1.36	0.26	0.42**

[1] Frequently beneath reliable detection limit of 5 ppm.

TABLE 2 — Levels of dissolved elements in water over sludge area, and in adjacent river

Element	Water over sludge (ppm)	River water (ppm)
P	0.750	0.003
Fe	< 0.1	< 0.1
NH_4—N	1.8	< 0.1
NO_3—N	0.7	0.1
Na	25.3	2.1
Mg	0.88	0.25
Zn	< 0.1	< 0.1
Cu	< 0.1	< 0.1
Mn	< 0.1	< 0.1
K	4.78	0.69
Ni	< 0.1	< 0.1

zone. Eleven additional rooted aquatic species grew in coarse sediment just outside the sludge-area, and appeared unable to penetrate very far into the sludge zone. As with the plants of *S. validus* growing in the sandy sediment bordering the sludge, element concentrations were not very different from those found in the same species well outside the sewage lagoon.

Determination of the exact causes of why only *Scirpus validus* was present in the area of high sludge deposition is beyond the scope of the present limited study. This would require evaluation of the response to various levels of the particular combination of elements found in the sewage lagoon, coupled with competition experiments employing the various species present. The concentrations of elements found in *Scirpus validus* growing in the high sludge deposition area are not particularly high judged by concentrations which have been observed in other plants (Antonovics et al. 1971), and element concentration in particular plant species cannot be used to reflect accurately environmental toxicity without previously establishing the relationship between element uptake and growth. The present study has served simply to suggest that whereas substrate conditions in areas of high deposition of sewage sludge appear to restrict drastically the number of aquatic plant species present, just beyond the areas of high sewage sludge accumulation many rooted aquatics appear able to grow successfully, and to grow without unusually high accumulation of elements present in the most contaminated adjacent sewage areas.

Acknowledgments

The technical assistance of M. McGrath and C. O'Meara in the analysis of the soil and water samples is gratefully appreciated. Leaf tissue analyses were conducted by the Technological Services Unit of the Department of Agriculture. We thank Drs. A. J. Maclean, M. Webber, and I. L. Bayly for criticism of the manuscript.

Literature Cited

Antonovics, J., A. D. Bradshaw, and **R. G. Turner.** 1971. Heavy metal tolerance in plants. Advances in Ecological Research 7: 1–85.

Jones, B. J. 1969. Elemental analyses of plant leaf tissue by several laboratories. Journal of the Association of Official Analytical Chemists 52: 900–903.

Hackman, M. 1967. Minerals in feeds by atomic absorption spectrophotometry. Journal of the Association of Official Analytical Chemists 50: 45–50.

Horowitz, W. (Editor). 1965. Official methods of analysis of the association of official argicultural chemists. 10th edition. Association of Official Agricultural Chemists, Washington, D.C. 957 pp.

Keay, J. and **P. M. A. Menage.** 1970. Automated determination of ammonium and nitrate in soil extracts by distiliation. Analyst 95: 379–382.

Macbride, C. H. 1967. Determination of secondary and minor plant nutrients in fertilizers by atomic absorption spectrophotometry. 3rd collaborative study. Journal of the Association of Official Analytical Chemists 50: 401–407.

Parks, P. F. and **D. E. Dunn.** 1963. Evaluation of the molybdovanadate photometric determination of phosphorus in mixed feeds and mineral supplements. Journal of the Association of Official Agricultural Chemists 45: 836–838.

Sowden, F. J. 1972. Effects of silicon on automated methods for the determination of phosphate in water. Canadian Journal of Soil Science 52: 237–243.

Teloh, H. A. 1956. Determination of serum chloride. American Journal of Clinical Pathology 26: 535–542.

Ward, G. M. and **F. B. Johnston.** 1962. Chemical methods of plant analysis. (Revised edition). Canada Department of Agriculture Publication 1064. 59 pp.

Watanabe, F. S. and **S. R. Olsen.** 1965. Test of an ascorbic acid method for determining phosphorus in water and $NaHCO_3$ extracts from soil. Soil Science Society Proceedings 29: 677–678.

Received 9 July 1974
Accepted 26 September 1974

Preliminary Study of Seasonal Moose Movements in Laurentides Provincial Park, Quebec

YVON E. ROUSSEL,[1] EMILE AUDY,[2] and FRANÇOIS POTVIN[2]

[1] Wildlife Management Service, Department of Tourism, Fish and Game, Quebec City, Quebec
[2] Biological Research Service, Department of Tourism, Fish and Game, Quebec City, Quebec

Roussel, Y. E., E. Audy, and F. Potvin. 1975. Preliminary study of seasonal moose movements in Laurentides Provincial Park, Quebec. Canadian Field-Naturalist 88(1): 47–52.

Abstract. This paper reports preliminary results on the seasonal movements of 179 tagged moose in Laurentides Provincial Park. The linear distance between locations was calculated according to seasons, and sex and age of the animals. Movements of yearlings and 2-year-old males are greater than those of adult males. From one summer to the next, adult males do not wander more than adult females; however, from summer to fall, adult males move more than adult females. From summer range to winter range, movements of adult males are not statistically different to those of adult females. Studies suggest that the moose in the study area are a migratory population.

To achieve an effective management of moose populations, one must have a knowledge of the movement patterns of the species. This would then provide a basis for controlling logging operations and hunting. The principal objective of the present study, which was conducted within Laurentides Provincial Park (Figure 1), was to seek some consistency in the wanderings of moose according to seasons, and sex and age of the animals. Previous moose-movement studies had been initiated by DesMeules and Brassard (1964) in the same study area in 1962.

Study Area

The 9,573-square-kilometer (3,696-square-mile) Laurentides Provincial Park, situated 50 km (30 miles) north of Quebec City, lies between latitudes 47°30′ and 48°20′ N. Longitudinal boundaries are 71°00′ and 72° 15′ W (Figure 1). A controlled moose hunt has been held each year within the study area since 1962. The annual harvest of moose is approximately 125. Furthermore, there are some 50 moose road-killed yearly.

Brassard et al. (1974) class the forest of Laurentides Provincial Park in the "Forest zone 4." This zone of boreal forest is characterized by the occurrence of balsam fir (*Abies balsamea*), black spruce (*Picea mariana*), white spruce (*Picea glauca*), and paper birch (*Betula papyrifera*). The rough topography and shallow soils of this zone lower its productivity. Snow precipitation ranges from 300 to 500 cm (120 to 200 inches) per year; scattered observations indicate that the snow accumulation on the ground varies from 60 to 150 cm (25 to 60 inches). The mean period without snowfall extends from April 20 to October 31 (Wilson 1971). Moose density in Forest zone 4 is quite low: 1.5 moose per 10 square kilometres (3.8 moose per 10 square miles). In the park area, however, the moose density reaches 3.5 moose per 10 square kilometers (9.5 moose per 10 square miles) (Bouchard and Moisan 1974).

Large parts of the study area were logged over by extensive clear-cutting operations. In addition, past budworm epidemics have created an irregular forest canopy resulting in an even distribution of small patches of cover, adjacent to openings of younger forest.

Material and Methods

Tagging

As described by Roussel and Pichette (1974), a helicopter, a snowmobile, and a boat were used to restrain and mark 157 moose. Furthermore, 22 animals were tagged during April 1973 using M-99 (Etorphine). The temporal distribution of tagged moose

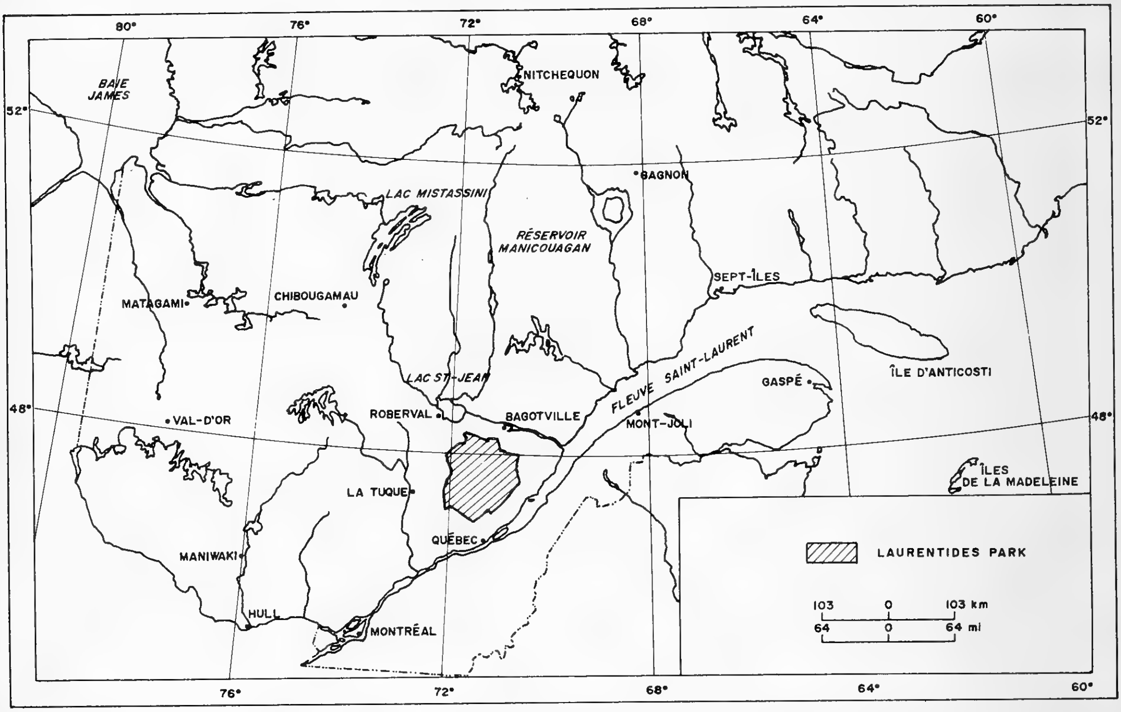


FIGURE 1. Location of the Laurentides Provincial Park, Quebec

according to age-class and sex is illustrated in Table 1. A numbered metal or plastic tag was affixed to one or both ear pinnae of all animals. As well, 164 of the 179 tagged animals were fitted with a numbered collar of the type described by Roussel and Pichette (1974).

Observations

Observations were reported by project personnel, park staff, and visitors. As with every movement study using tags, some limitations are present, e.g., summer observations were mostly made during the tagging operations near aquatic feeding sites; fall observations were principally done by hunters and, during the winter, systematic searches of the study area were done using a helicopter. A certain bias in the observation procedure is evident but this bias cannot be accounted for. All the observations were mapped on 1:50,000 topographic charts. The linear distances between

TABLE 1 — Number, sex, and age groups of moose tagged from 1969 to 1973 in the Laurentides Provincial Park, Quebec

Year	Adults		Calves		Total
	Male	Female	Male	Female	
1969	6 (2)*	17 (1)	1	0	19
1970	17 (2)	18 (1)	4	6	45
1971	7 (2)	10 (0)	7	4	28
1972	13 (2)	12 (2)	1	4	30
1973	12 (2)	21 (1)	12	12	57
Total	55 (10)	73 (5)	25	26	179

* The number in parenthesis refers to the numbers of yearlings included in the number of adults.

observations were computed to the nearest 0.2 kilometer (0.1 mile).

Data Analysis

All tagged moose were aged (whenever possible) and sexed. We consider that calves-of-the-year can be accurately identified by relative body-size during the first 10 months of life. Yearlings and adults were classified according to the methods explained by Goddard (1970).

The following three periods were distinguished:

1, Summer (S): from June to August;
2, Fall (F): from September to November (the rutting period and hunting season);
3, Winter (W): from December to May.

Table 2 illustrates the symbolization used to classify the observations according to the period of the year and the age of the animal. Each symbol (S, F, and W) has a subnumber corresponding to the age of the animals.

When an animal was observed more than two times in the same season, an overall mean of all the possible distances between all the observed locations was calculated. An overall mean for inter-seasonal (or inter-year) movements was estimated using the distance between observed locations from one season (or year) to the next.

Results and Discussion

Of the 179 tagged moose, a total of 179 different observations was made on 78 different animals. The combined data suggest all movements of yearlings and 2-year-old males are greater ($P \leq 0.05$) than those of adults (Table 3). Females were excluded from this particular analysis because of insufficient data. Results were then divided into three age groups: (1) calves, (2) yearlings and 2-year-olds, and (3) adults.

Intra-seasonal and Intra-year Movements

Young males (yearlings and 2-year-olds) moved more than adult males during the same summer (Table 4). This had been suggested by Goddard (1970).

Movements of adults during the same summer as shown in the same table have the same range as those reported by Goddard (1970), Houston (1968), Ballenberghe and Peek (1971), and others. Data are in accor-

TABLE 2 — Symbolization used to classify the observations with respect to period of the year and the age of the animal. S = summer, F = fall, W = winter.

Estimated age		
Age group	Symbols	Unknown age symbols
Calf (0 – 12 months)	S_0, F_0, W_0	—
Yearling 13 – 24 months)	S_1, F_1, W_1	—
Adults (25 – 36 months)	S_2, F_2, W_2*	S_n, F_n, W_n**
		S_{n+1}, F_{n+1}, W_{n+1}***

* Further observations on those animals are considered in the S_n, F_n, W_n heading.
** 25 months + (first year of observations).
*** 25 months + (second year of observations).

TABLE 3 — Comparison between mean linear distance (in kilometres) travelled by two different age groups of tagged moose in the Laurentides Provincial Park, Quebec. Pairs of data having the same letter are statistically different; a = $P \leqslant 0.05$.

	Age group			
	Yearling and 2-year-olds		Three years and older	
	Mean (N)	Range	Mean (N)	Range
All movements	12.7 (18)	0.0–32.0 (a)	3.4 (40)	0.0–11.3 (a)

dance with the hypothesis suggested by Ballenberghe and Peek (1971), Peterson (1955), and Ritcey and Verbeek (1969), that heavy use of aquatic feeding sites by moose explains the small summer range observed. A slight difference ($P \geqq 0.20$) between adult males and adult females was noted. This difference is apparently not influenced by the presence of the calf: there is no significant difference ($P < 0.20$) between females with and without calves (Table 5). Knowlton (1960) reported that adult males have a greater summer range than females with calf. We think that this may be a tentative conclusion as a result of limited data. Phillips et al. (1973) reported that similar-sized areas were occupied by cows with calves and those without calves.

Intra-seasonal and Inter-year Movements

Movements of adult males and females from one summer to the next are not statistically different (Table 6) and the mean distance of travel for both sexes is 2.0 kilometres (1.2 miles). This is in agreement with Geist's (1963) hypothesis and the results of Goddard (1970). Adult females appear to wander the same distance yearly ($S_n - S_{n+1}$ observations and $W_n - W_{n+1}$ observations are not different and are of 1.9 kilometers (1.2 miles)). This is in close agreement with findings by Phillips et al. (1973), LeResche (1970), and Houston (1968).

Movements of calves of either sex from their first winter to the second are not different from those of adult females over the same time period (Table 6). This comparison, however, is based on small samples (five and eight respectively) and may reflect the behavior of only a portion of the population.

TABLE 4 — Intra-seasonal and intra-year movements (in kilometres) of tagged moose in the Laurentides Provincial Park, Quebec. Pairs of data having the same letter are statistically different; a, b = $P \leqslant 0.05$.

Movement		Males		Females	
		Mean (N)	Range	Mean (N)	Range
In the same summer	(S_1 and S_2)	6.3 (6)	0.0 – 26.5 (a)		No data
In the same summer	(S_n)	1.8 (11)	0.0 – 7.6 (a, b)	3.4 (18)	0.0 – 11.6 (b)

TABLE 5 — Intra-seasonal and intra-year movements (in kilometres) of tagged female moose with and without calves in the Laurentides Provincial Park, Quebec. Pairs of data having the same letter are statistically non-different; a = $P < 0.20$.

Movement	Female with calf	Female without calf
	Mean (N) Range	Mean (N) Range
In the same summer (S_n)	3.4 (8) 0.0–6.1 (a)	3.5 (10) 0.0–11.6 (a)

TABLE 6 — Intra-seasonal and intra-year movements (in kilometres) of tagged moose in the Laurentides Provincial Park, Quebec. Pairs of data having the same letter are not statistically different; a, b, c = $P > 0.20$.

Movement	Males		Females		Combined data	
	Mean (N)	Range	Mean (N)	Range	Mean (N)	Range
W_0 to W_1	Insufficient data		Insufficient data		4.5 (5)	0.0–5.6 c)
S_n to S_{n+1}	2.1 (15)	0.0–11.3 (a)	1.9 (16)	0.0–5.8 (a, b)	2.0 (31)	0.0–11.3
W_n to W_{n+1}	Insufficient data		1.9 (8)	0.0–5.8 (b, c)		—

Inter-seasonal and Intra-year Movements

Adult males are less active in their movements between summer and fall of the same year than are yearlings and 2-year-olds (Table 7). This result has been observed by Pimlott (1959), Simkin (1965), Phillips et al. (1973), Goddard (1970), and Endress (1963). Saunders and Williamson (1972), however, presented data which do not agree with ours and those mentioned. Our data suggest that summer and fall wanderings of adult males were greater than those of adult females. Thus adult females are less active than males during the rutting season, as was also concluded by Houston (1968), Knowlton (1960), Goddard (1970), and Phillips et al. (1973).

Between the summer and winter ranges a mean linear distance of 6.9 kilometres (4.3 miles) has been calculated for adults. No difference has been observed between the males and females. Adult females' movements from summer to fall are less than movements from summer to winter (Table 7). This may be owing to the fact that during the fall, adult females are nearly in their summer range.

Inter-seasonal and Inter-year Movements

As illustrated by Table 8, there is no difference between winter and summer movements for calves compared with adults. Although the calf is not with the cow at the beginning of the summer, having been separated from the female during winter-tagging operations, it seems that their movements are not different.

Migratory Aspects

The means of inter-summer and inter-winter movements of adult moose are both 1.9 kilometres (1.2 miles). But the distance travelled from summer to winter ranges is 6.9 kilometres (4.3 miles). This variable is statistically ($P \geqq 0.05$) different from the other two. The fact that summer and winter ranges are non-overlapping suggests that there could be a migratory behavior among this population. This is the first time that this aspect of movement has been noted in Quebec although it is quite common in other North American moose populations, as reported by LeResche (1972) in Alaska, Houston (1968) in Wyoming, Knowlton (1960) and Stevens (1970) in Montana, Nielson and Shaw (1967) in Idaho, Edwards and Ritcey (1956) and Hatter (1946) in British Columbia, Ballenberghe and Peek (1971) in Minnesota, and Goddard

TABLE 8 — Inter-seasonal and inter-year movements (in kilometres) of tagged moose, Laurentides Provincial Park, Quebec. Pairs of data having the same letter are not statistically different: a = $P < 0.20$.

Movement	Males and Females	
	Mean (N)	Range
W_0 to S_1	7.7 (8)	3.7–15.9 (a)
W_n to S_{0+1}	7.4 (11)	2.4–10.8 (a)

TABLE 7 — Inter-seasonal and inter-year movements (in kilometres) of tagged moose in the Laurentides Provincial Park, Quebec. Pairs of data having the same letter are statistically different; a, b, c, d = $P \leqslant 0.05$.

Movement	Males		Females		Combined data	
	Mean (N)	Range	Mean (N)	Range	Mean (N)	Range
S_{1-2} to F_{1-2}	15.1 (7)	3.2 – 31.4 (a)		No data	—	
S_n to F_n and F_n to S_{n+1}	7.6 (5)	2.7 – 10.2 (a, b, c)	3.5 (8)	0.0 – 5.3 (b, d	—	
S_n to W_n and W_n to S_{n+1}	6.3 (6)	1.6 – 9.5 (c)	7.4 (11)	2.4 – 13.4 (d)	6.9 (17)	1.6 – 13.4

(1970) in Ontario. It is, however, evident that these moose migratory movements do not have the amplitude of those reported by Hatter (1946) in British Columbia, but they are within the range recorded in Ontario by Goddard (1970).

There are some aspects, such as the movements of calves and yearlings, that are at present unavailable, but future observations should furnish the much-needed data. Those additional data will allow us to calculate a statistically sound mean for each type of movement and will give us a complete proof of the migratory behavior of this population. We hope to extend the study area as well.

Acknowledgments

We express our gratitude to wildlife technicians of the Service, Jacques Turgeon and Aldée Beaumont, who made the field observations during the study. We are also indebted to Linda Garrard for her aid in the preparation of the manuscript.

Literature Cited

Ballenberghe, V. V. and **J. M. Peek.** 1971. Radiotelemetry studies of moose in northeastern Minnesota. Journal of Wildlife Management 35(1): 63–71.

Bouchard, R. and **G. Moisan. 1974.** Controlled moose hunts in Quebec's Provincial Parks. Paper presented at the International Symposium on Moose Ecology, Quebec, 1973. Naturaliste Canadien 101. (*In press.*)

Brassard, J. M., E. Audy, M. Crête, and **P. Grenier.** 1974. Distribution and winter habitat of moose in Quebec. Paper presented at the International Symposium on Moose Ecology, Quebec, 1973. Naturaliste Canadien 101. (*In press.*)

DesMeules, P. and **J. M. Brassard.** 1964. Une méthode pour le marquage automatique de l'orignal. Québec, Ministère du Tourisme, de la Chasse et de la Pêche, Service de la Faune, Rapport 3: 148–159.

Edwards, R. Y. and **R. W. Ritcey.** 1956. The migrations of a moose herd. Journal of Mammalogy 37(4): 486–494.

Endress, H. P. 1963. Moose checking station, Lake Superior Provincial Park, October 1–14, 1962. Resource Management Report, Ontario Department Lands and Forests 68:9–18. Mimeo.

Geist, V. 1963. On the behavior of the North American moose (*Alces alces andersoni,* Peterson 1950) in British Columbia. Behavior 20: 377–416.

Goddard, J. 1970. Movements of moose in a heavily hunted area of Ontario. Journal of Wildlife Management 34(2): 439–445.

Hatter, J. 1946. A summarized interim report on a study of the moose of central British Columbia. Report, Provincial Game Commission. pp. 44–52.

Houston, D. B. 1968. The shiras moose in Jackson Hole, Wyoming. Grand Teton Natural History Association, Technical Bulletin 1. 110 pp.

Knowlton, F. F. 1960. Food habits, movements and populations of moose in the Gravelly Mountains, Montana. Journal of Wildlife Management 24(2): 162–170.

LeResche, R. E. 1970. Moose investigations. Alaska Department Fish and Game. P-R Project Report, W-17-2. 13 pp. Multilith.

LeResche, R. E. 1972. Migrations and population mixing of moose on the Kenai Peninsula (Alaska). Paper presented at the 8th North American Moose Conference and Workshop, held in Thunder Bay, Ontario, February 16–18, 1972. pp. 185–207.

Nielson, A. E. and **W. M. Shaw.** 1967. A helicopter-dart gun technique for capturing moose. Proceedings of 47th Annual Conference of the Western Association State Fish and Game Commissioners. pp. 183–199.

Peterson, R. L. 1955. North American moose. University of Toronto Press, Toronto. 280 pp.

Phillips, R. L., W. E. Berg, and **D. B. Siniff.** 1973. Moose movement patterns and range use in northwestern Minnesota. Journal of Wildlife Management 37(3): 266–278.

Pimlott, D. H. 1959. Reproduction and productivity of Newfoundland moose. Journal of Wildlife Management 23(4): 381–401.

Ritcey, R. W. and **N. A. M. Verbeek.** 1969. Observations of moose feeding on aquatics in Bowron Lake Park, British Columbia. Canadian Field-Naturalist 83(4): 339–343.

Roussel, Y. E. and **C. Pichette.** 1974. Review of the techniques used to restrain and mark moose in Laurentides Park, Quebec. Paper presented at the 9th North American Moose Conference and Workshop held in Quebec, March 29–30, 1973. (*In press.*)

Saunders, B. P. and **J. C. Williamson.** 1972. Moose movements from eartag returns. Paper presented at the 8th North American Moose Conference and Workshop held in Thunder Bay, Ontario, February 16–18, 1972. pp. 177–184.

Simkin, D. W. 1965. Reproduction and productivity of moose in northwestern Ontario. Journal of Wildlife Management 29: 740–750.

Stevens, D. R. 1970. Winter ecology of moose in the Gallatin Mountains, Montana. Journal of Wildlife Management 34(1): 37–46.

Wilson, C. V. 1971. Le climat du Québec. Première partie, Atlas climatique. Service Météorologique du Canada. Information Canada T57-7/11-1.

Received 18 June 1974
Accepted 12 August 1974

Notes

Harmful Effects of Small Mammal Populations on a Tree Plantation in Southern Ontario

Abstract. Excessive girdling damage to trees on several hardwood plantations established in southern Ontario prompted an investigation into the species and numbers of potentially destructive rodents to be found on one such plantation. Live-trapping and ear-tagging methods revealed the presence of at least 33 animals per acre. Of the 281 animals handled in a total of 623 captures and recaptures, 78.3% were *Microtus pennsylvanicus*.

Résumé. Des dommages excessifs d'annélation subis par les arbres de plusieurs plantations de reuillus situées dans le sud de l'Ontario ont amené à faire dans une de ces plantations une étude des espèces et du nombre de rongeurs potentiellement destructeurs qui peuvent vivre dans ce genre d'habitat. Grâce à des méthodes de piégeage et d'étiquetage d'animaux vivants, on a relevé la présence d'au moins 33 animaux à l'acre. Des 281 animaux étudiés d'un total de 623 captures et récaptures, 78.3% étaient de l'espèce *Microtus pennsylvanicus*.

One of the most destructive and conspicuous type of damage to young orchard and plantation trees occurs when rodents remove the outer bark and devour the underlying cambium layer. If girdling is complete, trees are killed. If girdling is not complete, vigor of the trees is reduced. The extent of such damage varies with the abundance and number of species of rodents present. Losses as great as 95–99% of plantation-grown trees are not uncommon (Moore 1940; Eadie 1954; von Althen 1971). Before control measures to alleviate damage of this nature can be effectively undertaken, basic information must be obtained as to which small mammal species are present in the area, population fluctuations with time, feeding habits, alternate foods available, and acceptability of candidate rodenticide baits.

Excessive rodent damage had occurred in past years on the Coulson Tract, an area about 30 miles southwest of Toronto, Ontario (von Althen 1971). This abandoned farmland was planted in 1958 with white ash (*Fraxinus americana* L.) and basswood (*Tilia americana* L.) saplings. Within a year many of the original planting stock had been either girdled by "mice," browsed by rabbits (presumably *Sylvilagus floridanus*), or smothered by tall weeds. During 1959, intervening rows of white pine (*Pinus strobus* L.) and white spruce (*Picea glauca* L.) were planted and subsequently suffered similar rodent damage. Between 1960 and 1965, dead trees were replaced each spring and the weeds between the tree rows were cut each fall using a rotary mower.

Tree losses from girdling damage were especially severe during the winter of 1967–1968 (von Althen 1971). Although Phosbait-treated grain was applied by management personnel to the area each autumn to reduce numbers of small mammals, surveys were not undertaken to assess the effectiveness of the control measures. In 1971 the Canadian Wildlife Service was requested to determine the number and species of small mammals present on the Coulson Tract as a prelude to the hopeful development of more effective control measures.

The plantation at that time consisted of several incomplete rows of white pine alternating with several rows of white spruce. Only scattered remnants of the 1958 white ash–basswood planting remained. By August dense weeds 1 to near 2 metres high, consisting of wild carrot (*Daucus carota* L.), Canada thistle (*Cirsium arvense* L. Scop.), wild aster (*Aster* spp.), and goldenrod (*Solidago* spp.) dominated much of the area. Abundant grasses, including quackgrass (*Agropyron repens* L. Beauv.), chess (*Bromus secalinus* L.), downy brome grass (*Bromus tectorum* L.), and timothy (*Phleum pratense* L.) provided a suitable habitat for a large population of small mammals.

Live Trapping

For the small mammal survey a rectangular grid of 8.3 acres (3.4 hectares) was established on a 20-acre (8.1-hectare) sector of the Coulson Tract. Three hundred Sherman-type live-traps were set at marker stakes spaced 40 feet apart on rows 30 feet apart. Traps were baited with a paste mixture of ground beef suet, raisins, walnuts, rolled oats, peanut butter, and oil of aniseed. A small handful of "Terylene fiberfill" placed in the back of each trap provided nesting material. Plywood covers placed over each trap prevented excessive exposure to sun and chilling at night. The bait was replaced each time the trap caught an animal. Fresh bait was supplied to all traps midway through the 10-day trapping schedule.

All 300 traps were checked twice daily, generally between 7:00 a.m. and 10:30 a.m., and again between 5:00 p.m. and 7:30 p.m. Trapping was carried out between September 16 and 26, 1971 (Period 1). Captured mice (*Peromyscus* spp.), meadow voles (*Microtus pennsylvanicus*), and short-tailed shrews (*Blarina brevicauda*) were marked with ear tags and a numbered ring tag was applied to the ankle of masked shrews (*Sorex cinereus*) before release.

As the small mammal population level had been determined in the initial trapping period, the opportunity was taken to test the use of an anticoagulant rodenticide. Rozol-treated oat groats, applied at a rate of 2.5 pounds per acre (2.8 kilograms/hectare) were broadcast using cyclone seeders over the 20-acre study area on September 28. Live-trapping and tagging were carried out on the 300-trap grid for a second 10-day period (Period 2) between September 30 and October 9. Because of the short interval of time between application of the rodenticide and the second period of trapping, it was considered unlikely that reproduction or reinvasion would have altered significantly the population level. For this reason, a second non-poisoned control area was not considered necessary in evaluating the effectiveness of the poison application.

A total of 281 small mammals were taken in 623 captures and recaptures during the two 10-day trapping periods. The number of new animals taken in any one 24-hour period ranged from 3 to 31, while total daily captures ranged between 3 and 73 individuals. The number of individuals captured and the corresponding percentage of the total number of animals handled were as follows: *Microtus pennsylvanicus* 220 (78.3%), *Sorex cinereus* (10.3%), *Peromyscus* sp. 18 (6.4%), *Blarina brevicauda* 14 (5.0%).

The number of new animals taken, alive and dead, during each check of the traps, the number of recaptures, alive and dead, the accumulating number of tagged animals released and presumed to be therefore available for recapture, and the ratio of total recaptures in the total daily catch were parameters used in calculating the population (following Hayne 1949) and fiducial limits (95% probability) of the small mammals present on the study area. The calculated rodent population (shrews excluded from the trapping data) on the area was 28.7 animals per acre (24.2 to 35.2; 95% confidence interval) at end of Period 1, and 31.6 animals per acre (29.8 to 33.5) at end of Period 2.

Eighty-two of the 126 *Microtus* (65%) tagged during the first 10 days of trapping were trapped one or more times again following application of the poisoned bait, indicating much of the resident rodent population had not been killed by the bait during the latter 3 weeks of the study. A subsequent survey indicated the entire marked population had either succumbed to similarly treated poisoned bait left over winter in 50 feeder stations distributed over the 20-acre study area, had suffered natural mortality, or had moved out of the area. An inadequate concentration of rodenticide on the grain bait and/or an inadequate rate of field application may have caused the apparent ineffectiveness of the attempted control measure within the study period. Similar broadcast applications using higher concentrations and rate of seeding proved entirely successful in later studies (Radvanyi 1974a, b).

The home range of 119 *Microtus* captured two or more times was calculated and expressed in Figure 1 as square-footage mean values for animals captured the same number of times. For this purpose, one-half the distance from the outermost trap in which the animal was taken and the next trap in line in which it was not taken was used to delineate the home range boundary (following Stickel 1954).

Relatively few deer mice or shrews were trapped on the study area and the frequency of recapture of these species was too low to warrant comment on home range. Shrews appeared distributed uniformly over the grid area while *Peromyscus* were taken mainly on that portion of the grid adjacent to a more open and recently tilled field.

Discussion

The live-trapping and tagging survey of the Coulson Tract indicated an autumn population of at least 33 small mammals per acre on the area. Of the 281 animals captured, 78.3% were *Microtus pennsylvanicus*, the species most likely responsible for much of the girdling damage on the area. Whereas a large percentage of the individuals being taken during the last few days of trapping were juveniles and a high ratio of the adult females encountered were still pregnant, the calculated population must be considered as

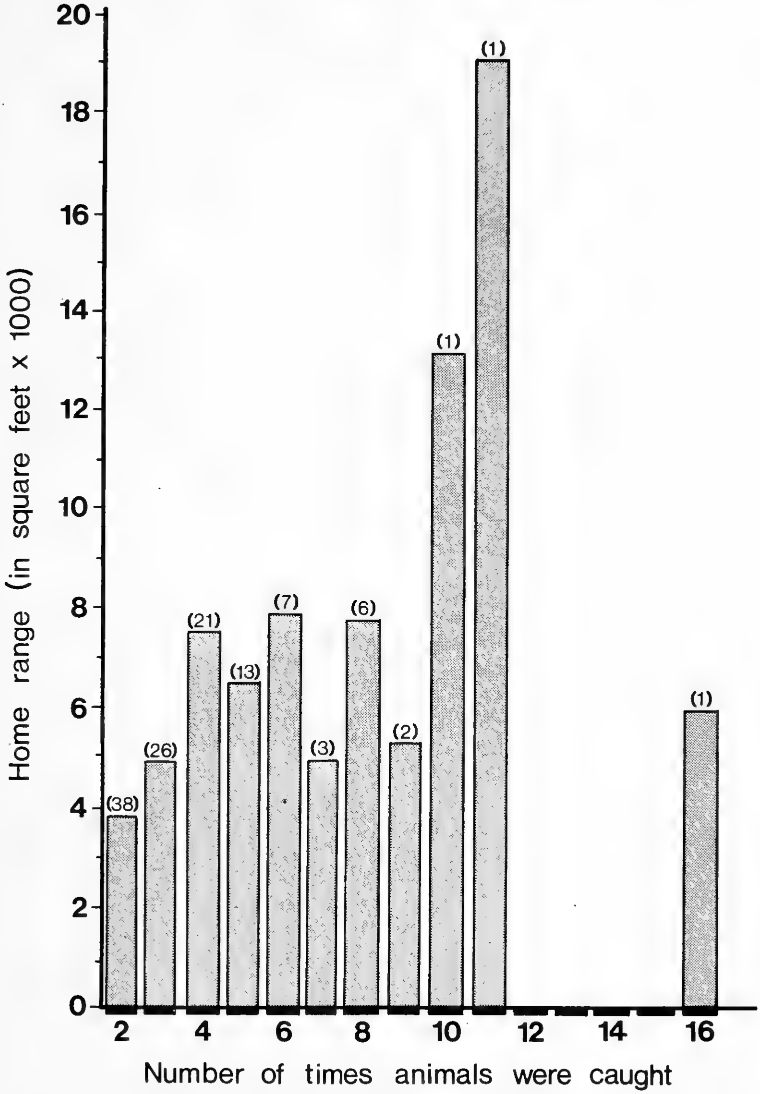


FIGURE 1. Calculated home range of 119 *Microtus* captured two or more times. Bracket indicates sample size.

being a conservative evaluation of what the actual population would become shortly thereafter. While the greater portion of rodent damage occurs during winter months, fresh basal attacks on particularly the deciduous component of the plantation trees were noted as early as mid-August during 1971. As no previous small mammal study had been carried out on the Coulson Tract area, it was not possible to conjecture where the population level would fit into the 3- to 4-year cycle.

Home range calculations based on an inadequate number of recaptures may greatly underestimate the actual home range of individuals. While the home range of *Microtus* is generally accepted as being between ¼ and ½ acre (Blair 1940; Radvanyi 1962), this value varies undoubtedly with habitat, sex of animal, and season. A Student's "t" test analysis of the data based on four or more captures of *Microtus* on the Coulson Tract, as compared with home range of animals captured three times or less, indicated there is a very highly significant (at the 0.1% level) difference in the size of home range of the two groups, with animals captured four times or more having the larger home range. Within the group captured four times or more, home range estimated on the basis of the first three points of capture only was significantly smaller (at the 5% level) than those based on all points of capture. Within the group captured four times, the home range based on the first three points of capture was significantly smaller (at the 1% level) than that using all four capture points. Similarly, of animals captured five times, home range based on the first three points of capture was significantly smaller (at the 1% level). On the other hand, of animals captured five times, the home range based on the first four points of capture was not significantly different from that based on all five points of capture, but that for the first three captures was significantly lower than that based on four captures (5% level).

Considering only those animals captured four times or more, the mean home range of 55 *Microtus* on the Coulson Tract was 7,505 square feet or just over one-sixth of an acre. Of these, 15 male animals had a mean range of 9,560 square feet, while that of 40 females averaged 6,735 square feet. The dense grass vegetation may have restricted the movement of *Microtus* somewhat, or at least reduced the need to move extensively in search of food and/or shelter. On the other hand, the relatively small home range may have resulted from high population levels existing on the study area. Krebs (1966) noted adult male *Microtus* in dense populations moved about considerably less during the breeding season than did those occurring in sparse populations. The points of recapture do not explain why the two animals captured 10 and 11 times respectively had the largest home range. The animals in question were taken in nine and seven traps respectively. Both had travelled extensively back and forth across the grid. The final points of capture for each were in traps bracketed by traps in which they had previously been taken. Both were resident animals and were not being captured in an extended line of traps as the animals made their way across the grid.

While several authors have documented the excessive damages that small mammals can cause to plantation areas (Parker 1941; Littlefield et al. 1946; Staebler et al. 1954; Jokela and Lorenz 1959), yet a paucity of data exists relating population levels on such areas to what numbers of animals can be tolerated before control measures become imperative. Almost a half century ago Seton (1929) estimated that meadow voles could number 10,000 per square mile during peak years. Eadie (1954) suggested suitable habitat may support 30 to 60 mice per acre in midsummer of an average year but that these numbers could double, triple, or quadruple during a peak year in the 3- to 4-year cycle. Mice were so abundant in the Oregon meadow mouse irruption of 1957–1958 (Vertrees 1959) as to stimulate newspaper accounts of 10,000 mice per acre. Field studies of that rodent irruption revealed 800 mice per acre was a more accurate evaluation.

United States Department of Agriculture scientists state each vole requires approximately 30 pounds of green vegetation, eaten or wasted, per year (Wood 1947). In other words, as few as 66 *Microtus* can devour one ton of vegetation per year, be this in the form of grass, immature grain heads, mature grain, or cambial bark. If this rate of destruction could be applied to a square mile of habitat similar to that of the Coulson Tract, the rodent population on such an area would number 20,212 animals and these would be capable of destroying the equivalent of over 306 tons of vegetation per year! Even very high densities of big game animals in ideal habitat — say 25 white-tailed deer or four moose per square mile — consume only approximately 20 tons of vegetation per species per year (Telfer 1972). The immensity of the impact of small mammals on the environment is seldom appreciated and until more effective weed- and rodent-control methods are developed and used on the Coulson Tract, successful establishment of tree plantations will continue to be a precarious endeavor.

Literature Cited

Blair, W. F. 1940. Home range and populations of the meadow vole in southern Michigan. Journal of Wildlife Management 4(2): 149–161.

Eadie, W. R. 1954. Animal control in field, farm, and forest. The Macmillan Company, New York.

Hayne, D. W. 1949. Two methods for estimating populations from trapping records. Journal of Mammalogy 30: 399–411.

Jokela, J. J. and **R. W. Lorenz.** 1959. Mouse injury to forest planting in the prairie region of Illinois. Journal of Forestry 57(1): 21–25.

Krebs, C. J. 1966. Demographic changes in fluctuating populations of *Microtus californicus*. Ecological Monographs 36: 239–273.

Littlefield, E. W., W. J. Schoomaker, and **D. B. Cook.** 1946. Field mouse damage to coniferous plantations. Journal of Forestry 44(10): 745–749.

Moore, A. W. 1940. Wild animal damage to seed and seedlings on cutover Douglas fir lands of Oregon and Washington. United States Department of Agriculture Technical Bulletin 706. 28 pp.

Parker, L. A. 1941. Factors causing rodent damage to tree plantations in southeastern Minnesota. Journal of Wildlife Management 5(3): 297–303.

Radvanyi, A. 1962. Effects of small mammals on forest regeneration in Alberta. Canadian Wildlife Service Project Progress Report No. 2 (Project M 1-4), Edmonton, Alberta. 73 pp.

Radvanyi, A. 1974a. Survey and control of small mammal populations on two hardwood plantations in southern Ontario. Forestry Chronicle. 50(5): 181–185.

Radvanyi, A. 1974b. Small mammal census and control on a hardwood plantation. Proceedings of the Sixth California Vertebrate Pest Conference, Anaheim, California, March 5–7, 1974. pp. 9–19.

Seton, E. T. 1929. Lives of game animals. Doubleday, Doran and Company, New York. 4 volumes.

Staebler, G. R., P. Lauterbach, and **A. W. Moore.** 1954. Effect of animal damage on a young coniferous plantation in southwest Washington. Journal of Forestry 52(10): 730–733.

Stickel, L. F. 1954. A comparison of certain methods of measuring ranges of small mammals. Journal of Mammalogy 35(1): 1–15.

Telfer, E. S. 1972. Report on the establishment of range trend transects at Elk Island National Park. Canadian Wildlife Service, National Parks Project 6248. 15 pp.

Vertrees, J. D. 1959. The Oregon meadow mouse irruption of 1957–58. Federal Cooperative Extension Service, Oregon State College, Corvallis. 88 pp.

von Althen, F. 1971. Mouse damage in an 8-year-old plantation. Forestry Chronicle 47(3): 160–161.

Wood, K. 1947. A nature guide for farmers. L. R. Larson Publishing Company, Vancouver, B.C. 116 pp.

ANDREW RADVANYI

Canadian Wildlife Service
Edmonton, Alberta T5J 1S6

Received 15 February 1974
Accepted 3 September 1974

Notes on the Distribution and Habitat of Amphibians and Turtles in Northwestern Quebec

In May 1974 we collected amphibians in northwestern Quebec, and thereby considerably clarified or extended the known ranges of some species. As this was a late wet spring we almost certainly missed species that we might have otherwise found, and our dates for breeding are not representative of a normal year. All of our specimens will be deposited in the collection of the National Museum of Natural Sciences, National Museums of Canada.

Most of our observations come from four camps (see Figure 1):

Louvicourt Camp, (10–20 May, 22 May, 26–28 May) 4 km north of Louvicourt, Louvicourt Township, Abitibi County, 48°6′ N, 77°23′ W. This area was burned, apparently about 30 years ago, and grew back to jack pine (*Pinus banksiana*), paper birch (*Betula papyrifera*), and trembling aspen (*Populus tremuloides*), with alders (*Alnus* sp.) dominant in wet areas. We collected in the ditches along Highway 113, which are confluent with a small lake through an area of leatherleaf (*Chamaedaphne calyculata*) marsh.

Lac Cameron Camp, (20–22 May) southwest side of Lac Cameron on the townline of Desjardins and Franquet Townships, 49°18′ N, 76°47′ W. We collected in small ponds in a gravel pit near an abandoned sawmill. The cleared area was surrounded by a dense forest of paper birch, spruce (*Picea*), balsam fir (*Abies balsamea*), and *Populus*. *Typha latifolia* (common cattail) was the dominant emergent plant in the ponds.

Chaste Township Camp, (22–23 May) small lake east of Highway 61, mile 47.5 from Amos, Chaste Township, 49°7′ N, 77°58′ W. This is a small kettle lake, apparently without fish, surrounded by spruce forest, much of which was recently cut over, and fringed by a floating bog mat dominated by leatherleaf.

Douay Township Camp, (23–25 May) near a lake northwest of Highway 61, mile 81 from Amos, 49°35′ N, 78°5′ W. This is an area of jack pine forests, with spruce or *Populus* stands in the lowlands. We collected in ditches along Highway 61, that were confluent with an outlet of the lake and had little emergent vegetation.

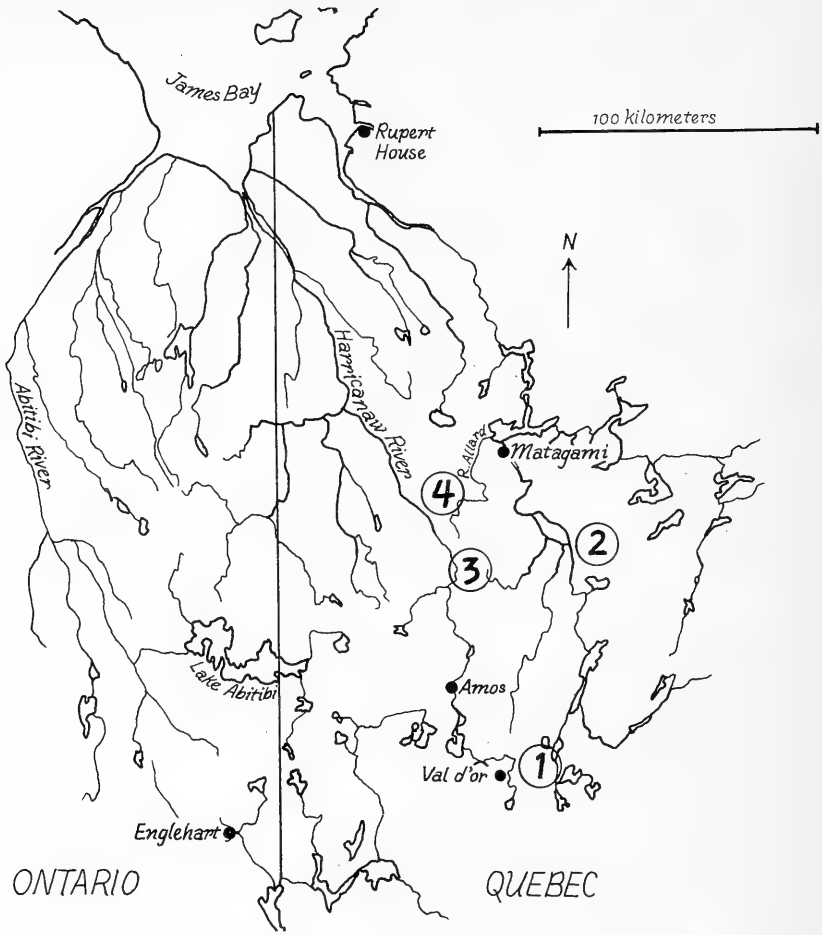


FIGURE 1. Map showing some localities mentioned in the text. 1 = Louvicourt Camp, 2 = Lac Cameron Camp, 3 = Chaste Township Camp, 4 = Douay Township Camp.

Species Accounts

BLUE-SPOTTED SALAMANDER. (*Ambystoma laterale*). Abundant at all camps, and taken at several other localities. Most were taken in minnow traps in roadside ditches or ponds, adjacent to fairly mature spruce or deciduous forests; we took a few under logs in such habitats, and found many crossing the road a few kilometers south of the Douay Township Camp on the night of 25 May.

RED-SPOTTED NEWT. (*Notophthalmus viridescens*). We took one adult male, in breeding condition, in a minnow trap at the Louvicourt Camp on 28 May. We did not find any efts at this locality despite extensive collecting of other salamanders under logs and in pitfall traps. Logier and Toner (1961) did not report this species from Western Quebec or from adjacent Ontario north of Lake Temagami, Nipissing District.

RED-BACKED SALAMANDER. (*Plethodon cinereus*). Abundant at the Louvicourt Camp, but not found elsewhere despite considerable searching. Most (80%) of the specimens were found within or under burned logs in a stand of jack pine. The soil was a fine reddish washed sand and the ground cover was mostly *Cladonia* spp. and other lichens, with some blueberry (*Vaccinium angustifolium*). On 17 and 19 May most of the salamanders taken were in the sun-warmed upper 3–4 cm of the decayed burned logs. Of the 46 taken, two were of the plain, or lead-backed, morph, one was intermediate, and the rest were of the striped morph (see Schueler 1974). This species' abundance at this camp is a puzzling contrast to its apparent absence elsewhere. The only more northerly record from Quebec is McCoy and Durden's (1965) unsubstantiated (specimens lost in transit) record from the James Bay lowlands.

AMERICAN TOAD. (*Bufo americanus*). We took 10 at the Lac Cameron Camp, both in the ponds and moving towards them at night, and heard one short trill. We also found one there under a board in a shallow depression which may have been its hibernaculum. We found no toads elsewhere, perhaps because of the late sping.

SPRING PEEPER. (Hyla *crucifer*). Abundant at all camps and calling abundantly throughout the region. Pairs were found in amplexus at the Lac Cameron Camp (20 May, water 11°C) but not elsewhere.

MINK FROG. (*Rana septentrionalis*). Overwintered tadpoles (mean body length = 32.9 mm, stages 28–37, mean 36.3 (Gosner 1960), n = 48) were common at the Louvicourt Camp, and we took two adults there on 28 May.

WOOD FROG. (*Rana sylvatica*). Abundant at all camps and calling abundantly throughout the region. Amplexed pairs were observed at all camps. At the Louvicourt Camp the first eggs were laid on 16 May, when the water temperature at dusk first exceeded 9°C (10.5°). These and later eggs had hatched and calling was much reduced there on 26–28 May.

NORTHERN LEOPARD FROG. (*Rana pipiens*). Common at the Louvicourt and Douay Township Camps in the deep (⩾1 m) ditches and at the margins of the lakes. Calling was heard only at Louvicourt, and only when the water temperature reached 12°C on 19 May. Vigorous calling from the margin of the lake there on the nights of 26 and 27 May have indicated breeding, but we found no eggs.

SNAPPING TURTLE. (*Chelydra serpentina*). Mr. Peter St-Denis of Val d'Or and other local people told us that snapping turtles were taken infrequently in lakes in the Val d'Or area. *Chelydra* is also found well north of its previously reported range in adjacent Ontario, as Mr. James C. Rice, of this department, saw a large adult of this unmistakable species in a shallow oxbow of the Englehart River, 2.5 km west of Englehart, Timiskaming District, on 28 July 1973. These are the first eastern reports of this species from the vicinity of the Arctic Watershed (Logier and Toner 1961).

Discussion

Several of these records significantly extend the ranges of the respective species known to Bleakney (1958) and Logier and Toner (1961). We report them here, however, largely to point out the efficiency with which funnel-ended wire-mesh minnow traps and pitfall traps took forms which were difficult to obtain by active collecting. A minnow trap placed in a ditch or pond overnight near appropriate habitat usually caught 5–30 *Ambystoma*, which we saw infrequently in the same habitat during active collecting, and such traps caught most of the tadpoles and the only *Notophthalmus*. The traps we used had 6.5-mm mesh and 3-cm apertures; small *Ambystoma* could escape through the mesh. A ditch, 3-m long and 20-cm deep, at the Louvicourt Camp caught 11 *Ambystoma*, four *Plethodon*, and our only yearling *Hyla* between 22 and 28 May.

Acknowledgments

We thank the National Museum of Natural Sciences for the loan of equipment, National Research Council of Canada grant #A5999 to James D. Rising for financial support, Peter St-Denis and Sujanna Brisebois of Val d'Or for their hospitality, and Francis R. Cook for his helpful criticism of the manuscript.

Literature Cited

Bleakney, J. S. 1958. A zoogeographic study of the amphibians and reptiles of eastern Canada. National Museum of Canada Bulletin 155: 1–119.

Gosner, K. L. 1960. A simplified table for staging anuran embryos and larvae with notes on identification. Herpetologica 16: 183–190.

Logier, E. B. S. and **G. C. Toner.** 1961. Checklist of the amphibians and reptiles of Canada and Alaska. Royal Ontario Museum, Life Sciences Division, Contribution 53: 1–92.

McCoy, C. J. and **C. T. Durden.** 1965. New distribution records of amphibians and reptiles in eastern Canada. Canadian Field-Naturalist 79: 156–157.

Schueler, P. W. 1974. Color morphs of the Red-backed Salamander, *Plethodon cinereus,* in New York and New England. Engelhardtia. *In press.*

FREDERICK W. SCHUELER
ALETA R. KARSTAD

Department of Zoology
University of Toronto
Toronto, Ontario M5S 1A1

Received 10 June 1974
Accepted 11 October 1974

Nest Site Availability as a Factor Limiting Population Size of Swallows

There are many examples of competition for nest sites in hole-nesting birds (Norton 1917; von Haartman 1957; Erskine 1964). The extent to which the availability of nest sites limits population size is more difficult to demonstrate. In hole-nesting species, especially those species that cannot excavate their own cavity, nest-site availability is critical to breeding success. This study investigates the changes in the population sizes of the Eastern Kingbird, *Tyrannus tyrannus*, Purple Martin, *Progne subis*, Barn Swallow, *Hirundo rustica*, and Tree Swallow, *Iridoprocne bicolor*, following the introduction of artificial nest sites at Long Point, Ontario.

The Eastern Kingbird, although not a hole-nesting bird, is included here because it feeds on aerial insects as do the three swallow species (Holroyd 1972). As the number of swallows breeding in the study area increased, changes in the size of the Eastern Kingbird population were noted.

Methods

Long Point, Norfolk County, Ontario, is a 20-mile-long sand peninsula extending from the north shore of Lake Erie. The eastern tip (1.25 miles in length and 0.5 square miles in area) comprises the study area. The vegetation consists of the early stages of dune succession (Haylock et al. 1970). Cottonwoods line the dune ridges; sedge swales and ponds dominate the interdune. Most cottonwoods are less than 30 feet high but in a few clumps, trees reach 45 feet.

The records of the Long Point Bird Observatory, dating from 1960, were searched for observations of bird-breeding attempts at the eastern end of Long Point and for notes on the construction of nest boxes. Additional and more complete records of nesting birds were collected in the summers of 1970 to 1973 by the author.

Results

Breeding bird censuses, conducted on part of the present study area from 1965 to 1968, showed that the Eastern Kingbird was the most common breeding bird (4 pairs on 48 acres) (Fairfield 1969). The only hole-nesting species were the Starling, *Sturnus vulgaris*, and the Common Flicker, *Colaptes auratus*. There were no other flycatchers (Tyrannidae) and no swallows (Hirundinidae) breeding in the area censused in those four years although they did nest in other parts of the present study area.

The Eastern Kingbird, Eastern Wood Pewee (*Contopus virens*), and Eastern Phoebe (*Sayornis phoebe*) were the only flycatchers known to remain during the summer months in the study area. During the summers of 1970 and 1971 an Eastern Wood Pewee sang throughout the summer. The pewee was always observed near the end of the point in a small grove of cottonwoods, but no observation was made of young or of a second pewee. It is not likely that a breeding attempt was made. The only known Eastern Phoebe nest was located in an abandoned car in 1967, and the nest was destroyed by a predator.

In the study area, all Eastern Kingbird nests were found in cottonwoods and the mean nest height above ground was 12 feet (range 5 to 30 feet, N = 24). Data from 1967 to 1973, including accurate mapping of adult kingbird territories by G. Fairfield since 1968, show that the breeding population of Eastern Kingbirds has fluctuated from 6 to 12 pairs (mean 9.7, Table 1).

TABLE 1 — Territorial pairs of Eastern Kingbirds

Year	Total
1964*	1
1965*	6
1966*	8
1967	10
1968	12
1969	10
1970	9
1971	11
1972	10
1973	6

* Data incomplete.

Swallows breeding in the area include the Tree Swallow, Barn Swallow, Purple Martin, Cliff Swallow (*Petrochelidon pyrrhonota*), and Bank Swallow (*Riparia riparia*). Two pairs of Cliff Swallows attempted to breed in 1965. Both pairs attached their mud nests to building walls. One pair was evicted by a pair of House Sparrows (*Passer domesticus*), and the second pair lost its brood of four young when the nest collapsed.

In 1972 a pair of Cliff Swallows successfully fledged at least four nestlings. From 1967 to 1969 Bank Swallows excavated 5, 19, and 2 holes respectively in low sharp banks on the south side of the south dune. No data were collected on nesting success and the banks have since collapsed.

Apartment house boxes are the only nest sites used by Purple Martins in the study area. Through the 1950s and earlier, the local lightkeepers put up some nest boxes. During the early 1960s, however, these boxes fell into disrepair and few Purple Martins bred in the study area. A colony has thrived for many years at the Gravelly Bay cottages (about 4 miles west of the end on the north shore of Long Point). In 1963 and 1964, a 16-hole apartment house was available in the study area and used by martins. From 1965 to 1967 the house was taken down while experiments were conducted with a large (6 × 6 × 6 feet) structure with boxes on the outside. Only one egg was ever laid by a Purple Martin in this structure. Since 1968, apartment house boxes have been available as nest sites in the study area (Table 2).

TABLE 2 — Number of breeding pairs of Purple Martins in the study area

Year	Number of boxes	Number of apartments	Number occupied
1961			several
1962			2+
1963	1	16	16
1964	1	16	14
1965	2	4+(42)	2+(1)
1966	1	(42)	0
1967	1	4+(42)	2+(1)
1968	1	16	?
1969	2	32	17
1970	3	48	39
1971	3	48	44
1972	4	64	54
1973	3	48	42

NOTES: 1961, 1962, and 1968 data are incomplete;
1965 to 1967 — The 42-hole box is included but it was unsuitable for the Purple Martins;
1970 to 1973 — Two boxes were checked each year. Occupancy in other boxes was estimated from these data.

All recorded Barn Swallow nest sites at Long Point were in or on buildings. At the end of the point, the Barn Swallows have built nests in three general locations: a ruined lighthouse building, an old barn which is part of the present lighthouse complex, and other buildings scattered on the end of the point.

The old lighthouse building, located about ½ mile from the east end of the point, has collapsed but the original supporting pillars still hold the floor of the building 6 feet above ground level. Barn Swallows nested on the sides of the beams under the floor.

The old unused barn had interior beams about 8 feet above the floor and these beams also were used as nest sites by the Barn Swallows. The other houses and buildings supplied overhanging eaves under which the Barn Swallows often nested. Nests in these locations were generally 10 to 12 feet aboveground.

The numbers of known Barn Swallow nesting attempts in the ruins, the old barn, and the other buildings are summarized in Table 3. The number of pairs involved was not known. Since the Barn Swallows may raise more than one brood per year, the number of nesting attempts will be more than the number of Barn Swallow pairs. Until 1970 only two or fewer checks were made on Barn Swallow nests during the summer months. Many nesting attempts were probably not noted. Since 1970 coverage has been more intense.

Until 1970 the majority of the Barn Swallows nested in the old barn. In 1970 the swallow access routes, namely the doors and windows of the barn, were closed. There was a corresponding increase in the number of nesting attempts made in the ruins.

In 1969, two Tree Swallow nests were found in natural cavities in cottonwoods. Both cavities had previously been excavated by another species, probably the Common Flicker. The only data recorded were for single visits to each hole when one egg and three eggs were noted as nest contents. A pair of Tree Swallows fledged three young from a nest in a tree trunk in 1973.

Since 1963 nest boxes placed in the study area have been occupied by Tree Swallows. Until 1969 boxes were placed at a height of 4 to 8 feet on cottonwood trunks. These boxes faced in all compass directions. In 1969 all of the boxes were moved and set 4 to 5½ feet high on poles in a grid. The grid was rectangular, 23 rows by 5 rows, and the boxes were placed 80 feet apart, all facing east. In 1971 the grid was expanded to 160 boxes and sheet metal "shields" were placed on many poles to deter predators. The number of boxes available and occupancy rates are summarized in Table 4.

Discussion

Many birds have specific nest-site requirements (Caldwell 1964; Gibb 1964; Holcomb and Twiest

TABLE 3 — Number of breeding attempts by Barn Sallows in the study area

Year	Barn	Ruins	Other	Total	Comments
1960	—	—	—	13	One check, July 2
1961	?	?	2	?	Not visited
1962	?	?	?	?	Not visited
1963	8	0	4	12	Two checks, June 9, July 11
1964	3	1	1	5	Two checks in May
1965	6	4	5	15	Checks from June 4 to 19
1966	11	2	3	16	Two checks, June 1 and 11
1967	15	4	1	20	Two checks, July 4 and 5
1968	16	6	2	24	One check, June 26
1969	19	?	1	20+	Two checks, June 12 and 29
1970	0	25	5	30	Many visits
1971	0	20	7	27	Many visits
1972	0	17	14	31	Many visits
1973	0	21	9	30	Many visits

NOTES: Checks from 1960 to 1969 recorded only one brood or part of a brood each year. The barn was closed in May, 1970.

TABLE 4 — Number of nesting attempts of Tree Swallows in the study area

Year	Number of boxes available	Number of nesting attempts	Other species nesting attempts in boxes
1963	6	2	3
1964	12	4	1
1965	46	18	7
1966	44	17	12
1967	42	17	5
1968	95	39	12
1969	107	52	0
1970	105	69	1
1971	174	89	1
1972	171	152	1
1973	152	*	2

Other species nesting in the boxes

House Wren	1
Eastern Bluebird	19
Starling	2
House Sparrow	22
Brewer's Blackbird	1

* Data lost in a fire.

1968). The Eastern Kingbird prefers open habitats such as farmland, parklands, open woodlots, and river edges (Bent 1942; Godfrey 1966). The habitat of dunes and scattered cottonwoods at the end of Long Point appears ideal for the kingbird and indeed, excluding those species that inhabit artificial nest sites, this species is the most common breeding bird in the study area. The number of breeding pairs has fluctuated from 6 to 12 during the last five years and although this variation may not be random biologically, it is within the realm of chance statistically (chi-square Goodness of Fit, $P = 0.5$). The increase in swallow numbers during the study period does not appear to have had any detrimental effect on the size of the Eastern Kingbird population.

Eastern Kingbirds are highly territorial and in the study area they often include a relatively dense stand of cottonwoods in their territories. There are, however, many stands of cottonwood in the study area that appear suitable for nest sites that are not used by kingbirds, and stands occupied one year are often vacant the next. The availability of cottonwoods for nest sites does not appear to be a limiting factor of population size in the study area.

Johnston (1971) found the Eastern Kingbird was not syntopic with other flycatchers. The habitat at the end of Long Point appears unsuitable to other flycatchers. The dearth of other tree-nesting species, including other flycatchers, precludes competition for nest sites with the Eastern Kingbird.

Unlike Eastern Kingbirds, Purple Martins nest colonially. "Before the advent of the white man the [Purple] Martin used natural cavities of trees and cliffs for nesting sites" (Bent 1942, p. 490). In 1955, G. Bennet (Ontario Nest Record Scheme) recorded a pair of Purple Martins using a tree cavity near the base of Long Point as a nesting site. The study area at the end of Long Point does not have any suitable tree cavities for Purple Martins and all recorded nesting attempts have been in artificial nest boxes.

Suitable nest boxes were heavily used by Purple Martins every year that they were available. The high occupancy rate by this species shows that the lack of suitable nesting sites is still the major factor limiting population size. The addition of more apartment house boxes would likely result in an increase in the number of Purple Martin breeding pairs.

The Barn Swallow also tends to nest in groups. Nineteenth century ornithologists found Barn Swallows nesting "in rocky caves, in crevices in rocky cliffs, on shelves of projecting rocks where some protection from above was afforded and even in holes or natural cavities in cut banks" (Bent 1942, p. 442). There are no such cliffs or rocky slopes on Long Point. The Barn Swallows in the study area use buildings to support their nests. The number of nest sites in use from 1963 to 1969 appeared to be relatively constant. The low count of five in 1964 probably reflects the early inspection date. The increased number of recorded attempts from 1970 to 1973 reflects the more regular checking rather than a population increase.

The population size remained relatively constant despite an apparent abundance of nest sites. The increased use of the ruins in 1970, after the closing of the barn, indicates there were unused nest sites in previous years. Thus there was always an excess of nest sites, and some factor other than nest-site availability limited the size of the breeding population of Barn Swallows until 1970. Since 1970 there still may be an excess of nest sites, as sites used one year may not be used the next.

The Tree Swallow is a hole-nester. Its natural nest sites are in hollow stumps, hollow limbs, and trees (Norton 1917; Taverner 1919). Nest boxes and "niches in buildings" (Norton 1917, p. 258) have served as artificial nest sites for many years. The existence of a suitably sized hole and cavity is possibly the chief factor controlling the location of a Tree Swallow nest (von Haartman 1957).

Unlike hole-builders, such as woodpeckers, that are able to construct their own cavities in their preferred habitats, Tree Swallows are dependent on existing holes. The Common Flicker is the hole-building species in the study area, and the aggressive Starling uses the old flicker cavities. This competition for nest holes between the Starling and Tree Swallow has virtually eliminated the use of natural cavities by Tree Swallows in the study area.

The number of nesting pairs of Tree Swallows is directly related to the number of boxes available. From 1965 to 1967 both the number of boxes and the number of nesting attempts were relatively constant. The increase in nesting attempts each year after 1968 appears to be due to the increase of available boxes, although the Tree Swallow numbers seem to lag behind the increase in boxes. From 1968 to 1972 there is no indication of a leveling-off in the number of Tree Swallow pairs. If the number of boxes were increased in the future, there is no reason to assume that the number of Tree Swallows would also increase. Thus the availability of nest sites appears to be the critical factor limiting the number of breeding Tree Swallow pairs at the end of Long Point.

Chapman (1935) gave similar conclusions for a New England colony that he established in open farmland. Whittle (1926) describes a colony of Tree Swallows of 150 pairs, all nesting in boxes within three-quarters of an acre of ideal open habitat.

Conclusion

Populations of the Purple Martin, Barn Swallow, and Tree Swallow are normally limited at Long Point by the availability of suitable natural nest sites. The Eastern Kingbird is the exception. The three swallow species have all increased in numbers with the availability of artificial nest sites. The Barn Swallow, however, appears now to have an excess of nest sites and seems to be limited by some other factor. The Tree Swallow and Purple Martin populations still seem limited by nest-site availability.

Acknowledgments

This study could not have been undertaken without the cooperation of the Long Point Observatory and the enthusiasm of its members who gave their time and energy to collect a great deal of the data. I thank them all and extend a special thank you to M. Bradstreet, G. Fairfield, and D. J. T. Hussell. I am indebted to the Canadian Department of Transport, the Long Point Company and their employees for their assistance throughout the study.

I am grateful to Dr. D. M. Power, Dr. W. G. Sprules, and E. M. Holroyd for their critical reading of earlier drafts of this manuscript.

This study was financed by National Research Council of Canada grants A4901 to Dr. Power, and A6388 to Dr. Sprules.

Literature Cited

Bent, A. C. 1942. Life histories of North American flycatchers, larks, swallows and their allies. United States National Museum Bulletin 179: 1–555.

Caldwell, L. D. 1964. Dove production and nest site selection in southern Michigan. Journal of Wildlife Management 28: 732–738.

Chapman, L. B. 1935. Studies of a Tree Swallow colony. Bird Banding 6: 45–47.

Erskine, A. J. 1964. Nest site competition between Bufflehead, Mountain Bluebird and Tree Swallow. Canadian Field-Naturalist 78: 202–203.

Fairfield, G. M. 1969. Long Point breeding bird census. Ontario Bird Banding 5: 1–6.

Gibb, J. A. 1964. Nest site selection. *In* A new dictionary of birds. *Edited by* A. L. Thomson. McGraw-Hill Book Co., New York. 928 pp.

Godfrey, W. E. 1966. The birds of Canada. National Museum of Canada Bulletin 203. 428 pp.

Haartman, L. von. 1957. Adaptation in hole-nesting birds. Evolution 11: 339–347.

Haylock, B. J., J. Cebrowski, and **G. L. Holroyd.** 1970. A study of sand dune succession at Long Point. Long Point Bird Observatory Newsletter 2(2): 5–10.

Holcomb, L. C. and **G. Twiest.** 1968. Ecological factors affecting nest building in Red-winged Blackbirds. Bird Banding 39: 14–22.

Holroyd, G. L. 1972. Resource use by four avian species of aerial insect feeders. M.Sc. thesis, University of Toronto. 100 pp.

Johnston, D. W. 1971. Niche relationships among some deciduous forest flycatchers. Auk 88: 796–804.

Norton, A. H. 1917. Remarks on the nesting habits of swallows. Bird Lore 19: 257–258.

Taverner, P. A. 1919. Birds of eastern Canada. Biological Series 3. Queen's Printer, Ottawa.

Whittle, C. L. 1926. Notes on the nesting habits of Tree Swallows. Auk 43: 247.

GEOFFREY L. HOLROYD

Department of Zoology
University of Toronto
Toronto, Ontario M5S 1A1

Received 4 June 1974
Accepted 14 September 1974

Common Redpolls Nesting at Edmonton, Alberta

On 20 April 1974, Mrs. J. Harrold Elliot of Edmonton called me to say a pair of Common Redpolls (*Acanthis flammea*) were nesting in her garden. The nest was situated 7 feet from the ground in the leafless branches of an Amur maple (*Acer ginnala*) but was partly obscured by the seed clusters that still hung on the tree. When the report was checked on 22 April the nest held three eggs. Mrs. Elliot commented that the male had been seen feeding the female on the nest.

On 6 May 1974, after I had mentioned this nesting in a weekly column on birds that I write for the Edmonton Journal, I received two more reports of breeding redpolls. Mrs. Fred Jones telephoned to say she had a nest just 3 feet from the ground in her cotoneaster hedge (*Cotoneaster lucida*), while Mrs. R. E. Miller told of another nest 7 feet up in a chokecherry (*Prunus virginiana*) in her garden. Neither of these women seemed aware of the rarity of such nestings and would not have reported them had they not read the note in the newspaper. Both commented that they too had seen the male feeding the female at the respective nests. These nests were checked on the same day they were reported and each was found to hold four unfledged young. All three of these nests were on the south side of the North Saskatchewan River in Edmonton but were in widely separated areas.

Then on 10 May 1974, Wesley Hochachka reported he had found another redpoll's nest at Devon, some 15 miles southwest of Edmonton. This nest was 10 feet up in a Manitoba maple (*Acer negundo*). When identification was confirmed on 12 May it held four well-grown young.

The identification of the birds at each of the nesting sites was made by two or more competent observers. These included Dr. Kathleen Ball, Dr. Cyril Hampson, Reginald Heath, Edgar T. Jones, Dr. Robert W. Turner, and the writer.

Of the four reported nestings three were successful with the young seen on the wing. The fourth, that in the garden of Mrs. Miller, met disaster. The female disappeared during the afternoon of May 6 and next morning the young were dead in the nest. The male remained in the vicinity for a few hours on 7 May and then left.

With the reporting of these four nests one wonders how many more were not found, went unrecorded, or were not identified. Redpolls, both Common and Hoary, were unusually numerous in the Edmonton area during the winter of 1973–74 but they have been just as common in years gone by when no nesting was reported.

It has been suggested to me that in the past, such nestings have been overlooked. This could have happened in one locality but scarcely across the settled parts of Canada where the birds are more or less common winter visitors. The only comparable nesting records that I am aware of are reported from Mortlach, Saskatchewan by Lahrman and Nero (1961. Blue Jay 19(3): 113–114) and from Saskatoon, Saskatchewan in 1970 by Hans Blokpoel (recorded in Canadian Field-Naturalist 84(4): 394–396).

Weather in Edmonton throughout the winter was moderately cold with much greater snowfall than usual. Spring was late but most of the snow, at least in the city, had gone before the birds nested. It is difficult to see what bearing weather had on these not only southerly but remarkably early nestings.

ROBERT LISTER

11115-84th Ave.
Edmonton, Alberta

Received 6 June 1974
Accepted 23 September 1974

An Unusual Association of Damselfly Naiads with Fish Carcasses[1]

On 27 June 1974 many damselfly naiads of the genera *Ischnura* and *Enallagma* were clinging to floating carcasses of the cisco (*Coregonus artedii*) in Oneida Lake, New York. Thousands of these fish die each summer, probably as a result of stresses from heavy parasitism by sea lampreys (*Petromyzon marinus*) (Dence and Jackson 1959) and the annual cycle of increasing temperatures and decreasing levels of dissolved oxygen (Frey 1955). Because the cisco is a coldwater fish (Frey 1955) it is restricted to the deepest water near the center of the large lake (207 km^2), from which the dying and dead fish float to the surface and may be subsequently blown toward shore. These particular fish had died during a relatively calm period, however, and were still floating in water over 9 meters deep and over 2 kilometers from shore. Since the carcasses had not previously been in shallow water or near shore, it appeared that the naiads were somewhat pelagic, a departure from their normal benthic existence.

No damselfly nymphs have been found in bottom samples taken over 15 years in the offshore areas of Oneida Lake. A few have been taken, however, in nets towed near the surface in deep water to capture fish fry. The Coenagrionidae are listed by Pennak (1953) as climbers that move about on vegetation or organic debris. Since windrows of floating vegetation are common offshore in Oneida Lake, it appears that the naiads, along with the uprooted plants to which they are clinging, are transported by water currents to the surface of deeper areas. Reasons for the subsequent congregation of the predaceous naiads on the carcasses are not known.

[1] A contribution of Federal Aid in Fish and Wildlife Restoration Project F-17-R.

Literature Cited

Dence, W. A. and **D. F. Jackson.** 1959. Changing chemical and biological conditions in Oneida Lake, New York. School Science and Mathematics 59: 317–324.

Frey, D. G. 1955. Distributional ecology of the cisco (*Coregonus artedii*) in Indiana. Investigations of Indiana Lakes and Streams 4: 177–228.

Pennak, R. W. 1953. Fresh-water invertebrates of the United States. Ronald Press Co., New York. 769 pp.

MICHAEL D. CLADY

Department of Natural Resources
Cornell University
Ithaca, New York 14580

Received 16 July 1974
Accepted 14 September 1974

The Fern Genus *Woodsia* in Manitoba

The woodsias are small ferns which are found on rock outcrops, cliff faces, and screes. Three species were reported from Manitoba by Scoggan (1957): *Woodsia glabella* R. Br., *W. ilvensis* R. Br., and *W. alpina* (Bolton) S. F. Gray.

Woodsia ilvensis is by far the most frequently found species in the province. It occurs on outcrops throughout the Precambrian formations of southeastern, central, and northern Manitoba (Scoggan 1957). A specimen collected by Bourgeau labelled Winipeg [sic], which was cited by Brown (1964), undoubtedly came from somewhere in the Winnipeg River drainage area (see discussion under *W. oregana*).

Woodsia glabella is much rarer. It is found occasionally on limestone outcrops in the central part of the province.

Sir John Richardson collected the first specimen of *Woodsia alpina* from the province of Manitoba at Norway House (K; photo DAO). This was reported by Hooker (1840) *sub W. hyperborea* as "Canada to the Saskatchewan. Pursh. Dr. Richardson. Drummond," and by Macoun (1890) also *sub W. hyperborea*, as "Norway House, Lake Winnipeg (Richardson)." Ritchie (1956) reported a specimen of *W. alpina* from Tod Lake near the Saskatchewan border (*Ritchie 1264* (MAN; photo DAO)). Here the species grew in a deeply shaded cliff ledge on the north-facing side of a high outcrop ridge on the northwest shore of the lake. At the time, Ritchie considered this to be the first authentic record for Manitoba but the earlier report by Hooker and Macoun has since been verified.

Recently, two species of *Woodsia*, *W. oregana* D. C. Eaton and *W. scopulina* D. C. *Eaton* (*W. oregana* var. *lyallii* (Hook.) Boivin) have been discovered in the western part of central Manitoba. Jackson et al. (1922) reported *Woodsia oregana* for Manitoba but without locality. This report was repeated by Lowe (1943) as "on rocks. In a previous list without locality." Scoggan (1957) repeated this report, stating that there were no supporting specimens. There are indeed no supporting specimens in the herbarium of the University of Manitoba (MAN) nor are there any at Ottawa (CAN, DAO), but Brown (1964) in his monograph of the genus *Woodsia*, cited a Bourgeau specimen labelled Winipeg which is preserved at Kew. This specimen ("Winipeg [sic], dans les Rochers, Bourgeau"; — Figure 1) however, will not have been collected in the vicinity of the city of Winnipeg which lies in an area of heavy clay soil at the junction of the Red and Assiniboine Rivers, but rather from some rocky outcrop in either Manitoba or Ontario along the Winnipeg River system between Lake of the Woods and Lake Winnipeg. There is no date on the specimen, but from the record of Astronomical Observations taken in 1857 (Palliser 1859), it can be determined that the party was at Fort Frances on July 1, Rainy River on July 3, Portage de Bois on July 4, Winipeg River on July 5 and 6, Winipeg Lake on July 11, and Upper Fort Garry (the site of the city of Winnipeg) on July 16.

Data for the collections of *Woodsia oregana* are as follows. Manitoba: 70 to 80 clumps in schist over ¼ mile of 5-ft-high shore cliff, associated with the lichen *Xanthoria elegans*, Bakers Narrows Provincial Park, 8 miles SE of Flin Flon, *J. D. Lafontaine*, 13 August 1973 (DAO); growing with *Woodsia scopulina* in dry crevices in schist cliff 4.5 miles by road N of Bakers Narrows Provincial Park (5 miles SE of Flin Flon), *J. D. Lafontaine*, 14 August 1973 (DAO). These represent the first authentic records of *W. oregana* from Manitoba.

The data for *Woodsia scopulina* are as follows. Manitoba: about 12 clumps in schist cliff, 4.5 miles by road N of Bakers Narrows Provincial Park (5 miles SE of Flin Flon), *J. D. Lafontaine*, 14 August 1973 (DAO). Here it was associated with *W. oregana*. This is the first record of *Woodsia scopulina* for Manitoba. Like *W. oregana*, *W. scopulina* is known in Thunder Bay District, Ontario and at Lake Athabaska in Saskatchewan. *Woodsia oregana*, however has a broader range in Saskatchewan than *W. scopulina*, being known as well from the Cypress Hills and near Bengough in the Wood Mountain district (DAO).

Scoggan (1957) gave a key to four of the five species of *Woodsia* reported in this paper. This key is expanded here to include *W. scopulina*:

Stipes jointed near the base.
- Stipes chaffless or with a few scattered scales
  - Indusia of 5–8 short filamentous segments; stipes green or straw-color .... *W. glabella*
  - Indusia of 10–20 long curving filamentous segments overtopping the mature sporangia; stipes brown .... *W. alpina*
- Stipes very chaffy, at least when young .... *W. ilvensis*

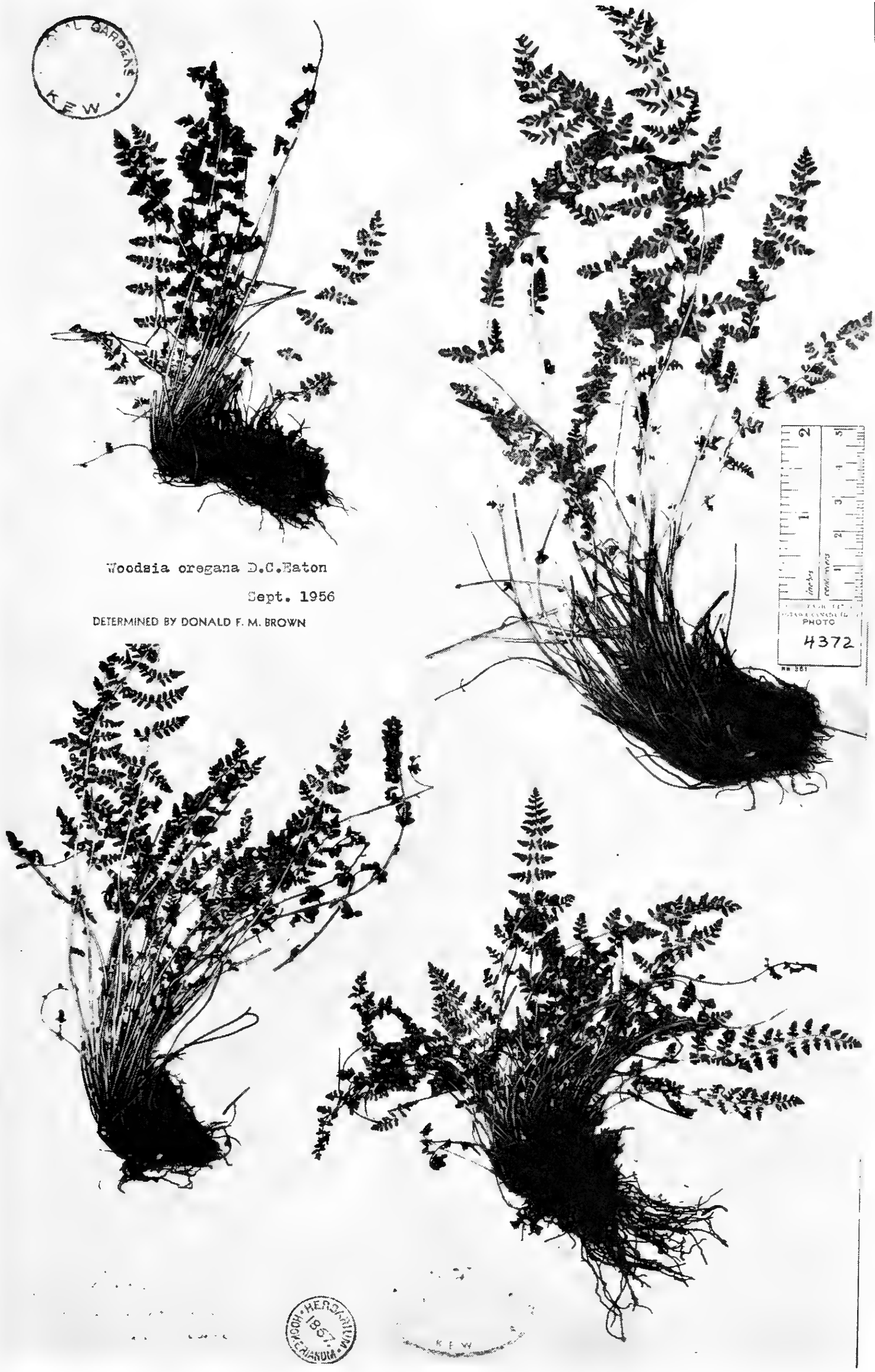


FIGURE 1. *Woodsia oregana*, Winipeg, Bourgeau (K).

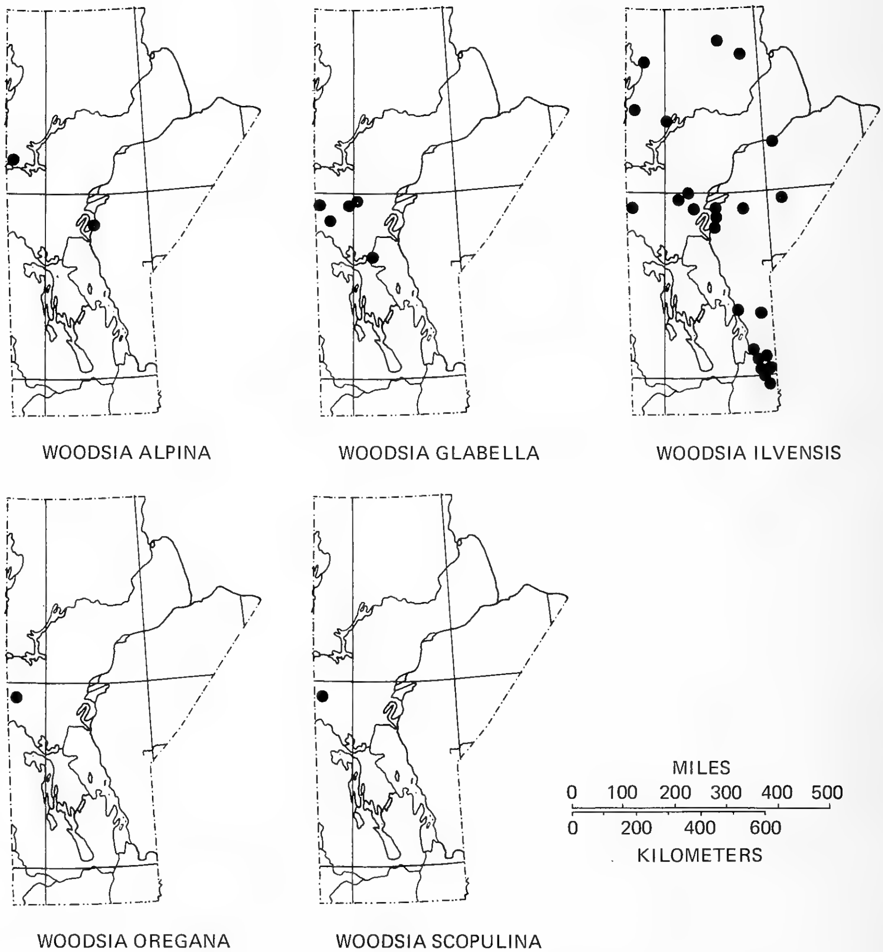


FIGURE 2. Distribution of *Woodsia* species in Manitoba.

Stipes not joined.
  Indusia plate-like; pinnae and rachis bearing glands and articulate hairs .... *W. scopulina*
  Indusia composed of glandular articulate hairs and linear lobes; pinnae and rachis bearing glands but no articulate hairs .... *W. oregana*

Maps depicting the known distribution of the five *Woodsia* species in Manitoba are shown in Figure 2.

Literature Cited

Brown, D. F. M. 1964. A monograph of the fern genus *Woodsia*, Beihefte zur Hedwigia 16: 1–154.

Hooker, W. J. 1840. Flora Boreali-Americana. Volume 2, Part 12. Henry G. Bohn, London. pp. 241–328.

Jackson, V. W., J. F. Higham, H. Groh, and **C. W. Lowe.** 1922. Checklist of Manitoba flora. Natural History Society of Manitoba, Winnipeg. 36 pp.

Lowe, C. W. 1943. List of the flowering plants, ferns, club mosses, mosses and liverworts of

Manitoba. Natural History Society of Manitoba, Winnipeg. 110 pp.
Macoun, J. 1890. Catalague of Canadian plants. Part V. Acrogens. William Foster Brown & Co., Montreal.
Palliser, J. 1859. Papers relative to the exploration by Captain Palliser of that portion of British North America which lies between the northern branch of the River Saskatchewan and the frontier of the United States; and between the Red River and Rocky Mountains. Eyre and Spottiswoode, London. 75 pp.
Ritchie, J. C. 1956. Additions and extensions to the flora of Manitoba. Rhodora 58: 321–325.
Scoggan, H. J. 1957. Flora of Manitoba. National Museum of Canada Bulletin 140: 1–619.

WILLIAM J. CODY
J. DONALD LAFONTAINE

Biosystematics Research Institute
Central Experimental Farm
Ottawa, Ontario K1A 0C6

Received 20 September 1974
Accepted 19 November 1974

Scheuchzeria palustris L. (Scheuchzeriaceae) in Northwestern North America

In the eighth edition of *Gray's Manual of Botany*, Fernald (1950) gave the North American range of the circumpolar *Scheuchzeria palustris* as Newfoundland to Manitoba and Washington south to New Jersey, Pennsylvania, northern Ohio, northern Illinois, northern Iowa, Nebraska, New Mexico, and California. These North American populations he (Fernald 1923) had designated as var. *americana* Fern. on the basis of what he described as larger follicles with longer curving beaks and larger seeds. The variety, however, may not be distinct and Hultén (1968) comments that the difference is not well marked in Alaskan specimens.

When Fernald wrote the section of the manual on *Scheuchzeria*, he probably relied on his 1923 paper for the Canadian distribution. Thus he did not take into account the collections of Hugh Raup from the south shore of Lake Athabaska in northwestern Saskatchewan (Raup 1936), and he was apparently unaware of the collections from Prince Albert National Park, Saskatchewan (*W. P. Fraser*, 20 Aug. 1935 (DAO)) reported by Fraser and Russell (1937, 1944), Nestow, Alberta (*E. H. Moss 4411* (DAO)) in 1938, or Pigeon Lake, Alberta (*G. H. Turner 5858, 5867* (DAO)) in 1947 (Turner 1949).

From British Columbia too there is a collection from as early as 1939 preserved at Ottawa: Reid Lake, 20 miles north of Prince George (*H. Groh 618* (DAO)). But indeed there are earlier records of *S. palustris* from British Columbia: Lulu Island (Henry 1915) and Horsethief Creek (Ulke 1935). Henry (1915), too, mentions the occurrence of *S. palustris* in Alaska. Other collections from these provinces have been gathered more recently. It is evident that, although the species is rather dispersed in its distribution because of its peculiar habitat requirements, it is by no means as rare as was indicated by Fernald.

During the early stages of preparation of the *Checklist of the Vascular Plants of Continental Northwest Territories, Canada* (Porsild and Cody 1968), Erling Porsild suggested that *S. palustris* would eventually be found in southern Mackenzie District. This suggestion was based on the proximity of suitable habitats in that area to the known stands on the south shore of Lake Athabaska. The following summer (1966), while conducting field studies in that part of Mackenzie District adjacent to the Saskatchewan border, I found *Scheuchzeria* at three different sites: Porter Lake, Scott Lake, and Spearfish Lake. These collections were reported by Cody and Porsild (1968).

More recent surveys have since proved the occurrence of this plant as far north as about 64°N latitude in Mackenzie District, and indicate that the plant is not as rare in the District as earlier suspected. Data for these collections is as follows: dominant in a wet thaw pocket, peat plateau near Barefoot Lake southeast of Trout Lake, 60°20' N, 120°45' W, 8 July 1971, *J. S. Rowe 1758* (DAO); in an ombrotrophic peatland

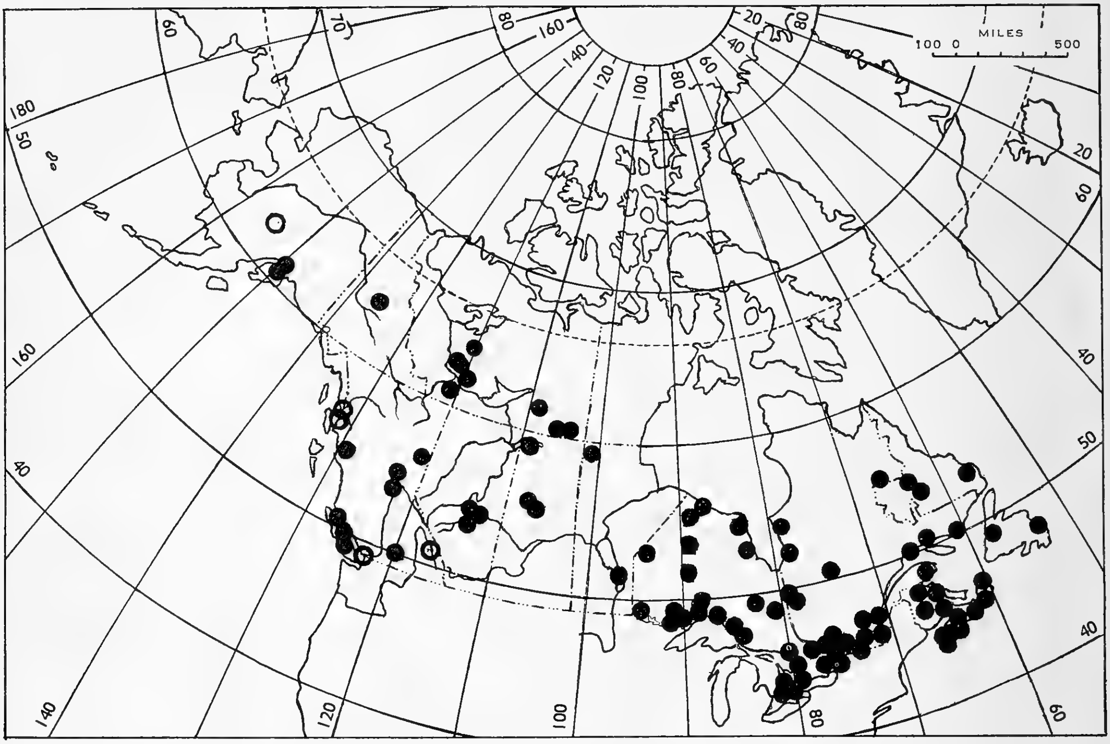


FIGURE 1. Canadian and Alaskan distribution of *Scheuchzeria palustris* as known from the Ottawa Herbaria (DAO, CAN) (closed circles) and selected references (open circles).

in a flooded depression growing in *Sphagnum majus*, southwest corner of Heart Lake, 60°48' N, 116°37' W, 27 June 1972, *S. S. Talbot 2263* (DAO); open bog area with *Sarracenia purpurea* and *Sphagnum magellanicum* near base of Horn Plateau, 61°48' N, 120°15' W, 16 July 1971, *P. Darron 1839* (DAO); in ooze in cold bog by small lake on top of Ebbutt Hills, 62°20' N, 122°13' W, 11 July 1970, *W. J. Cody 18789* (DAO); common in wet thaw pockets of bog hollow in peat plateau south of Willow Lake River, 62°30' N, 122°30' W, 21 July 1971, *J. S. Rowe 1955A* (DAO); common in wet *Sphagnum* of cold bog, unnamed lake southeast of Cartridge Hills, 63°52' N, 120°05' W, 9 July 1970, *W. J. Cody 18742* (DAO).

The boggy and often quaking bog margins of small ponds and lakes, in which *S. palustris* is frequently found growing in profusion, are not the types of habitats through which the casual collector of plants will venture. Also the narrow grass-like leaves, although they are quite stiff and have a characteristic green coloration, might easily be overlooked if the plant was lacking flowers or fruit as is frequently the case. Thus a more detailed knowledge of the distribution of this plant in the boreal forest zone may have to wait until more extensive botanical or ecological surveys are conducted.

Hultén's (1968) map of *Scheuchzeria palustris* suggests that there is a major gap in its distribution in most of the province of Manitoba. The only Manitoba collection known to him was the one from Reindeer Lake (*Baldwin 2418* (CAN)) in the northwest part of that province (Baldwin 1951). I would suggest, however, that this apparent void is due to a lack of botanical activity in the boreal parts of Manitoba rather than an actual absence of the species. This is borne out at least in part by an unreported collection made in 1961 on Hecla Island in southern Lake Winnipeg (*W. G. Dore 19587* (DAO)).

The only known site in the Yukon is the one from Halfway Lakes, 15 miles north of Mayo where it was collected by J. A. Calder (*Calder et al. 4223* (DAO)).

In 1947, Dutilly, Lepage, and O'Neill collected *Scheuchzeria palustris* 5 miles south of Anchorage in Alaska. Their collections were undoubtedly available to E. Hultén when he mapped the species for his flora (Hultén 1968), as was the material from the Kenai Peninsula gathered by J. A. Calder (*Calder 6804* (DAO)). The dot on Hultén's map from the Anchorage area would cover both of these collections. Another Alaska locality shown on Hultén's map about 200 miles northwest of Anchorage in the valley of the Kuskokwim River west of the Alaska Range of mountains is based on a collection made by W. H. Drury (1956).

A map of the Canadian and Alaskan distribution of *Scheuchzeria palustris* as known from the herbaria at Ottawa (DAO, CAN) and selected literature references is given in Figure 1.

Literature Cited

Baldwin, W. K. W. 1951. Botanical investigations in the Reindeer–Nueltin Lakes area, Manitoba. National Museum of Canada Bulletin 128: 110–142.

Cody, W. J. and **A. E. Porsild.** 1968. Additions to the flora of Continental Northwest Territories. Canadian Field-Naturalist 82: 263–275.

Drury, W. H. 1956. Bog flats and physiographic processes in the upper Kuskokwim River Region, Alaska. Contributions from the Gray Herbarium of Harvard University 178: 1–130.

Fernald, M. L. 1923. The American variety of *Scheuchzeria palustris.* Rhodora 25: 177–179.

Fernald, M. L. 1950. Gray's manual of botany. Eighth edition. American Book Company, New York, N.Y. 1632 pp.

Fraser, W. P. and **R. C. Russell.** 1937. List of the flowering plants, ferns and fern allies of Saskatchewan. University of Saskatchewan, Saskatoon. 46 pp.

Fraser, W. P. and **R. C. Russell.** 1944. A revised, annotated list of the plants of Saskatchewan. University of Saskatchewan, Saskatoon. 64 pp.

Henry, J. K. 1915. Flora of Southern British Columbia and Vancouver Island. Gage and Company Ltd., Toronto, Ontario. 363 pp.

Hultén, E. 1968. Flora of Alaska and neighboring territories. Stanford University Press, Stanford, California. 1008 pp.

Porsild, A. E. and **W. J. Cody.** 1968. Checklist of the vascular plants of continental Northwest Territories, Canada. Canada Department of Agriculture, Plant Research Institute, Ottawa. 102 pp.

Raup, H. M. 1936. Phytogeographic studies in the Athabaska–Great Slave Lake Region, I. Catalogue of the vascular plants. Journal of the Arnold Arboretum 17: 180–315.

Turner, G. H. 1949. Plants of the Edmonton District of the Province of Alberta. Canadian Field-Naturalist 63: 1–29.

Ulke, T. 1935. List of the vascular plants of the Horsethief Creek–Purcell Range, British Columbia. Canadian Field-Naturalist 49: 49–55.

WILLIAM J. CODY

Biosystematics Research Institute
Canada Department of Agriculture
Ottawa, Ontario K1A 0C6

Received 16 May 1974
Accepted 23 September 1974

Possible Intra-specific Killing by a Great Gray Owl

On 23 January 1974, at 1200 hours, I observed a possible case of intraspecific "predation" by a Great Gray Owl (*Strix nebulosa*). The location was 15 feet off Hihgway 93 (57°27′ N, 117°26′ W) at 5000 feet above sea level in Jasper National Park, Alberta. The ambient air temperature was about −3°C (26°F), with a southwest wind gusting to 20 mph.

The observation of a Great Gray Owl standing on top of a dead Great Gray Owl was made from a bus containing 20 students. When the bus stopped, the feeding bird flew off. Examination of the site did not reveal any signs of a significant struggle. The thin body of the dead owl was still warm. No blood was found, nor were broken bones or external hemorrhages present. A small area of skin had been opened on it's breast, and there was a hole approximately 1.5 inches (3.81 cm) in diameter in the ear area. Feathers were scattered in small quantities downwind from the site.

This observation implies at least two things: (1) the owl was feeding on carrion; (2) the owl preyed upon an individual of its own kind.

The Great Gray Owl preys almost entirely on mice and voles (Bent 1938; Craighead and Craighead 1956; Law 1960; Godfrey 1967; Hoglund and Lansgren 1968; Nero 1969; Brunton and Pittaway 1971). In some cases birds have been found to constitute small portions of the Great Gray Owl's diet: the common crow (*Corvus brachyrhynchos*) (Bent 1938); the redpoll (*Acanthis* sp.) (Fisher 1893); and the Hazel Hen (*Tetrastes bonasa*) (Mikkola and Sulkava 1970). The taking of birds by Great Gray Owls must be assumed to be uncommon; however, of 4,026 prey items examined in their study of pellets, Mikkola and Sulkava (1970) found 1.1% avian remains, including finches, adult and young game birds (Tetraonidae), two jays (*Garrulus glandarius*), and a Tengmalm's Owl (*Aegolius funerea*). In Canada, however, Brunton and Pittaway

(1971) had not observed the Great Gray Owl to feed on birds.

One could assume that the dead owl may have been hit by an automobile, but park wardens informed us that the road had been closed to public travel up to this date because of danger from avalanches. We were the first travellers on it for some time, other than the wardens. This information, and the lack of external hemorrhages, suggest that the Great Gray Owl attacked and killed an individual of its own kind, possibly an individual diseased or starved to a point where the live bird responded to it's abnormal behavior.

My thanks to Mr. R. Fyfe and Dr. A. Oeming for their helpful remarks in reviewing the manuscript.

Literature Cited

Bent, A. C. 1938. Life histories of North American birds of prey. Part 2. Dover edition, 1961. United States National Museum Bulletin 167.

Brunton, D. F. and **R. Pittaway, Jr.** 1971. Observations of the Great Gray Owl on winter range. Canadian Field-Naturalist 85: 315–322.

Craighead, J. J. and **F. C. Craighead, Jr.** 1956. Hawks, owls and wildlife. Dover edition, 1969. 443 pp.

Fisher, A. K. 1893. The hawks and owls of the United States. United States Department of Agriculture.

Godfrey, W. E. 1967. Some winter aspects of the Great Gray Owl. Canadian Field-Naturalist 81: 99–101.

Hoglund, N. H. and **E. Lansgren.** 1968. The Great Gray Owl and its prey in Sweden. Viltrevy 5: 363–416.

Law, C. 1960. The Great Gray Owl of the woodlands. Blue Jay 18: 14–16.

Mikkola, H. and **S. Sulkava.** 1970. Food of Great Gray Owls in Fenno-Scandia. British Birds 63: 23–27.

Nero, R. W. 1969. The status of the Great Gray Owl in Manitoba, with special reference to the 1968–1969 influx. Blue Jay 27: 191–209.

BOB M. FISHER

10830–69 Avenue
Edmonton, Alberta T6H 2E2

Received 29 April 1974
Accepted 17 October 1974

Intergeneric Grouse Hybrids *(Bonasa* x *Canachites)*

Gray (1958), Short (1967), and Johnsgard (1973) imply that no hybrids are known involving the Ruffed Grouse, *Bonasa umbellus*. Similarly, Ouellet (1974) in describing a recently taken specimen of such a hybrid *Bonasa umbellus* × *Canachites canadensis,* considered it to be the first known example of such a cross.

Actually instances of hybridization between *Bonasa umbellus* and *Canachites canadensis* have been known for a long time. Downs (1888) recorded an example he found at a butcher's shop in Halifax, Nova Scotia. This specimen is still extant and may be examined in the mounted bird collection of Acadia University, Wolfville, Nova Scotia (Tufts 1962). Piers (1894) mentions this and other specimens of *B. umbellus* × *C. canadensis.*

Literature Cited

Downs, A. 1888. A catalogue of the birds of Nova Scotia. Proceedings and Transactions Nova Scotian Institute of Natural Science 7(2): 142–178.

Gray, A. P. 1958. Bird hybrids. Commonwealth Agricultural Bureaux, Farnham Royal, Bucks, England. 390 pp.

Johnsgard, P. A. 1973. Grouse and quails of North America. University of Nebraska, Lincoln. 553 pp.

Ouellet, Henri. 1974. An intergeneric grouse hybrid (*Bonasa* × *Canachites*). Canadian Field-Naturalist 88(2): 183–186.

Piers, Harry. 1894. Notes on Nova Scotian Zoology: No. 3. Transactions Nova Scotian Institute of Science 8: 395–410.

Short, L. L., Jr. 1967. A review of the genera of grouse (Aves, Tetraoninae). American Museum Novitates 2289: 1–39.

Tufts, R. W. 1962. The birds of Nova Scotia. Nova Scotia Museum, Halifax. 481 pp.

R. W. TUFTS

Wolfville, Nova Scotia

Received 3 October 1974
Accepted 3 October 1974

The Sandhill Crane in Quebec

Abstract. Recent observations and two specimen records establish that the Sandhill Crane (*Grus canadensis*) occurs and has probably bred in the James Bay lowlands of Quebec. The species heretofore was not known to occur in Quebec.

Résumé. Il est maintenant possible d'homologuer la Grue du Canada (*Grus canadensis*) pour le Québec sur la foi de deux spécimens et d'observations récentes. Certaines de ces observations, consignées dans les basses terres de la partie orientale de la baie James, permettent aussi de croire que l'espèce a pu nidifier dans cette partie du Québec.

The Sandhill Crane (*Grus canadensis*) until now was not known to occur in Quebec (Godfrey 1966; Todd 1963; Walkinshaw 1973), although it has been found to be a regular breeder in the lowlands of northern Ontario (Lumsden 1971). As the James Bay lowlands of Ontario and Quebec are contiguous, it was suspected that this crane could occur in Quebec also. Elsewhere in eastern Canada, east of Quebec, it is accidental (Godfrey 1966).

During the spring, summer, and fall of 1972 air surveys by helicopter were undertaken by the Canadian Wildlife Service in the James Bay lowlands of Quebec, between 50° and 52° N, and 72° and 80° W. Concurrently, during June and July 1972, Ouellet conducted ornithological field studies on behalf of the National Museum of Natural Sciences in the southern part of the James Bay lowlands.

As a result of these surveys, the Sandhill Crane observations recorded establish that the species occurs and possibly breeds in Quebec. Our Quebec observations for 1972 are summarized as follows:

Cabbage Willows Bay (mouth of brook at 51°31′, 79°18′)

a, near mouth of brook, one, 7 May (Bourget),

b, near mouth of brook, two, 18 May (Bourget),

c, 4 miles south of coordinates, two, 4 July (Bourget),

d, 2 miles south of coordinates, two, 11 July (Ouellet),

e, 3.5 miles east of coordinates, four, 14 July (Ouellet),

f, 2.5 miles south of coordinates, two, 16 July (Ouellet);

Fort Rupert (51°30′, 78°45′)

a, 6 miles southwest, two, 3 July (Bourget),

b, 3 miles southwest, two, 5 July (Bourget),

c, 5 miles southwest, three, 5 July (Bourget);

Pontax River (near 51°30′, 78°40′)

a, 1 mile south of river, two, 4 July (Lehoux, Rosa),

b, near mouth, two, 5 July (Bourget);

Boatswain Bay (51°25′, 79°00′)

a, 3 miles inland, two, 6 July (Bourget).

Two additional records were obtained in the spring of 1974 (*fide* S. Curtis), as follows:

Tees Bay (53°43′, 79°03′)

a, one specimen, 13 May;

North of Fort George, but probably not farther than Paul Bay (54°00′, 78°55′)

a, one specimen, in May.

The birds observed by Bourget on 5 July in the Cabbage Willows Bay area were in a bog and behaved as if they were near a nest or had young when the helicopter moved in close, but no other evidence of breeding could be obtained. On 14 July, Ouellet watched through a telescope four birds that were displaying at a distance of approximately two miles. The display observed was very reminiscent of that described for that species by Hersey and Brandt (*in* Bent 1926). This suggests that these birds were probably nesting in the vicinity. Unfortunately, the display area could not be reached for further investigation.

A specimen which had been dead for a few weeks was found by Bourget in July, hanging in a tree near Fort Rupert. It was saved and is now preserved as a skeleton (National Museums of Canada, Cat. No. S392). On the basis of its tarsal length (232 mm) it probably belongs to the subspecies *C. c. rowani*, according to the measurements provided by Walkinshaw (1965). The Tees Bay specimen, an adult female, belongs also to the subspecies *C. c. rowani* on the basis of its measurements and coloration (National Museums of Canada Cat. No. 60151).

It therefore appears that there is a small summer population of Sandhill Crane in the James Bay lowlands of Quebec. Further studies should be undertaken to determine the size of the population and the area it occupies in this highly vulnerable region. The fact that this part of Quebec has now become readily accessible by road and that extensive works that will upset the present ecological conditions will probably be undertaken in the vicinity in the years to come, means that these wary birds may be driven away from the only area where they are now known to occur in Quebec.

We thank Messrs Denis Lehoux and Jacques Rosa for providing their observations, and Germain Tremblay for his assistance in the field (Canadian Wildlife Service) as well as Messrs Richard M. Poulin and Michel Giroux for their assistance in the field (National Museum of Natural Sciences.) We are thankful to Mr. Steven Curtis (Canadian Wildlife Service) for providing the 1974 information and the Tees Bay specimen. We are also grateful to Dr. W. Earl Godfrey and Mr. H. Boyd for their critical reading of the manuscript.

Literature Cited

Bent, A. C. 1926. Life histories of North American marsh birds. United States National Museum Bulletin 135.

Godfrey, W. E. 1966. The birds of Canada. National Museum of Canada Bulletin 203. 428 pp.

Lumsden, H. G. 1971. The status of the Sandhill Crane in Northern Ontario. Canadian Field-Naturalist 8(4): 285–293.

Todd, W. E. C. 1963. Birds of the Labrador Peninsula and adjacent areas. University of Toronto Press, Toronto.

Walkinshaw, L. H. 1965. A new Sandhill Crane from Central Canada. Canadian Field-Naturalist 79(3): 181–184.

Walkinshaw, L. H. 1973. Cranes of the world. Winchester Press, New York.

HENRI OUELLET[1]
ANDRÉ BOURGET[2]

[1] National Museum of Natural Sciences
National Museums of Canada
Ottawa, Ontario K1A 0M8

[2] Canadian Wildlife Service
1141, route de l'Eglise
Sainte-Foy, Québec G1V 3W5

Received 24 May 1974
Accepted 24 September 1974

An Additional Record of the Fulvous Tree Duck in Quebec

Records of the Fulvous Tree Duck (*Dendrocygna bicolor*) in Canada have been summarized by Munro (1967. Occurrence of the Fulvous Tree Duck in Canada. Canadian Field-Naturalist 81 (2): 151–152). The following records were then reported from Quebec: Lake St. Peter, near Nicolet, in the fall of 1955; and from the Thurso area on the Ottawa River, in mid-September 1964, in May 1965, and in August 1966.

A specimen in the flesh was recently donated to the National Museum of Natural Sciences by Mr. M. Demers, through the courtesy of Mr. Denis Germain, Service de la Conservation, Ministère du Tourisme, de la Chasse et de la Pêche du Québec. The specimen had been secured by Mr. Demers near Montmagny on 3 November 1973. The bird weighed 495.5 g. It proved to be a female in good condition, with little subcutaneous fat. The alimentary canal contained pieces of unidentified plant material. This specimen (National Museums of Canada No. 59932) constitutes the northernmost record of the species in eastern Canada (Godfrey, W. E. 1966. The birds of Canada. National Museum of Canada Bulletin 203. 428 pp.; Munro, *op. cit.*).

HENRI OUELLET

National Museum of Natural Sciences
National Museums of Canada
Ottawa, Ontario K1A 0M8

Received 24 May 1974
Accepted 2 September 1974

Carex illota L. H. Bailey in Alberta

In 1969, while one of us (H) was examining a collection of Carices made by the other (S) from the Sunshine area of Banff National Park, an immature specimen (*Scotter 11387*) was encountered which could not be satisfactorily keyed from Moss (1959). By a process of elimination in which section *Ovales* was excluded because the perigynia, although young, appeared wingless, the plant was assigned to *Carex bipartita*. Two years later a similar but fully mature specimen (*Scotter 17135*) was collected in Jasper National Park. Cronquist's (1969) treatment of *Carex* in *Vascular Plants of the Pacific Northwest* was now at hand, and using that reference, the specimen keyed out speedily and clearly to *Carex illota* L. H. Bailey, a species not cited for Alberta in current manuals. It was then realized that the earlier specimen, *Scotter 11387*, was immature material of the same species.

Collection data for the two specimens are as follows:

11387: "Banff National Park, Simpson Pass region, 51°04′45″ N, 115°50′ W. Open area along stream and lake shore, 7000′–7300′. *G. W. Scotter 11387*, 26 July 1969." Specimens in Fraser Herbarium, University of Saskatchewan, and in Canadian Wildlife Service herbarium, Edmonton.

17135: "Jasper National Park, 52°43′ N, 118° 19′ W. Meadow south of the east end of Moat Lake, Tonquin Valley. *G. W. Scotter 17135*, 12 August 1971." Specimens in Canadian Wildlife Service herbarium, Edmonton, and Department of Agriculture Herbarium, Ottawa.

Carex illota looks amply distinct from all other *Ovales* in its densely congested inflorescence and small dark perigynia, 2.5–3.2 mm long, which lack marginal wings or serrulations on the sides of the beak. Cronquist (1969) gives the range as ". . . Olympic and Cascade mts. of Wash. and adj. B.C., s. in the Cascade-Sierran axis to Calif., w. [sic] to Mont., Wyo., and Colo. . . ." Boivin (1967) omitted it entirely from Canada, but he may have submerged it in something else. It is evidently not too uncommon in British Columbia; the Fraser Herbarium has a sheet from Vancouver Island — a 50–50 mixture with *C. macloviana* (*J. A. Calder & K. T. MacKay 31883*, 25 July 1961, Forbidden Plateau, 49°39′ N, 125°11′ W) — and recently it was collected in Mount Revelstoke National Park at 51°03′ N, 118°07′ W, altitude 5800′ (*Landals and Scotter 1062*, 1973). Harrington (1964) gives its altitude in Colorado as 8500–12000 feet, so 6000–7000 feet would not be unreasonable in the Canadian Cordillera.

Porsild (1959) included *C. illota* in a checklist of vascular plants of the Sunshine region, Banff National Park. But he had no voucher specimen from there, nor are there any from Alberta in the National Herbarium in Ottawa. He believes the specimens cited actually were *C. festivella* (A. E. Porsild, personal communication). Among his collections not yet inserted in the National Herbarium is one specimen of *C. illota* from Alberta. It was collected along the road to Cameron Lake, Waterton Lakes National Park, on 19 September 1945, collection No. 15101 (A. E. Porsild, personal communication).

The problem in identifying *C. illota* is principally one of keys in floras. With a specimen in hand, one may arrive at proper identification of *C. illota* by using Henry (1915), Rydberg (1922), Harrington (1964), or Cronquist (1969). One cannot get to *C. illota* by using the keys in Mackenzie (1931–35), Davis (1952), or Hermann (1970), because in these works the perigynia must be winged for one to gain entry to Section *Ovales*, and no provision has been made for keying *C. illota* in sections with wingless perigynia.

Although these are the first known specimens of *C. illota* from Alberta, in view of the difficulties described in the foregoing paragraph, one may well wonder whether older Alberta specimens exist, mislabelled in herbaria. A botanist identifying it for the first time would naturally consult Mackenzie's treatment, go astray at the fork of his key which contrasts "perigynia narrowly to broadly winged-margined" with "perigynia at most thin edged," and stay lost thereafter.

Literature Cited

Boivin, B. 1967. Enumération des plantes du Canada. Naturaliste Canadien 94(6): 471–528.

Cronquist, A. 1969. Cyperaceae. *In* Vascular plants of the Pacific Northwest. Volume 1. *Edited by* C. L. Hitchcock, A. Cronquist, M. Ownbey, and J. W. Thompson. University of Washington Press, Seattle.

Davis, R. J. 1952. Flora of Idaho. W. C. Brown Co., Dubuque, Iowa.

Harrington, H. D. 1964. Manual of the plants of Colorado. 2nd edition. Sage Books, The Swallow Press, Chicago, Ill.

Henry, J. K. 1915. Flora of Southern British Columbia. W. J. Gage & Co., Toronto.

Hermann, F. J. 1970. Manual of the Carices of the Rocky Mountains and Colorado Basin. Forest Service, U.S. Department of Agriculture, Agricultural Handbook No. 374.

Mackenzie, K. K. 1931–35. Cariceae. *In* North American flora. Volume 18 (parts 1–7). The New York Botanical Garden, New York.

Moss, E. H. 1959. Flora of Alberta. University of Toronto Press, Toronto.

Porsild, A. E. 1959. Botanical excursion to Jasper and Banff National Parks, Alberta: alpine and subalpine flora. National Museum of Canada, Department of Northern Affairs and National Resources, Ottawa.

Rydberg, P. A. 1922. Flora of the Rocky Mountains and adjacent plains. The New York Botanical Garden. Second edition reprinted (1954) by Hafner Publishing Co., New York.

GEORGE W. SCOTTER[1]
JOHN J. HUDSON[2]

[1] Canadian Wildlife Service
Edmonton, Alberta

[2] W. P. Fraser Herbarium
University of Saskatchewan
Saskatoon, Saskatchewan

Received 21 May 1974
Accepted 11 October 1974

Tree Nesting Sites and a Breeding Range Extension of Brewer's Blackbird in the Great Lakes Region

Brewer's Blackbird (*Euphagus cyanocephalus*) has been expanding its breeding range eastward into the Great Lakes region since the turn of the century (Stepney and Power 1973; Walkinshaw and Zimmerman 1961). It was first recorded breeding at Minneapolis, Minnesota in 1914 (Roberts 1914) and had reached Sudbury, Ontario by 1962 (Devitt 1964). To date, this expansion represents a distributional increase of over 700 miles.

Throughout the expanded portion of its range this blackbird nests commonly in small groups usually not larger than 12 pairs. Its typical nesting areas are along highway and railroad rights-of-way, particularly where these are adjacent to one another and surrounded by agricultural lands. Its nests in this part of its range are usually placed on the ground.

On 9 June 1974 eight nests of this species were located at Warren, a town on the eastern boundary of Dunnet Township in the District of Sudbury. This record not only constitutes a very recent eastward expansion of the breeding range of nearly 60 miles, but is unusual in that the nests were placed in trees. The birds occupied the common right-of-way of the highway and railroad immediately to the east of Warren, nesting in a row of pines (*Pinus* sp.) planted adjacent to the highway. The nests were from 4½ to 6 feet above the ground and the distances between adjacent nests varied from approximately 15 to 360 feet. They contained either eggs or young (Table 1).

TABLE 1 — Number of eggs or young, approximate age of young, and heights of nests of Brewer's Blackbird nesting at Warren. Asterisk denotes an apparently abandoned nest in which the eggs were cold and wet.

Nest number	Nest contents	Nest height (feet)
1	6 young, 6 days old	4.0
2	5 young, 8 days old	4.0
3	5 eggs	6.0
4	5 young, 7 days old	5.5
5	5 eggs	5.0
6*	6 eggs	4.5
7	5 young, 9 days old	5.5
8	3 young, 6 days old 1 infertile egg	5.0

Nesting at Warren constitutes the first substantiated record for the species east of the immediate Sudbury area at that latitude. The presence of the species has been implied by the statement "[they] continue to spread along the highways and railways rights-of-way toward Lake Nipissing . . ." but no details were given (Goodwin 1966). In late May 1971 and 1972 the author examined seemingly suitable habitat along the highway between North Bay and Sudbury. The species was not detected east of Sudbury though a breeding colony has been observed at Estaire, 25 miles south of Sudbury since 1970, and Devitt (1964) found the species breeding at Rutter, 60 miles south of Sudbury in 1962. Data indicate that the species nested at Warren for the first time in 1973. Three old nests were also found along with the active ones, but in 1972 no evidence of the species was detected.

Brewer's Blackbird has been moving eastward at an overall rate of approximately 11 miles per year. Expansion from Sault Ste. Marie to Sudbury was seemingly favored by increased amounts of favorable habitat, and the rate in that region was about 17 miles per year (Stepney and Power 1973). The amount of potential habitat, however, decreases sharply for about 45 miles from Sudbury east to the town of Hagar. From there farther east to Sturgeon Falls the amount of apparently suitable habitat increases again. It took Brewer's Blackbird 11 years to cover the 60 miles from Sudbury to Warren, giving an apparent expansion rate in this region of about 5 miles per year.

There are apparently only three accounts of this species nesting in trees in the Great Lakes region. The first instance occurred in Saint Paul, Minnesota in 1942 (Roberts 1942) and the second at Sault Ste. Marie in 1954 (Speirs 1954). On two other occasions nests of this species have been recorded at heights of less than 1 foot from the ground. The nest located at Luther Marsh, Ontario in 1967 was situated in a shrub (Goodwin 1967) and over the past five years several nests in one colony site at Sudbury investigated by the author have been situated in very low shrubs. Neither of these examples, however, is regarded as a true departure from ground nesting. In both instances if they had been placed any lower the nests would have been in contact with water beneath the shrubs in which they were built.

Examination of these reports involving arboreal nesting suggests a common factor may have influenced departure from normal ground-nesting behavior. The trees chosen in at least two of the cases were evergreens which, as a result of pruning, supported a thick growth of foliage. The type of tree occupied in Saint Paul was not indicated though it was stated that the trees were part of a hedge. As a hedge, it is likely these latter trees also supported a denser growth of foliage. This unusually dense foliage provided nest sites that approximated the amounts of concealment and support normally present only on the ground. With the same nesting requirements available in these two non-ground sites as are normally provided only by ground ones, the fact that trees were involved appears to be incidental. The sites selected in trees seem to be chosen for the same characteristics that sites on the ground are chosen. In the present case all eight nests were placed within the excessively thick growth which had developed around the flattened tops of the trees where their crowns had been removed. The nests at Sault Ste. Marie were likewise placed in dense foliage which had resulted from pruning (Speirs, personal communication). Evergreens grown without human interference apparently do not offer the same inducement to nesting as pruned trees. Four colony sites under investigation since 1970 have contained evergreens (*Pinus* and *Picea* spp.), but the trees have never been occupied, though the nests were often placed near them on the ground.

In addition, evergreens provide concealment for nests at a time early in the breeding season when deciduous trees are not in full leaf and much of the herbaceous vegetation has not matured. This may explain, in part, why the tree nestings involved evergreens and why the birds often place their nests on the ground near or at the base of the trunk of an evergreen.

I gratefully acknowledge the financial assistance of The Canadian National Sportsmen's Show in 1973 and 1974, part of a five-year study of Brewer's Blackbird in Ontario. This paper developed from these investigations.

Literature Cited

Devitt, O. E. 1964. An extension in the breeding range of Brewer's Blackbird in Ontario. Canadian Field-Naturalist 78: 42–46.

Goodwin, C. E. 1966. Nesting season June 1 to August 15. Audubon Field Notes 20: 566.

Goodwin, C. E. 1967. Nesting season June 1–August 15. Audubon Field Notes 21: 563.

Roberts, T. S. 1914. Brewer's Blackbird (*Euphagus cyanocephalus*) breeding in southeastern Minnesota. Auk 31: 538–540.

Roberts, T. S. 1942. The season and breeding bird census. Audubon Magazine 142: 10.

Speirs, J. M. 1954. Brewer's Blackbird nesting at Sault Ste. Marie, Ontario. Federation of Ontario Naturalists Bulletin 65: 29.

Stepney, P. H. R. and **D. M. Power.** 1973. Analysis of the eastward breeding expansion of Brewer's Blackbird plus general aspects of avian expansions. Wilson Bulletin 85: 452–464.

Walkinshaw, L. H. and **D. A. Zimmerman.** 1961. Range expansion of Brewer's Blackbird in eastern North America. Condor 63: 162–177.

PHILIP H. R. STEPNEY

Department of Zoology
University of Toronto
Toronto, Ontario M5S 1A1

Received 16 July 1974
Accepted 19 November 1974

Glaucous-winged Gull Predation on Feral Rock Doves

In early July of 1972, in the Vancouver freight yards of the C.N.R., the author and Mr. W. Parks had occasion to observe a Glaucous-winged Gull (*Larus glaucescens*) carrying a live pigeon (*Columba livia*) in its mandibles. On further observation it was observed that the gull put the pigeon down and proceeded to peck at the struggling victim until it could no longer make escape attempts. We frightened the gull away before it could kill the victim. The wounded pigeon had feathers missing just posterior to the rib cage on the dorsum but otherwise appeared in good health.

On subsequent inspection, at least six dead pigeons were found in the same general vicinity. These birds all had lesions in the same general body area where the previously examined victim had feathers pulled out. But these all had large holes in the back, and the viscera were missing. The victims were adults or flying young. We had several opportunities to observe the hunting behavior of the gulls. Pigeons would flock around a grain spill and go into a feeding frenzy. The hunting gull would land nearby and walk casually into the feeding flock. Once there, it would make a vigorous attempt to capture a pigeon. The pigeons usually responded either by flying away, or flying or running in a short arc around the gull. They did not appear very frightened.

Finally, in late July, on top of a boxcar, a gull was seen pulling the viscera out of a pigeon and eating them. Thus, although we have never seen the sequence of hunting–capturing–killing–eating in its entirety, we have seen enough of it to conclude that Glaucous-winged Gulls are preying on pigeons. It would appear that only a few adult gulls in this freight yard are involved in this kind of behavior and these are not often successful.

F. J. Sanford (1974. An instance of gull predation. Discovery (New Series) 2(4): 120) also observed this kind of predation. But he observed only young pigeons being killed, whereas we observed both young and adults being preyed upon. This predator–prey association may have evolved since Vancouver became an important grain port. It appears that the pigeons have not yet developed a behavioral adaptation to this predation by gulls. The laxity of their response to the approach of the gull seems inappropriate considering the gravity of the consequences of capture.

I thank Mr. Wayne Parks for assistance in making observations.

JORMA A. JYRKKANEN

Department of Zoology
University of British Columbia
Vancouver, British Columbia V6T 1W5

Received 1 April 1974
Accepted 22 November 1974

The Feral House Cat as a Predator of Varying Hares

A Note by Doucet (1973. House cat as predator of snowshoe hare) in the Journal of Wildlife Management (37: 591) concerning the house cat (*Felis domestica*) as a predator of varying hare (*Lepus americanus*), has prompted me to add my observations to this little-known facet of predation. Doucet comments that he was unable to find any reference in the literature of a domestic cat killing a varying hare, but then described a probable cat–hare encounter at Lac Carré Ecological Station in Quebec. The purpose of this note is to describe two similar encounters that I observed between feral house cats and varying hares in northern Michigan.

From the 1940s through the early 1960s, the Upper Peninsula of Michigan experienced a considerable depopulation of its rural areas. In particular, many of the marginal farms were abandoned, and large numbers of house cats that were traditionally kept on farmsteads were left to fend for themselves. With such abandonment, numbers of domestic cats reverted to a feral state and were commonly observed during this period in forested lands adjacent to old farmsteads.

In mid-November 1960, I was engaged in a Northern Michigan University zoology project that involved, among other things, the collecting of varying hares for laboratory analyses. I made collections, by snaring, along the headwaters of Younger's Creek, 8 km northwest of Amasa, in Iron County, Michigan. On 13 November at approximately 0830 hours, while walking toward the first of my snares, I heard the vocalization of a varying hare under stress, similar to that reported by Doucet. Shortly thereafter I arrived at the first snare and witnessed a large light-colored house cat in the process of dispatching an adult varying hare that was caught in the snare. The predator was disturbed by my arrival and ran off, leaving the dying hare. Investigation revealed that the hare had been snared immediately before my arrival, as evidenced by a lack of strangulation and no wire marks on its neck from the snare. There were several punctures at the base of the skull which were bleeding slightly. There was no doubt that although the hare had been captured by the snare, the cat was responsible for its death.

Because my interest had been aroused by this incident, I then attempted to determine whether this was an isolated occurrence. The varying hare population was high in the study area during the autumn of 1960, and this, along with the relatively large numbers of feral house cats in the vicinity, created a good opportunity for further observations.

Snow conditions favored tracking, and consequently between 14 and 16 November, I began to search for house cat signs by making transects through the study area. Once a cat had been located, I tracked it and made observations on its predatory activity. Altogether, I followed what appeared to be two separate house cats during three days, for an approximate total distance of 20 km. I tracked the first house cat for about 8 km, and during this distance it was unsuccessful in obtaining prey, although it twice pursued (for several tens of metres), varying hares that it flushed from forms. This cat had also apparently made several attempts at capturing subnivean small mammals during this period, but it was not possible to determine its success.

The second house cat appeared to have developed a different, and more successful, hunting method: its tracks, followed over some 12 km, indicated that it had waited in ambush along a well-used varying hare runway until its prey arrived. During the time I tracked it, the cat made attempts, two successful and one unsuccessful, at preying on a hare in this fashion. The successful ambush of its prey was made from beneath a low white spruce (*Picea glauca*) limb that paralleled a hare runway. The greatly deranged snow leading away from this location indicated that a vigorous struggle had taken place. Several flecks of blood, and much hair from both the varying hare and the darker-colored cat, further illustrated the struggle between predator and prey.

Drag marks leaving this area led to another low-limbed spruce tree, under which was found a relatively freshly-killed, but now cold, adult varying hare. It had been partly eviscerated, and the liver, heart, and lungs eaten. Tracks of the feral house cat led away from its prey, but I followed no longer, newly convinced of the ability of the house cat to prey successfully upon an adult varying hare.

As similarly found by Doucet, the distance covered by the two house cats, and the efforts they exerted in attempting to secure large prey, is noteworthy. These observations indicate that whether feral or wandering, the house cat may, in some locations and under certain conditions, be a more significant predator on varying hares than has previously been recognized.

DON GILL

Boreal Institute for Northern Studies
University of Alberta
Edmonton, Alberta T6G 2E9

Received 24 July 1974
Accepted 24 September 1974

Sight Record of a Western Skink on Vancouver Island

The status of the western skink (*Eumeces skiltonianus*) on Vancouver Island, British Columbia is in doubt (Cowan 1937; Carl 1968). Neither Patch (1934), Mills (1948), nor Logier and Toner (1961) included Vancouver Island in the Canadian range of this species. On the other hand, Ditmars (1907, p. 199), Van Denburgh (1922, p. 583), and Taylor (1935, p. 426) list it for the island, Van Denburgh citing Boulenger (1887) as authority for the record and Taylor listing British Museum specimens. Boulenger (1887, p. 373), however, gives no details, merely listing Vancouver Island for specimens of this skink donated to the British Museum of Natural History by J. K. Lord. Thus Cowan (1937, p. K21) and Carl (1968, p. 24), lacking any additional information, considered Boulenger's listing as incorrect. This skink's known mainland range in British Columbia is in the Arid Transition Zone east of the Cascade Mountains in the south-central portion of the province (Cowan 1937; Logier and Toner 1961).

A sighting of the western skink at Wolf Lake, about 12 miles northwest of Courtenay, on 28 August 1972 is therefore of interest. My wife and I first saw the lizard apparently sunning on a sand bank along an old skid road at the base of Constitution Hill near the lake. The skink, which was 5 to 6 inches long, quickly ran into the underbrush, but we were able to view clearly two distinctive bluish-brown longitudinal bands on each side of its body, bluest on the tail, before it was out of sight. These bands distinguished this individual from the northern alligator lizard (*Gerrhonotus caeruleus*) which we have observed about 5 miles from Wolf Lake. Thus, the lack of observations of this skink on Vancouver Island may reflect more a lack of herpetological work than an actual lack of skinks, although the possibility that the species has recently arrived naturally or by introduction cannot be ruled out.

I thank Francis R. Cook and Patrick T. Gregory for comments on this note.

Literature Cited

Boulenger, G. A. 1887. Catalogue of lizards in the British Museum. Volume 3. London, England. xii + 575 pp.

Carl, C. G. 1968. The reptiles of British Columbia. Third edition. British Columbia Museum Handbook Number 3. 65 pp.

Cowan, I. M. 1937. A review of the reptiles and amphibians of British Columbia. Report of the Provincial Museum of British Columbia for 1936. pp. K16–K25.

Ditmars, R. L. 1907. The reptile book. Doubleday, Page and Company, New York, xxxii + 472 pp.

Logier, E. B. S. and **G. C. Toner.** 1961. Check list of the amphibians and reptiles of Canada and Alaska. Life Sciences Division, Royal Ontario Museum, Contribution Number 53. 92 pp.

Mills, R. C. 1948. A checklist of the reptiles and amphibians of Canada. Herpetlogica 4 (second supplement). 15 pp.

Patch, C. L. 1934. *Eumeces* in Canada. Copeia 1934: 50–51.

Taylor, E. H. 1935. A taxonomic study of the cosmopolitan scinoid lizards of the genus *Eumeces* with an account of the distribution and relationships of its species. Kansas University Science Bulletin 23: 1–643.

Van Denburgh, J. 1922. The reptiles of western North America. California Academy of Science, Occasional Papers Number 10. Volume 1. 611 pp.

MARTIN K. MCNICHOLL

Department of Zoology
University of Alberta
Edmonton, Alberta T6G 2E1

Received 27 September 1974
Accepted 6 November 1974

New Records of Amphibians and Garter Snakes in the James Bay Area of Quebec

The following observations were made during the summer months of 1973 and 1974 while the authors were working on an environmental study for the Service d'Environnement, Société d'Energie de la Baie James (SEBJ) in the James Bay region of Québec. In 1973, work was done at Lac Attila (53°35′ N, 77°35′ W) and in 1974 at Lac Nathalie (53°29′ N, 77°26′ W) (Figure 1). The study involved the use of the sand-transect technique (Bider 1968) as well as the collection of specimens. Specimens were catalogued at the National Museum of Canada (NMC). Range extensions for blue-spotted salamander (*Ambystoma laterale*), spring peeper (*Hyla crucifer*), leopard frog (*Rana pipiens*), and mink frog (*Rana septentrionalis*) were recorded. American toad (*Bufo americanus*), wood frog (*Rana sylvatica*), and eastern garter snake (*Thamnophis sirtalis*) were also collected in the area.

The specimen of *Ambystoma laterale*, NMC 15854, was captured at Lac Attila on 20 August 1973 near a small stream overgrown with sphagnum (*Sphagnum* spp.), willow (*Salix* spp.), and alder (*Alnus* spp.). All salamander movements followed the axis of this stream. During the five-month study period in 1973, 29 crossings by *Ambystoma* were recorded on the transect, between 12 July and 8 October, indicating the presence of several animals. The salamanders were recorded over ½ mile from permanent water. The specimen of *A. laterale* represents a range extension of over 300 km from the previous record in northwestern Québec, the River Again at the southern end of James Bay (50°51′ N, 79°28′ W) (McCoy and Durden 1965) (Figure 1). In Labrador, Bleakney (1958) recorded it at Goose Bay, indicating that it may be an isolated northern disjunct there.

The three anurans were captured at Lac Nathalie in 1974. Specimens of *Hyla crucifer*, NMC 15861, *Rana pipiens*, NMC 15859, and *R. septentrionalis*, NMC 15862, were captured in a pond during the breeding season in the first and second week of June. Substantial choruses and populations of larvae and adults were noted in several ponds of the area.

The previous range limit of *H. crucifer* in the area was recorded by McCoy and Durden (1965) at River Again. It also has been reported, but not collected, at Menihek Lake (Bleakney 1958, p. 15) in western Labrador (Figure 1). The specimen taken at Nathalie represents an extension of over 300 km of the peeper's range in northwestern Québec. It was noted that *Hyla*

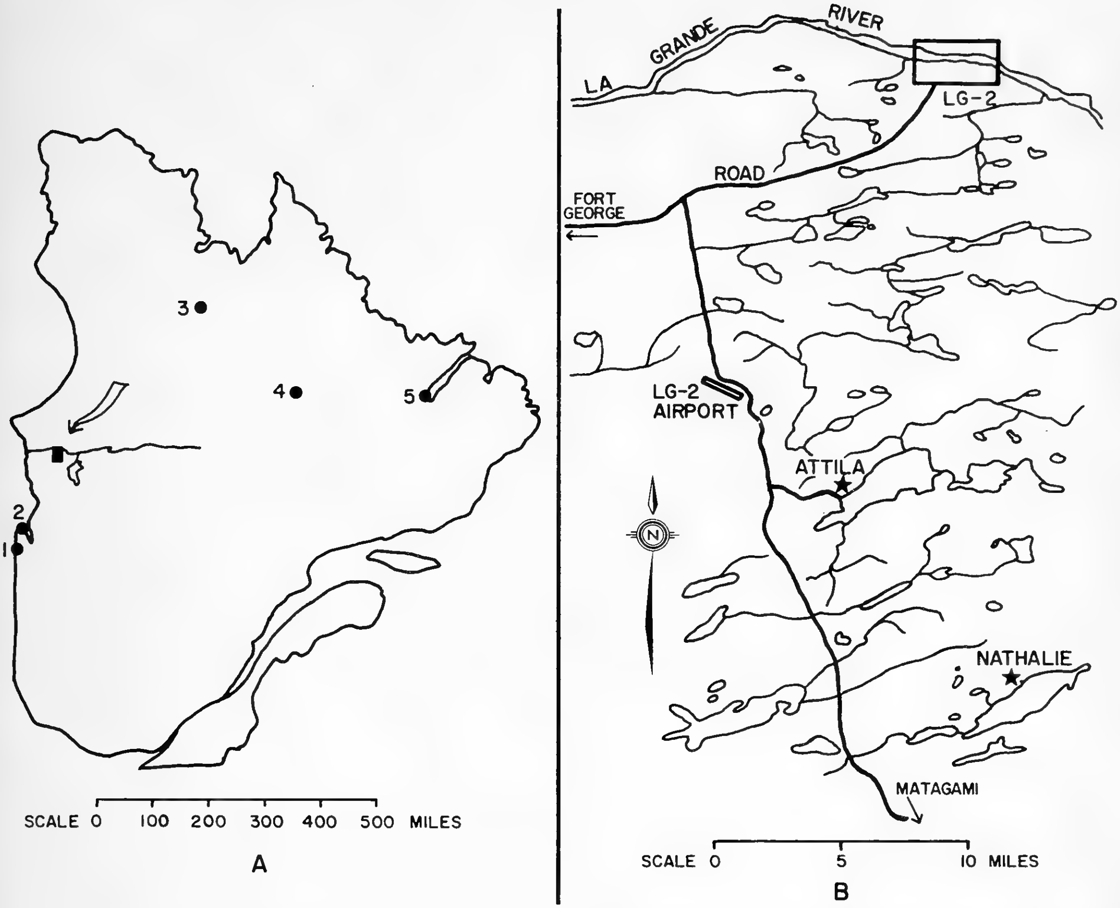


FIGURE 1. A: Map of Québec showing the study area (blackened square indicated by arrow) and locations of previous capture records. 1. River Again; 2. Point Comfort; 3. Lac Aigneau; 4. Menihek Lake; 5. Lac Melville.

B: Map showing the Attila and Nathalie sites in relation to the surrounding area.

preferred ponds with abundant grass or sedge cover for breeding.

Rana pipiens has been reported at Lac Melville, Labrador (Bleakney 1958, p. 33). The previous record of its occurrence in northwestern Québec was at Point Comfort, at the southern end of James Bay (Logier and Toner 1961) some 200 km south of Nathalie (Figure 1).

Rana septentrionalis has been collected from Lac Aigneau in north central Québec (Logier and Toner 1961, p. 42), as well as at River Again (Figure 1) (McCoy and Durden 1965). The specimen from Nathalie is a range extension in northwestern Québec. Their highest concentrations were found in the string bogs which are common in the region.

On 17 July 1973 an 87-cm (total length) specimen of *Thamnophis sirtalis*, NMC 15852, was captured at Lac Attila. The snake was a gravid female bearing six large-yolked eggs, 15–20 mm, and one smaller, 10 mm. One embryo removed and measured was 45 mm total length. Following the capture of the specimen, two snake crossings were recorded on the transect. At Nathalie in 1974, a *Thamnophis* skin was collected, one was observed, and one crossing was recorded on the transect. This species has been previously reported north as far as Fort George in western Québec (Cook 1968, p. 437), but the Attila specimen is the first one collected from this area.

All amphibians observed in the water were either in ponds or in small bays; none were found in larger, more open bodies of water. This creates some difficulty in collection as the most accessible locations are the larger lakes.

This study was funded by the Service d'Environnement, SEBJ. We thank Messrs J.-L. Fréchette, R. Ilsley, and T. Ramsay of SEBJ-Envinement for assistance in capturing specimens. Francis R. Cook of the National Museum of Canada confirmed identifications, provided distributional data, counted *Thamnophis* embryos, and reviewed the manuscript.

Literature Cited

Bider, J. R. 1968. Animal activity in uncontrolled terrestrial communities as determined by a sand transect technique. Ecological Monographs 38: 269–308.

Bleakney, J. 1958. A zoological study of the amphibians and reptiles of eastern Canada. National Museum of Canada Bulletin 155: 1–119.

Cook, F. R. 1968. Reptiles and amphibians. *In* Science, History and Hudson Bay. *Edited by* C. S. Beals. Department of Energy, Mines and Resources, Ottawa. pp. 436–442.

Logier, E. B. S. and **G. C. Toner.** 1961. Check list of the amphibians and reptiles of Canada and Alaska. Royal Ontario Museum, Life Sciences, Contribution 53: 1–92.

McCoy, C. J. and **D. J. Durden.** 1965. New distribution records of amphibians and reptiles in eastern Canada. Canadian Field-Naturalist 79(2): 156–157.

ROSS D. MACCULLOCH
J. ROGER BIDER

Department of Renewable Resources
Macdonald Campus, McGill University
Ste. Anne de Bellevue, Québec H0A 1C0

Received 24 September 1974
Accepted 22 November 1974

News and Comment

SI

A modernized metric system, the Système International d'Unités (SI), provides unique unambiguous symbols for units of measure and these symbols are standard in all languages. This makes for greater clarity and reduces the chances of mistakes. The Editor encourages the use of SI including the -re spelling for metre, litre, etc., in *The Canadian Field-Naturalist*.

There are some basic rules for writing symbols.

1. The symbols are always printed in roman (upright type).
2. Symbols are never pluralized: 45 km (not 45 kms).
3. A full stop is not used after a symbol, except when the symbol occurs at the end of a sentence.
4. When symbols consist of letters, there is always a full space between the quantity and the symbols: e.g., 45 m (not 45m).
   When the first character of a symbol is not a letter, no space is left: e.g., 42°C (not 42° C); or 42°12′45″ (not 42° 12′ 45″).
5. All symbols are written in lower case, except when the unit is derived from a proper name: e.g., m for metre but W for watt.
6. Symbols, not abbreviations, for SI units should always be used and unit names should not be written out (except for litre which is written out to avoid confusion with the number 1): e.g., 16 mm^2 and not 16 square millimetres.
7. Where a decimal fraction of a unit is used, a zero should always be placed before the decimal marker: e.g., 0.45 km (not .45 km).
8. Spaces must be used instead of commas to separate long lines of digits into easily-readable blocks of three digits with respect to the decimal marker: e.g., 32 453.246 072 5. A space is optional with a four-digit number: e.g., 1 234 or 1234.

Common SI units and other recognized units associated with SI that are sometimes used in *The Canadian Field-Naturalist* are millimetre (mm), centimetre (cm), metre (m), kilometre (km), milligram (mg), gram (g), kilogram (kg), second (s), minute (min), hour (h), day (d), and degree Celsius (°C).

(*After* How to write and type SI: a style guide. 1974. Published by Metric Commission, Box 4000, Ottawa, Ontario K1S 5G8)

The International Council for Bird Preservation

At the XVI World Conference of the International Council for Bird Preservation held in Canberra, Australia, 19–25 August 1974, 33 resolutions were unanimously adopted. The resolutions pertaining to Canada and the subjects with which they are concerned are:

1, 2, and 3 — responsible collecting by museums.
8 — habitat preservation for birds.
10 — ratification of the Convention on International Trade in Endangered Species. (Canada has signed but has not yet ratified the treaty.),
15 — research on toxic chemicals,
16 and 17 — oil developments in the arctic,
18 — seabirds and salmon nets,
33 — the desirability that the World Wildlife Fund (Canada) support ICBP (Canada).

Resolutions

The XVI World Conference of the International Council for Bird Preservation:

1. In furtherance of Resolution 10 of the ICBP Conference at Taxel in 1970 for the compilation of a register of material of endangered species held in various museums, and in view of the importance of such a register as a factor that could reduce or eliminate unnecessary collecting;

   Recommends that all efforts should be made by governments and institutions to aid the organisation and financing necessary for the compilation of such a register.

2. In furtherance of Resolution 10 of the ICBP Conference at Texel in 1970;
Urges scientists to consider alternative ways of obtaining information before resorting to the collecting of specimens; and that if collecting is justified, to ensure that all possible scientific information will be recorded from each specimen for permanent public record;
Urges museums around the world to establish self-regulating policies that require justification by their employees of each collecting project involving wild birds;

Urges the International Council of Museums (ICOM) to consider the possible preparation of policies and guidelines and to provide leadership in maintaining ethical standards in collecting wild birds, taking into account the long-term conservation of wild populations;

Urges governments to issue permits only to accredited museums and scientific institutions or their agents.

3. *Endorses* the resolution of the International Ornithological Committee of the XVI International Ornithological Congress on collecting by scientific institutions;
Emphasises that governments, before issuing permits to scientific institutions to collect specimens for scientific purposes, should satisfy themselves that the collection of such material is justified for the purpose of the research in question and will not endanger the population of the species.

8. *Recognising* that the continued survival of birds depends especially upon the maintenance of suitable habitat (or biotope) in large enough units and in proper geographical patterns;

Recognising that many populations of birds have become endangered partly because of the destruction of their habitat and that continuing pressures for the destruction of habitat will put additional populations and species in jeopardy;

Recognising that effective land-use planning is necessary for the conservation of habitat;
Urges that governments adopt land-use planning at all levels (local, national, and where possible international); (a) incorporating ecological principles including comprehensive inventories of natural resources; (b) acknowledging that wildlife populations and their habitat are important components with high social values; (c) giving special attention to protection of endangered wildlife and plants and their habitat but also recognising that most species cannot be maintained simply in isolated reserves but depend for survival primarily on the habitat quality of the ordinary countryside.

10. *Concerned* about massive and widespread abuses to wild birds and their populations for trade on a world-wide scale;
   (a) Sign, ratify and implement the Convention on International Trade in Endangered Species of Wild Fauna and Flora and cooperate with other governments by not permitting trade in species (i) which are protected in most of their range or (ii) taken in contravention of the law in their country of origin;
   (b) List the species which they will allow to be exported or imported;
   (c) Amend such lists on the basis of investigations of:
      (i) recruitment rate of the populations in the wild;
      (ii) the preservation of indigenous stocks; and
      (iii) the potential for harm of exotic birds whether as pests, through effects on native populations and ecosystems, or as vectors of diseases.

15. *Recognises* the concern shown by many governments for the safe use of toxic chemicals;

Recognising that the preservation of biomes, habitats and species are fundamental to the existence of natural ecosystems;
Recommends that governments
   (a) continue to monitor residues and their effects, publish residue data and phase out production, distribution and use of persistent toxic chemicals; and
   (b) that governments investigate and monitor the effects of short-lived chemicals on the environment.

16. *Recognising* there is likelihood of rapid development of resources, especially oil, in the arctic areas of the northern hemisphere;
Recognising such development threatens marine life as a result of factors related to the cold temperatures and oceanic circulation of the northern seas;

Recognising seabirds are indicators of the quality of the oceanic environment;

Recognizing an assessment of numbers and distribution of a species is a first step both in gathering basic data on the ecology of the species and in formulating conservation policy;
Urges that the countries bordering the arctic seas undertake steps to map and census the populations of seabirds breeding in the arctic.

17. *Recognising* that many regions of the world are underlain by sedimentary rocks which may contain oil;

Recognising that many of these regions also support valuable living resources;

Recognising that the release of oil has occurred as a result of accidents or negligence, that almost all the oil spills examined have resulted from human failure or error;
Recognising that oil exploitation causes considerable environmental disturbances;

Urges governments to consider the previous performance of a company and its contractors, including the frequency of accidents or spills, in awarding contracts for exploration, exploitation and shipment of oil, especially at sea, and to survey and designate coastal shorelines where onshore oil facilities will be prohibited because of unacceptable risk of pollution and disturbance.

18. *Recognising* the enormous mortality of seabirds associated with the salmon gillnet fisheries of northern oceans;

Recognising the inadequacy of present knowledge of seabird populations against which to gauge the impact of present and future mortality;

Urges governments of countries conducting commercial fishing operations to investigate all means of minimising or avoiding the killing of seabirds, and further recommends that governments consider hazards to seabirds when planning future operations at sea.

33. *Recalling* that financial assistance to the International Union for the Conservation of Nature and Natural Resources and the International Council for Bird Preservation was one of the main motives for the establishment of the World Wildlife Fund;

Recommends that National Sections of ICBP urge that the National Appeals of the World Wildlife Fund in their respective countries earmark funds for ICBP projects and activities in various parts of the world.

Directory of IBP Areas

The Canadian National Directory of IBP areas is now in press and will be available in late 1974. The Directory is a condensed compilation of the ecological checksheet surveys of National and Provincial Parks, ecological reserves, natural areas, wildlife refuges and unprotected wildland areas, completed under the auspices of the Conservation Subcommittee for the International Biological Programme, during the period 1968–1973. It consists of individual summary sheets containing outline information of value to potential users in research or educational fields. The directory is published in an unbound notebook format, divided into ten regions. It can be purchased in its entirety for $35.00 or as regional separates as follows:

Region		No. of summaries	Price
1	British Columbia	136	$ 7.00
2	Alberta	147	7.50
3	Saskatchewan	101	5.00
4	Manitoba	70	3.00
5	Ontario	215	13.50
6	Quebec	17	1.50
7	Maritimes: Prince Edward Island, Nova Scotia, New Brunswick	116	6.00
8	Newfoundland	67	3.50
9-10	Arctic and Subarctic: Yukon and Northwest Territories	52	3.00

Accession lists of the checksheeted IBP areas can be obtained for $2.00 for Canada or $0.50 per region. Individual summaries can be obtained for $0.25 each. (Price includes handling and mailing by parcel post in Canada.)

It should be noted that precise locations and boundaries of the areas have been purposely omitted from the summaries. Individuals interested in a particular site can obtain this information from the appropriate institution listed at the end of a summary.

Enquiries should be addressed to Dr. G. H. La Roi or Mr. T. A. Babb, Department of Botany, University of Alberta, Edmonton, Alberta T6G 2E1. Please make cheques or money orders payable to "Canadian IBP Areas Directory."

Book Reviews

Zoology

The Moths of America North of Mexico

By D. C. Ferguson *in* R. B. Dominick et al. 1971–72. E. W. Classey Ltd., Hampton, Middlesex, England. 277 pp. 22 pl.

Although the author says in his preface that he had no serious intention of working on saturniid moths prior to 1969, the first fascicle was published in 1971. One can only show admiration for the overall job done with these two fascicles, which certainly fill a serious gap. Incredible as it may sound, the North American saturniids have never previously been the subject of an adequate revision or monograph. Despite the enormous amount of literature consulted for this publication, there remain, as the author says, some unresolved problems in the taxonomy and nomenclature of the species, leaving ample room for further research, hopefully to be carried out with the same commendable care demonstrated by the author in the present fascicle; to mention one example (from p. 43), the larvae of the *Sphingicampa* species.

The impression one has when using this monograph is that it is almost all thoroughly done and contains much rare and useful information, both general and specific, on distributions, life histories, and nomenclature. Probably all of us will welcome Ferguson's treatment of genera. Perhaps the species and their distribution pattern would have been clearer had the author followed the format of species treatment found in previous fascicles of *MONA*, especially as he admits himself that, for instance, the subspeciation in *Automeris io* is based partly on guesswork.

Limiting myself now to the Canadian saturniid species, I find the author has put considerable effort into two entities that have always presented many problems: *Eacles imperialis* and *Dryocampa rubicunda.* The final work on the two species is still to be done, as Ferguson says himself. Whether there are one or two species of *Eacles* is a problem still more complicated by a fact which Ferguson missed — the "strikingly aberrant color forms" (p. 28) are not restricted "only" to the few specimens Ferguson mentions and figures but occur normally, and in numbers, over a broad area around Georgian Bay (R.O.M. has a whole series of them). *Dryocampa,* which Ferguson treats rather thoroughly and with much aptitude, still keeps its secrets but now looks more understandable than previously. Only a few remarks: (*a*) the *Dryocampa* larva is easily distinguished from *Anisota* larvae by the anal plate, a character useful in separating species in both genera; (*b*) the *Dryocampa* larva in its first instar does not show the well-developed thoracic horns, but only little stumps (like *Anisota finlaysoni*); (*c*) the name *semialba* "Rolle" is really a *nomen nudum*, as Rolle never published any "papers" at all, only sales-catalogues. Because of the longstanding uncertainty about the Rolle "paper," this reviewer sought the information directly from the Deutsches Entomologisches Institut, Eberswalde, German Democratic Republic, near Berlin where Rolle had his establishment "Kosmos."

The treatment of the difficult Hemileucinae is satisfying. More research is needed on the population of *Hemileucina maia* in Michigan (see p., 117, paragraph 3) where we find an oak and an aspen feeding population together in the same area. The larvae of each show different characters, but the aspen feeders are definitely not *H. nevadensis.*

The coverage of our large silkmoths is excellent, with many interesting remarks for both the general collector and rearer. Finally the nomenclature of *Samia cynthia* is straightened out! As to the *promethea* × *cynthia hybrids* (figured plate 16, Figure 7), the reading of the paper by L. H. Joutel (Journal of New York Entomological Society XV: 101, 1907), not quoted by Ferguson, is a must. It makes it probable that the *cynthia* was mated a second time with a *cynthia* to bring her to ovipositing. This then would somehow explain the likeness of the offspring. It may be added that the colony of *S. cynthia* which lived years ago (about 1936–1958) in Toronto was found on ash trees. *Actias luna* has its northern limits in Ontario surprisingly far north (Favourable Lake, 52°N). Also welcome is the synonymy of the *Saturnia* names (p. 176); that *Agapema* was preserved on grounds of larval characters is much appreciated by the modern taxonomist. The difficult genus *Hyalophora* is now much clearer although there are still problems in interpreting populations at the

Manitoba-Ontario border where it seems that *nokomis* genes may be present to some extent in *columbia* populations. *Callosamia angulifera* is now known all along the north shore of Lake Erie where *Liriodendron* is still preserved.

Despite a uniformly competent treatment of the other genera, the section on *Anisota* is thoroughly unsatisfactory. To go into details would be too much for a review, especially since a monograph of the entire genus (including the Mexican species) is in preparation. The following should be pointed out, however. (*a*) There are substantial series of *A. assimilis* (both males and females) available in different institutional collections and not only a "unique male type." All the Dampf specimens (destroyed through war action) were certainly *assimilis* as the figure in Seitz, plate 142, line f, in volume VI (misidentified as 1 and 2 of *A. leucostygma* clearly shows. (*b*) The two females of *A. consularis* from Cassadega, Florida, figured as numbers 24 and 25 on plate III by Kimball, are *consularis,* caught together with the accompanying male. It would have been easy to check on this as the specimens are clearly marked as such in the Florida State Collection of Arthropods. (*c*) The statements about eye size (p. 9) which play an important role in the genus *Anisota* should be read with G. A. Mazokhin-Preshnyakov's *Insect Vision,* Plenum Press, N. Y., 1969, for comparison. (*d*) *Anisota stigma* is known in southern Ontario from a few specimens only from localities on the north shore of Lake Erie; from North Bay only misidentified larvae found their way in the literature as *stigma,* and this mistake should not have been repeated here.

Finally, how long must we continue to correct mistakes in Canadian geography? The Niagara Peninsula, mentioned several times, comprises only the small area between Lakes Erie and Ontario but never includes Toronto or the north shore of Lake Erie (p. 235). The other sore point is "Southern Canada": on p. 55, places like Rainy River, Dryden, Sudbury, and Kirkland Lake are included there, yet on p. 8, the Citheroniinae and Hemileucinae are said to go as far as southern Canada, while the former go even to northern Canada (Sudbury, Kirkland Lake, Dryden). Again, on p. 101 it is said that *Hemileuca* species reach southern Canada in the western provinces; the western provinces, however, are not considered southern; and the worst of it all on p. 68: "in southern Ontario north to North Bay." The locality on plate 2, Figure 1, should read: Point-au-Barril.

The colored plates are, of course, of the now already renowned high quality, as are the drawings, of which one would have liked decidedly many more (costs notwithstanding).

J. C. E. RIOTTE

Department of Entomology and Invertebrate Zoology
Royal Ontario Museum
Toronto, Ontario M5S 2C6

Illustrated Keys to the Fresh-water Fishes of Alaska

By James E. Morrow. 1974. Alaska Northwest Publishing Company, Anchorage. 78 pp., 65 figures. $2.95 + .50 mailing.

A little booklet on freshwater fishes of a region is always a good idea, especially when there isn't one already available. To that extent, this illustrated booklet on what you might catch in Alaska lakes and streams is commendable. Unfortunately, the idea hasn't been well executed. Compared to many similar efforts for various parts of North America, this one has poor line-drawings, far less in the way of natural history notes than could have been printed on the pages, and it provides little to stimulate the reader to further interest in freshwater fishes. It would have been preferable to do a good job on either the illustrations or the text. As it is, neither have much substance. Undoubtedly, the book will be useful for a few years until something better comes along (and this perhaps is sufficient reason for its publication now). At $2.95 it would be a handy thing to have in the glove compartment if you were going fishing in Alaska.

P. A. LARKIN

Institute of Animal Resource Ecology
University of British Columbia
Vancouver, British Columbia V6T 1W5

Animals of Manitoba

Edited by Robert E. Wrigley et al. Illustrated by James A. Carson. 1974. Manitoba Museum of Man and Nature, Winnipeg. 158 pp. $2.50.

The authors state that "this book is not meant to be a key to identify the great diversity of wildlife that one may encounter." Rather, "the purpose . . . is to help people become more aware of the multitude of living things all around them, but so often missed; an invitation to stop, observe, and possibly then learn to appreciate the complex relationship that exists between them and their surroundings." The authors further state that the "accounts supply information on identification, habitat and life history of selected Manitoba animals representing some of the major groups." "Particular animals," they state, "were chosen on the basis of their illustrating the diversity present in each group, and/or their general occurrence in city yards, provincial and national parks, and along country roads – areas within easy reach of everyone."

The book is organized into seven major sections within which brief accounts of selected species of mammals, birds, reptiles, amphibians, fish, insects, and miscellaneous invertebrates are presented. A bibliography of readily available reference books on each of the groups of animals is included as is a Manitoba checklist for each group of vertebrates. Each of the species discussed is illustrated by an attractive black-and-white sketch by James Carson.

A map showing the broad life zones of the province, major park areas, and selected towns precedes the text. Unfortunately, the species selected for discussion in the book do not cover all of the province's life zones. This book might better have been titled "Animals of Central and Southern Manitoba." The marine, tundra, and sub-arctic transition zones are poorly represented in this book. The whale, seal, caribou, polar bear, snow goose, eider, gyrfalcon, ptarmigan, grayling, and sculpin, for example, find no place in the species accounts. Admittedly, these animals are not readily accessible to most Manitobans. Without some representation of the far northern species among the selected accounts, however, one cannot really purport to illustrate the great diversity of "Manitoba" animals.

After perusing this book, one cannot help but wonder whether a much more effective presentation might have been achieved had the authors organized their accounts by life zones.

There are annoying shortcomings in some of the brief accounts. At times, descriptions or ranges are poorly defined. In the brief account of the white admiral butterfly, for example, the author simply states, "A species related to the viceroy, and similar in size but quite different in colour is the white admiral (*Limentis arthemis*)." The black-and-white sketch accompanying the account does little to enlighten one regarding the noteworthy difference in color.

It is difficult to perceive the gap this book is intended to fill. It offers little in the way of new or generally unavailable information.

R. E. ENGLAND

RPC Ltd.
Resource Planning and Management Consultant
Winnipeg, Manitoba

Butterflies of Saskatchewan

By Ronald R. Hooper. 1973. Saskatchewan Department of Natural Resources, Saskatoon, Saskatchewan. 216 pp., illustrations, map. $3.00. Available from Museum of Natural History, P. O. Box 1121, Regina.

The Reverend Ronald Hooper has recently produced a most welcome field guide to the skippers and butterflies of Saskatchewan. It is particularly welcome as it is the first such book to appear on any area in western Canada. Prior to its publication the only regional sources available were a number of annotated provincial checklists and articles dealing with smaller areas.

The first 19 pages present details on the history of butterfly collecting in the province, what butterflies are, their life history and habits, life zones in the province, where and how to collect, and how to mount, label, and identify specimens. These comments are quite useful for the beginner and provide many helpful hints for more advanced workers.

The remaining pages are devoted to the 135 species that have been found in the province. The arrangement is according to families, each starting with a simple description and an easy-to-use diagram key to the individual species. All of the species are illustrated with black-and-white or, occasionally, color photographs. The latter are of excellent quality, but some of the former, especially those of the blues, could have come out better. It is to be regretted that color photography was not used more extensively. A particularly nice feature is the way in which the text for each species is on the page facing the illustration. This text includes the key characters used in identification, stressing ways by which related species may be distinguished. There is also a description of range, time of flight, ecology, and food plants. The book ends with a list of hypothetical and expected species, a bibliography of helpful references, and a checklist of the Saskatchewan species.

The book has been carefully proofread but a number of spelling mistakes have unfortunately crept in, such as *Atrylone* for *Atrytone* (p. 31), *immaculosis* for *immaculosus* (p. 95), shunk for skunk (p. 97), *scuderii* for *scudderii* (pp. 111, 206), *icaroides* for *icarioides* (pp. 113, 206), 433c for 443c (p. 206), and *acquilo* for *aquilo* (p. 206). Omissions occur on p. 206 where the subspecies *siva* was left off for *Callophrys siva*, and the subspecies *sirius* was left off for *Lycaena rubidus*. The author has seriously attempted to follow the nomenclature of C. F. dos Passos' "A synonymic list of the nearctic Rhopalocera" and subsequent revisions of the Melitaeinae and Lycaenidae but has differed, without explanation, where he gives *Polites mystic dacotah* instead of *sonora dacotah, Chrysophanus titus* instead of *Harkenclenus titus*, and *Nymphalis j-album* instead of *N. vau-album j-album*.

The author is to be commended for sorting out the appropriate subspecific status of most species. It is puzzling, however, that *Hesperia uncas* was not called *H. uncas uncas, Hesperia pahaska* was not called *H. pahaska pahaska, Erynnis brizo* was not called *E. brizo brizo, Danaus plexippus* was not called *D. plexippus plexippus*, and *Erebia discoidalis* was not called *E. discoidalis macdunnoughi*. Subspecies could have been listed, or at least discussed, for *Atrytonopsis hianna, Euchloe ausonides, Lycaena mariposa, Plebejus acmon, Nymphalis californica, N. milberti, Polygonia satyrus, Euphydryas anicia*, and *E. editha*. A deeper discussion of the *Colias eurytheme* and *alexandra* groups would have helped. One wonders, for example, how to differentiate the yellow specimens which he refers to as *C. eurytheme eriphyle* from *C. philodice*, and why only the subspecies *christina* is given for *Colias alexandra*.

Hooper points out that further work is needed in the *Phyciodes tharos* and *Papilio machaon* groups. He was justified in not naming subspecies at this time as detailed studies must be made of the complexes.

The above criticisms are minor and do not markedly detract from the great value of the book. In the writer's opinion, it is the best single source on the Rhopalocera of this region. It certainly fills a long-felt need and will be used extensively by naturalists in the prairie provinces and adjoining states. It would be a bargain at three times the cost.

CHARLES D. BIRD

Department of Biology
University of Calgary
Calgary, Alberta

Calf Mortality on the Calving Ground of Kaminuriak Caribou during 1970

By F. L. Miller and E. Broughton. 1974. Canadian Wildlife Service Report Series, No. 26, Ottawa. 26 pp. $1.

This report is one of several publications resulting from a 2½-year study by the Canadian Wildlife Service of the Kaminuriak caribou populations. The Kaminuriak herd inhabits the area west of Hudson Bay in northern Manitoba, Saskatchewan, and the Northwest Territories.

The authors provide us with a detailed picture of caribou calf mortality during the first month of life, based primarily on autopsy of 57 calves and a small number of adults in June and July 1970. Eighteen of these calves were killed by wolves (determined by evidence of hemorrhagic conditions), 12 were abandoned, 6 were stillbirths, 12 died from various physiological or pathological causes, 3 from injuries and 5 undetermined. The most striking feature of the wolf-killed calves was the low level of utilization. Six of the 18 were not utilized at all, and seven had only visceral parts eaten.

It is concluded that an estimated 25 nonbreeding wolves on the calving grounds of the Kaminuriak population could take from 20 to 30% of the new-born calves. The authors state that the most questionable part of their evaluation of the total impact of wolf predation is the estimation of the number of calves totally consumed by wolves and thus not detectible in surveys by helicopters. An equally important question is what proportion of the calves killed by wolves were already abandoned or suffering from various disorders or abnormalities. This is a crucial question since these latter two categories accounted for 10% and 30%, respectively, of the observed calf mortalities in which wolves were not involved. The low level of utilization of killed calves and the lack of carrion utilization suggest a superabundance of easy prey. The authors' contention that the 30% figure for physiological and pathological abnormalities, malnutrition, and injuries is "well within acceptable limits for healthy cervid populations" is debatable.

No mention is made of the possible role of brucellosis in the mortality pattern of the Kaminuriak population. A 1970 publication (Canadian Journal of Zoology 48: 1023–1027) reported a very low incidence (4.37% of 320 tested animals) in the period 1966–1968. Nevertheless, the frequency of observations of placental retention, stillbirths, metritis, etc. in the 1970 data suggest that the incidence of this condition may have increased.

It is stated that "wolves remain the most readily manageable of mortality factors in the life equation of the Kaminuriak caribou and possibly the least understood in their impact on the caribou population." Certainly a better understanding, especially of possible compensatory mechanisms, is necessary to verify the authors' conclusion that "Pressures of wolf predation . . . may be a principal factor limiting the population's growth." We must also be ready to resist the tendency that will come from advocates of wolf control to extrapolate these findings to other caribou populations without sufficient evidence.

PETER C. LENT

Alaska Cooperative Wildlife Research Unit
University of Alaska
Fairbanks, Alaska 99701

Shallow-water Gammaridean Amphipoda of New England

By E. L. Bousfield. 1973. Comstock Publishing Associates, Cornell University Press, Ithaca. 312 pp. $17.50.

The purpose of this book is to provide a comprehensive guide to the gammaridean amphipods occurring at depths of less than 100 feet along the New England coast. The gammaridea are one of four suborders of the amphipods, making up the bulk of this order, and are the most abundant crustaceans along the New England coast. Thirty families, including nearly 200 species, are covered in this volume.

In addition to the introduction, sections on the general biology of the amphipoda, how to collect and prepare amphipods for study, how to use this guide book, a list of gammaridean amphipods recorded or probably occurring in the New England shelf region, a guide to pronunciation and root meanings of scientific names, a glossary of scientific terms, selected references, and an index to common and scientific names are included. The greater part of the book consists of dichtomous keys to families, genera and species, with descriptions, distribution, ecology, and life cycle of each species given. Many of the keys are not restricted to New England species but cover those of the American Atlantic region in general. Although there was no opportunity to test the keys, several that I read through suggested no difficulty in their use.

Illustrations include a colored photograph of *Gammarus oceanicus* as a frontispiece, 13 figures illustrating terminology used in the text and keys, and 69 plates consisting of excellent line drawings of gammaridean amphipods and parts thereof. One hundred and fifteen species are illustrated in their entirety.

As stated in the foreword this book has been written for the informed layman, student biologist, and fisheries biologist, as well as the professional carcinologist. I suspect, however, that the price, although considering today's book prices is not at all inconsistent with the caliber of this book, will tend to limit its purchase to those in the last two categories.

WILLIAM B. PRESTON

Manitoba Museum of Man and Nature
190 Rupert Avenue
Winnipeg, Manitoba R3B 0N2

Grzimek's Animal Life Encyclopedia

Edited by B. Grzimek. 1972. Mammals. Volumes X to XIII. Van Nostrand Reinhold, New York. *ca.* 600 pp. per volume. $25 per volume.

Grzimek's Animal Life Encyclopedia has been called the definitive reference work on animals, and this judgment may be correct. It has been a tremendous undertaking, comprising 13 volumes, each of about 600 pages. The mammals alone, which I am reviewing here, are discussed in four volumes. They are treated in the more or less accepted evolutionary sequence: primitive terrestrial mammals plus primates up to gorillas; chimpanzees, man, bats, rodents, whales; lagomorphs, carnivores, pinnipeds, subungulates and horses; and the remaining ungulates.

It is as impossible to generalize about the contents of an encyclopedia as it is about those of an anthology. I shall therefore consider in detail, as a representative entry, the information given in the 95 pages of Volume 13 on the deer family, a family of particular interest to many Canadians. A five-page description of the Pecora introduces this section, followed by three and a half pages of general comment on the Cervidae. This part contains a detailed discussion of the relationship between hormones and antler growth in male deer, the use of antlers as aphrodisiacs in Old World cultures, and a few remarks on the evolution in Asia of both living and extinct species.

Following these general remarks are paragraphs describing each species with brief comments on their races, if any. In the eight pages devoted to the wapiti, or elk (considered here to be conspecific with the European red deer, *Cervus elaphus*), the life history of this species, antler growth and form, rutting behavior, and hunting by man are considered.

The emphasis in this encyclopedia is on European animals, which is not surprising since 125 of the contributors, well over half, are from Germany. Thus while six pages are needed to discuss the roe deer, the white-tailed and mule deer are dealt with in three. This may seem disadvantageous to some, but I found it refreshing to uncover new anecdotes and information drawn from the countryside and zoos of Europe. Too often wildlife articles from continental Europe are ignored by North American monolingual biologists.

Each volume is handsomely illustrated. There are seven full-page color photographs of cervids, over 100 colored drawings which distinguish the young, males, and females of various races and species, and many marginal line drawings of antler shape, distinctive postures, and range distribution.

This encyclopedia first appeared in German in 1968, but for this attractive 1972 edition many new data have been added. The clear translation is only rarely awkward (i.e., "The head size is from short to long," p. 154), and there are few typographical errors.

Each volume concludes with conversion tables for metric and English systems; a systematic classification of the species; the English, German, French, and Russian names of the species; a brief list of source articles; and an extensive index.

This encyclopedia would be an excellent acquisition for any public library, as well as for that of either the zoologist or the layman who can afford to buy it.

ANNE INNIS DAGG

Otter Press
Box 747
Waterloo, Ontario

Atlas of Animal Migration

By Cathy Jarman. 1972. John Day, New York. 124 pp. $10.95.

This small book is written strictly for the interested layman and not for a scientific audience. It discusses in a non-technical manner the major aspects of animal migration and there are many excellent drawings, maps, and diagrams. The book is visually pleasant and for a general reader I suspect there would be a considerable amount of useful information. From the non-technical point of view, my only objection to the book is the long captions under many of the illustrations which essentially repeat much that is said in the text. I suspect the author realizes that many people will look at the pictures and the captions without reading the text, and if this is true, then there is an excuse for the lengthy captions.

From the scientific point of view, the statements in the book are completely undocumented: e.g., on page 27 at the beginning of the first complete paragraph, there is a statement "some biologists think." My immediate reaction to this type of statement is, why are the biologists not named, and a reference cited. If some particular fact interests a person, there are no leads given to other literature and the only possible references that one might check are those mentioned under the acknowledgments on page 124. I find this complete lack of reference to other literature a decided fault, since any interested reader might like to check other references. Otherwise there is little to criticize. There are some vague statements and a few mistakes: i.e., the number of surviving bison differs on pages 57 and 59 although the statements supposedly refer to the same statistic.

The format of the book in many ways reflects the author's background. She has a B.Sc. in Zoology from Nottingham University and has subsequently lectured to children and students and served as an editor of an encyclopedia of animal life. Generally, statements in encyclopedias are often not documented, and in many ways the current book is written along encyclopedic lines but is more lavishly illustrated. It can be recommended as a general compendium on the subject but is somewhat lacking in depth so that it would not be of particular interest to a person knowledgeable on the subject of animal migration.

H. F. HOWDEN

Department of Biology
Carleton University
Ottawa, Ontario K1S 5B6

Pacific Fishes of Canada

By J. L. Hart. 1973. Fisheries Research Board of Canada Bulletin 180. 740 pp., numerous illustrations, eight color plates. Information Canada, Ottawa K1A 0S9. $8.

This volume is not a mere updating of the well-known *Fishes of the Pacific Coast of Canada* by Clemens and Wilby. It is, in essence, a completely new book well illustrated with new drawings as well as sketches of diagnostic features. The 325 species of marine fishes known to occur in British Columbia are described and figured. Superb color photos of live fishes, taken by F. T. Pletcher, embellish the volume. Several additional species were recorded from B.C. after the manuscript was well advanced, and are mentioned in various keys but not in the species accounts (e.g., *Xenomystax atrarius*, *Acantholiparis opercularis*, *Xeneretmus leiops*).

The brief introductory section includes a concise history of pertinent Pacific ichthyology which is complemented by a succinct summary of North Pacific oceanography. Sections on "Scope of Coverage," and explanations of "Species Accounts," "Keys," and 'Classification" complete the introduction.

The species accounts begin with a key to classes or subclasses; subsequent keys in these major sections lead either to species (Elasmobranchii) or to families (Osteichthyes). The familial key in Osteichthyes is quite workable and not excessively long (e.g., only 20 steps to Sciaenidae at couplet 84). Only occasionally is the key vague (e.g., couplet 64, "Fishes with one spine" would better read "Fishes with one dorsal spine"). Keys to species within familial groups (which we have tried) are clear and workable.

Each species account includes the derivation of the scientific name, a description (diagnosis, meristics, color, size), recognition (features for rapid recognition, which would be better placed at the beginning), and where known or pertinent, sections on life history and utilization. In some species (salmonids, clupeids, osmerids) these latter sections are extensive. Both world (unlike previous editions) and British Columbian distributions are given. An unusual but efficient combination of "numbering and authoring" is used for references. It is noteworthy that more than 1100 references (through 1970) are cited, attesting the exhaustive literature review. Species accounts are thorough, and with some notable exceptions, the illustrations are very good. The drawings of *Notolepis rissoi* and *Bathylagus milleri* give the misleading impression that scales are wanting, while that of *Argyropelecus lychnus* lacks the precise definition and high quality of *Macropinna microstoma*. The dawings of Pacific bonito and dusky rockfish are somewhat tipsy in their orientation.

Two inclusions that should be, but seldom are, standard for works of this nature are a gazeteer of the area under consideration and a list of the specimens used for illustration.

A short but generally adequate glossary of relevant ichthyological and anatomical terms is included. "Trifid" should be a separate entry and not placed under "bifid" and the definitions for shoulder girdle and placoid are poor.

The Fisheries Research Board of Canada deserves congratulations for having produced a most useful reference and guide to the richest of Canada's fish faunas. This book, which was Dr. Hart's last major project, stands as a tribute to the memory of a man who had spent a distinguished career in biology.

The first printing of 4100 copies is now almost sold out and a second printing is underway.

C. G. GRUCHY
D. E. MCALLISTER

Ichthyology Unit
National Museum of Natural Sciences
Ottawa, Ontario K1A 0M8

BOTANY

Research Experiences in Plant Physiology. A laboratory manual

By Thomas C. Moore. 1974. Springer-Verlag, New York. 462 pp. $9.50.

Thomas Moore's *Research Experiences in Plant Physiology* is a well-tested laboratory manual developed over a 12-year period by a teacher of plant physiology. As with many laboratory manuals, this one reflects a specific course and the author's personal approach to the subject. Moore presents 25 exercises, half of which emphasize plant growth and development, with the others devoted to photosynthesis, mineral nutrition, protein chemistry, and membranes. Although the manual is aimed at upper division undergraduate and graduate students, about half of the exercises could well be executed by sophomores, even in large classes; the remainder, which include protein electrophoresis and incorporation of radioisotopes, are definitely suited to small groups of advanced students.

Since courses in plant physiology often differ widely between and within universities in terms of the types of students to be taught, duration, topics, and personal style, this worthwhile manual may have restricted application. Recognizing this situation, Moore has purposefully set forth his manual in a rarely seen format which allows the ready utilization of any set of specific exercises and expeditious revision of the manual itself. Specifically, each exercise is complete in itself and is written in five sections. The "Introduction" gives the intended purpose and a rationale, context and perspective for the prescribed experiment or procedure. The "Materials and Methods" section gives the actual prescribed procedure in detail, alerts the student to critical points and instructs on the handling of the data. The third section is a list of references which is rather extensive and thus beneficial to students who happen to be particularly interested in that area of investigation. Next is a section on the required special reagents, supplies and equipment, and notes on scheduling. Moore has very helpfully included the sources (with complete addresses) for many of the special items. He also notes very realistically the laboratory time which a student must devote to the exercise. The concluding section is a set of report forms containing directive tables and graphs, as well as summarizing questions.

Moore intends the exercises to be *research experiences* for the students. The sometimes complex procedures and the analyses and interpretations required certainly tend toward this goal. I would suggest that the exercises are, however, just that, well-tested exercises with infrequent failures guaranteed when appropriate care and preparation are ensured.

WILFRIED E. RAUSER

Associate Professor
Department of Botany and Genetics
University of Guelph,
Guelph, Ontario

Woody Plants of the North Central Plains

By H. A. Stephens. 1973. The University Press of Kansas, Lawrence, Manhattan, Wichita. 530 pp. $20.

The states of North Dakota, South Dakota, Nebraska, and Kansas lie directly south of the western two-thirds and the eastern third of the provinces of Manitoba and Saskatchewan. These four states are mainly prairie: tall grass in the east, mixed tall and short grass in the central parts, and short grass in the west. Trees and shrubs are restricted almost entirely to the river valleys and hill country such as the Black Hills, Turtle Mountains and Pembina Mountains. Woody elements from the Eastern Deciduous Forest, Cordilleran Forest, and the Northern Conifer Zone extend into parts of the region.

The author devotes two pages to each of 255 woody or partly woody taxa. One page consists of a very detailed description, notes on habitat, range, a distribution map for the four states, synonomy, and occasionally a brief paragraph on how plants in this region differ from those in other parts of the range. The other page is comprised of a series of excellent line drawings of twigs, leaves, flowers, and fruits, made by the author, in most cases from fresh material. A key is given for the 255 taxa. A total of 98 taxa which have been reported for the region by several authors are excluded for various reasons.

The volume is rounded out with a short description of the region, a list of selected references, a glossary, and an index to common and scientific names.

This useful book will be a most welcome addition to the libraries of students, teachers, naturalists, and professional botanists alike, both in the four states and in the surrounding region. It is too heavy for the hiker to want to carry in his pack, but the traveller could readily carry it in his car for easy reference.

WILLIAM J. CODY

Biosystematics Research Institute
Central Experimental Farm
Ottawa, Ontario K1A 0C6

ENVIRONMENT

The Algal Bowl: Lakes and Man

By J. R. Vallentyne. 1974. Fisheries Research Board of Canada Miscellaneous Special Publication 22. 186 pp. $3.

The stated intent of this little book is to produce an account of lakes and eutrophication that would bring out the fundamental principles and factors involved in the interactions between man, nutrients, and water. The book is aimed at the environmentally aware public who are put off by scientific treatises yet who find ecology picture-books too trivial. The title is derived from an analogy drawn between the American dust bowls of the 1930s resulting from misuse of the land, and the present problem of the vast growths of algae in many lakes, "algal bowls," resulting from misuse of water. The book may have been subtitled "The damnation of phosphorus" for, in what amounts to a collection of nine essays, the major linking concept is a restatement of Dr. Vallentyne's well known thesis that the control of phosphorus alone will result in a drastic improvement in our polluted lakes.

The first four chapters are devoted to a brief account of limnology and in particular the processes of eutrophication which I am sure will be intelligible to any moderately well-informed layman. The examples of eutrophication are well chosen and give in simple language the fundamental causes and consequences. The specialist may be irritated in one or two sections where current or conflicting theories have been oversimplified. For example, not many paleolimnologists today hold to the theory of "a slow natural process of eutrophication accompanying the aging of lakes" (p. 14). The concept of a trophic equilibrium over long periods of time in most lakes is more widely accepted. On the other hand, the distinction drawn between natural and man-made eutrophication is very succinct and not a few professional limnologists would benefit from reading it.

Four chapters, or nearly half the book, are largely devoted to phosphorus. The accounts of phosphorus in the biosphere and the control of man-made eutrophication, complete with case histories, are concise and informative, but one wishes the author had stopped there. The two whole chapters on detergents and NTA are boring and little more than a rehash of the 1970 debate on organic matter versus phosphorus as the real culprit in eutrophication. Undoubtedly the smoke-screen of organic matter thrown up by the detergent manufacturers deserves some mention but there is really no justification in detailing the whole story in this book.

In the final chapter man-made eutrophication is interpreted as a symptom or sign that man's innate biological drive for survival is impairing his ability to survive; the only solution is for man to recognize fully his responsibility as part of the biosphere. Support is given to Barry Commoner's thesis that new technological products have contributed more to pollution than either increased population or affluence.

The book reads well and is sometimes quite witty. Dr. Vallentyne's erudition and fine sense of history is evident throughout. My only disappointment, apart from the undue emphasis on detergents, is that we learn nothing of the fate of the millions of taxpayers' dollars being spent on eutrophication research at Dr. Vallentyne's Freshwater Institute in Winnipeg and at other institutes. One cannot help pondering that if the solution, as claimed by Dr. Vallentyne, is simply to eliminate phosphorus, why is so much effort being put into research? Perhaps after all there *is* something more to eutrophication than just phosphorus.

H. C. DUTHIE

Biology Department
University of Waterloo
Waterloo, Ontario

Schoolyard and Beyond

By David Coburn. 1974. Collier-Macmillan Canada, Don Mills, Ontario. 64 pp. $2.75.

Schoolyard and Beyond introduces a variety of science studies for the senior elementary and junior secondary grades by encouraging students and teachers to carry their investigations beyond the classroom to the schoolyard and other outdoor areas. It illustrates how the environment surrounding the school can become a resource area for effective learning by students. The book contains three chapters related to the seasons of fall, winter, and spring. Each chapter had several topics. Studies suggested for the fall include insects (emphasis is on the honey bee), trees, seeds, and physical science investigations of sound, vibrations, incline planes, and levers. Those for winter deal with snow, ice, toboggan experiments, and further study of trees. Spring topics focus on sap and maple syrup, gardens, soil, plant succession, and stream community studies. This seasonal approach encourages students to conduct science investigations in the outdoors throughout the school year.

Each topic is introduced by some interesting facts, poems, and statistics. Measurements are given in metric units. Questions are raised for the students to investigate or to provoke further thought on the topic. Activities are outlined and many of these are designed to encourage field studies. The book would be of little value if students did not have the opportunity to do the activities and conduct follow-up investigations.

It is difficult to evaluate the effectiveness of this book as the objectives are not stated for it, and the author's intentions are not clear. It is a collection of topics organized to relate to the three seasons and there does not appear to be any intention of one topic relating to the next. Certain sections such as the ones on the honey bee and the stream community are well developed and provide a good basis for a unit of study by students. It is unfortunate that the section on plant succession was not integrated with the topics on trees and seeds to provide a more meaningful unit similar to the community study of the stream. Some of the topics are merely starting points and will require broader study and investigations by students if effective learning is to occur.

The value of the book is that it will capture student interest through interesting facts, poems, and pictures and then present the challenge of further questions and activities. The book will prove useful to teachers who wish to motivate students to extend their learning to the schoolyard and beyond.

DON MORRISON

Blair Outdoor Education Centre
R.R. 3
Cambridge (Preston), Ontario N3H 4R8

Natural Regions of the United States and Canada

By Charles B. Hunt. 1974. W. H. Freeman & Co., San Francisco. 725 pp. $14.95.

This book will help you to enjoy your travels in North America. The first 206 pages contain a series of topical overall views of the United States and Canada. The second part, entitled "The Provinces," comprises 480 more pages of detailed description and lucid explanation of the continent's natural regions except for the Canadian arctic islands. It is a large book but it contains more interesting material than an equal weight of paperback natural science books.

Charles Hunt served with the United States Geological Survey for 30 years and is now Professor of Geology and Geography at The Johns Hopkins University. His aim here has been to write a guide book or text book for the intelligent layman; he has succeeded admirably. The first nine chapters assume no prior specialized knowledge, as he explains each new term when he comes to it. The clarity of these capsule definitions makes this book especially valuable. In the first chapter, for example, he not only outlines regional boundaries with the help of good physiographic maps but goes to the trouble of explaining briefly how maps are made and why no map on flat paper can accurately portray a spherical earth. Every chapter has a bibliography: Appendix A tells how to obtain and use Canadian and American topographic sheets of the area you want to visit, though the addresses to write to are on page 23.

In Chapters 2 through 8 inclusive, he skillfully uses physiographic, topographic, photographic, and graphic means to supplement the text of excellent essays on the geologic structure of the continent, the shaping of landforms, climate, soil, plant, and animal geography. Chapter 9 discusses conflicts of interest with regard to resource use. One's respect for his fair treatment is so great that when he says leaching of mine wastes is not as great a polluter of streams as most people think, one remembers that he is a geologist, and one also remembers that he is an honest man, so one tends to believe him. His discussion of the North American Water and Power Alliance is brief but will interest Canadians; he feels that Canada has a lot of water it can't use so Canada would benefit from selling such water to the United States for irrigation and cities in dry, warm, western regions.

The regional chapters, 10 through 20, average almost 59 pages a piece. He deals with the Atlantic and Gulf Coasts, the Appalachians, Canadian Shield, Great Plains, Rocky Mountains, Colorado and Columbia Plateaux, Basin and Range Province, Pacific Mountains, Alaska, the Yukon, Hawaii, and Puerto Rico. For each natural province he deals meticulously with geologic structure and with the land forms they help to cause. He thinks that the names of the 12 geologic periods should be part of the equipment of every educated person. Description and explanation of special regional landforms, such as volcanoes, kettle holes, pingo hills, sand dunes, and deltas, is also painstaking and informative. Then, having given the reader a rich intellectual feast, he tops off each chapter by showing how climate, vegetation, water, minerals, and agriculture are related to structure, landforms, and to each other. In each chapter the text is supplemented by topographic maps, physiographic diagrams, cross sections, photographs, graphs, tables, and there is a Teacher's Manual.

A reviewer hesitates to find fault with a book that is generally so excellent, but Canadian readers will occasionally have the impression that Canada is included as a bit of an afterthought. The method of numbering western U.S. townships is illustrated, but Canada's own boustrephedon pattern is not mentioned. There is no Canadian map to match the U.S. map showing dates of territorial acquisitions. Most serious is the almost complete omission of the Canadian arctic islands. Both American and Canadian readers may wish for better soil diagrams and for some mention of plate tectonics. The ground blizzard map omits the incredible winter storms that occur in the lee of the Great Lakes.

All in all this is an excellent book. Charles Hunt is not just a scientist but also a humanist. He indicates how unwise or uninformed human action can lead to increased salinization of dry areas, how dam-building can lead to loss of more water by evaporation than is made available for irrigation, and how deforestation leads to higher soil temperatures, increased evaporation, and less stream run-off. Judicious use of humor makes this a pleasant book to read. His fluid descriptions of flooding and water table problems complement his dry remarks on farmers' reaction to years of drought.

DONALD Q. INNIS

Department of Geography
Geneseo State College
Geneseo, New York

Bird Damage to Fruit Crops in the Niagara Peninsula

By R. G. B. Brown. 1974. Canadian Wildlife Service, Report Series Number 27. 56 pp. $1.50.

The format of this publication is very appealing, which is characteristic of the reports in this series. The contents, however, may not provide enjoyable reading to the general public because of the tedious scientific treatment of the subject. The author is well versed in the field of bird behavior and the experience gained during the 4 years of this study provides a wealth of material on which he expounds in a knowledgeable fashion. But the detailed results from his many experiments and the statistical treatment of the data may appeal only to a specialist in this field. The many graphs are a help in understanding the results but the inconsistent use of symbols in adjacent figures is confusing.

The theme appears to be that ". . . bird damage is an inescapable side-effect of fruit growing." The vulnerability of various cherry and grape cultivars (presumably an acceptable term for cultivated varieties) was compared. The general conclusion was that the darker the fruit, the more readily it was selected by birds. Robins and starlings were the main bird species involved. Their populations, movements, diets and feeding behaviors were assessed. The results showed that local birds were responsible for inflicting most of the damage.

Methods for reducing damage were tested and discussed but the practical and economic factors involved were discouraging to the fruit grower. The emphasis was placed on protecting the fruit or reducing the bird population directly. Little consideration was given to reducing the local populations by modifying habitat conditions which would affect factors other than food.

This scientific publication should be of interest to students of bird behavior and fruit growers but the latter may be better served by a concise version of the problem and how to combat it.

A. B. STEPHENSON

Ministry of Natural Resources
Fish and Wildlife Research Branch
Box 50
Maple, Ontario

Terrain, Vegetation and Permafrost Relationships, Northern Mackenzie Valley and Yukon

By S. C. Zoltai and W. W. Pettapiece. 1973. Environmental-Social Committee Northern Pipelines, Task Force on Northern Oil Development Report No. 73-4. 105 pp. $2.

This document and the accompanying series of 1:250,000 maps present a valuable summarization of the results of much of the research and many of the potential problems involved in development of the Canadian Arctic. These maps should be one of the first sources of data consulted before any future planning of work in the Arctic.

The main purpose of the maps is to present, in a concise manner, an estimation of the problems encountered during construction in permafrost regions. Much research and many mistakes have proven that damage to terrain or vegetation in the Arctic can result in the melting of underlying permafrost layers followed by severe slumping, ponding, and erosion from which it can take decades to recover. It is thus a feat of major importance to map zones of sensitivity and present tables so that problem areas within these zones can be located. The authors correlate surface susceptibility to damage with vegetation type, presence of near-surface permafrost, depth of active layer, soil materials and moisture content, landform, and slope patterns. Maps prepared from this study are scaled 1:250,000 and cannot identify localized conditions for specific areas in the vast Canadian Arctic. For each mapping zone, charts are provided with readily discernible characteristics to enable the identification of exact localized terrain sensitivity.

This study presents a scientifically sound and technically feasible approach to the prevention of environmental damage in the Arctic. As such it has taken a great step forward beyond research "after the fact" which is often predominant in this region.

WILSON EEDY

Beak Consultants Limited
306 Rexdale Blvd.
Rexdale, Ontario M9W 1R6

The Unknown Island

By Ian Smith. 1973. J. J. Douglas Ltd., Vancouver. 174 pp. $17.50.

The unknown island is Vancouver Island, and Ian Smith is a wildlife biologist with a knack for writing — an excellent combination. Rarely can one find a book where the author is so adept in both what he is writing about and how he writes.

The Unknown Island is divided into four sections: the forests, the mountains, the underground, and the oceans. In each section Smith describes parts of the island unknown to most tourists — from the top, Mount Golden Hinde at 7,217 feet to the tide pools, from the elk to the navigator shrew, from huge Douglas fir to lichens.

Smith's knowledge of the island is vast because he was the regional wildlife biologist for a few years. He took the 90 color photographs which illustrate the book. Unfortunately some are over-enlarged and the result is sometimes fuzzy. Robert Keziere contributed the excellent black-and-white photographs. Carl Chaplin's sketches are more decorative than accurate.

The most annoying deficiency in the book is the lack of an index. Here is an encyclopedia of detail on the natural history of Vancouver Island, but one would have to scan the whole book to discover what is written on the deer mouse. Where does one begin to find out about the presence of peregrine falcons on the island? Most people would not have time to read the whole book to find such information, so that the book is far less useful as a reference source than it might have been.

Obviously the book has filled an important gap in the literature. The first edition of 7,000 copies is sold out and a second edition is in the press. Some of the deficiencies of the first edition are being rectified.

J. B. FOSTER

Ecological Reserve Program
Department of Lands
Victoria, British Columbia V8V 1X5

Environment and Man

By Richard H. Wagner. Second Edition. 1974. W. W. Norton, New York. 528 pp. $7.95.

The purpose of this book, according to the author, is "to provide an introduction to man-environment problems that pre-supposes no background in the sciences, one that any college student or other interested reader could read with understanding and profit." This is a difficult task, but I believe the author has largely succeeded.

The book consists of 23 chapters, in six sections. A list of the section headings will provide a general idea of the contents and arrangement. 1. Man in the landscape; 2. Natural traumas become pollutants; 3. Man makes new traumas; 4. The biotic world and man; 5. Man's urban environment; 6. The people problem. Within this general framework the author deals with a very wide range of subjects and almost anyone who reads the book should learn something new and interesting and valuable. I found particularly interesting the discussion on the ecological effects of fire, in Chapter 4, and all of Section 5. Chapter 17, describing the ecological effects of the war in Indochina, deals with a topic that I have not seen discussed before in a book of this kind, and deserves careful attention.

The general tone of the book is reasonable and humane. Anyone who reads it with care should gain a well-balanced understanding of the conflicting demands of man and nature that must be resolved if the human race is to continue to exist, and to be human.

The book is naturally concerned primarily with the United States but it should be useful to Canadians as well. Canadian readers should perhaps be told that snowmobiles (p. 439) have made life much easier, if less picturesque, for the people of the far north, whatever their effects may have been further south. They would also probably like to know more about *Triticale* (p. 481). If the book goes into a third edition, as I hope it will, the author might perhaps elaborate a little on topics like these to increase its international appeal.

I must now, unfortunately, become more critical. The book has a weakness which seems to be almost universal among books attempting to explain ecological concepts to a wide audience: it contains a number of speculations stated as facts, misleading simplifications, and outright errors. These are almost all in areas peripheral to the main theme of the book, and probably do not seriously impair its usefulness. Nevertheless I found them very irritating. I think it is worthwhile to list some of these, not for the sake of finding fault, but so that they may be corrected in the next edition.

It is not "without question" that the deepening of the Welland Canal allowed lampreys to enter Lake Erie (p. 29). It has been suggested that they may have been introduced as ammocoetes brought in as bait by anglers and released.

The view that the building of the Aswan Dam (p. 32) was a complete ecological disaster seems to be widespread among western ecologists. It would be fair to point out that Egyptian ecologists do not share this opinion.

The photolysis of water in photosynthesis does not produce a hydrogen ion and an oxide ion, as shows on p. 40. The process can be regarded as giving rise to a free hydrogen atom and a free hydroxyl radical.

The definition of pH on p. 42 is wrong and confusing.

It is a common practice among ecologists, but it is still wrong, to omit the charges on the formulas of nitrate, nitrite, and ammonium ions, as on p. 52.

To state, as the author does on p. 54, that "most nitrogen is in the configuration N_{14}" implies that nitrogen molecules consist of 14 atoms. The correct way of designating the isotopes of nitrogen is as ^{14}N and ^{15}N.

There seems to be some confusion on p. 56 between essential trace elements and accessory food factors. The latter were indeed first postulated by Hopkins, but the substances he was concerned with were organic compounds, now usually referred to as vitamins.

The oxygen atom has six valence electrons, not two as shown on p. 181.

I do not understand the statement (p. 241) that "near-empty tooth-paste tubes have been found to contain enough lead to deliver a dose of 1800 ppm to a child . . ." Does this mean 1800 mg per kg body weight? In a 20 kg child this would amount to 36 grams, which I assume would be almost immediately fatal.

The author is perhaps a little rash in his use of the word "probably" in discussing the possible role of lead poisoning in the fall of the Roman Empire (pp. 242–243).

It is probably inevitable that flaws like these will be present in any book dealing with a variety of topics so wide that nobody can be expert in them all. For this very reason the author and publishers of such a book have a particular responsibility to subject the manuscript to the widest possible range of criticism so that they may be eliminated before the book is published.

R. M. BAXTER

715 Dynes Road
Burlington, Ontario L7N 2V7

Wilderness Survival: a complete handbook and guide for survival in the North American wilds

By Berndt Berglund. 1972. Scribners, New York. 175 pp. $6.95.

Wilderness Survival can be thoroughly recommended for the novice and be of considerable use to the expert. In many ways it can be seen as a companion to *The Edible Wild* (Pagurian, Toronto, 1971) which the author and his wife Clare Bolsby previously published. Together they serve as a monument to the efforts of Berglund to increase our awareness of the rudiments of wilderness living. The Berglunds run National Wilderness Survival's School of Survival at Campbellford near Peterborough, Ontario.

Wilderness Survival is a straightforward book, without much poetry or adornment apart from many attractive and accurate sketches and a few asides by the author hinting at many great northern wilderness adventures involving himself "and an old Indian guide" in years gone by. The book discusses the whole range of topics involving survival more or less off the land, from survival psychology through North American physiographic diversity, the building of different kinds of fires for different purposes, the construction and use of signals, shelters, and traps the hunting, butchering, dressing, preserving, and cooking of wild game, to elementary first aid, knots, and the use of maps and compass.

Throughout Berglund's treatment of his subject one problem frequently surfaces, that of level. Dealing, for example, with topographical maps, knots, and first aid, the approach is extremely elementary. Yet when considering the construction of birch-bark coolers, igloos, smoke houses, and clay baking ovens, considerable sophistication and skilled use of tools are assumed. One would have hoped that anyone able to dress and preserve wild game for long periods of time in the hot summer bush during an emergency survival experience would know how to read a map, use a compass, and tie a clove hitch. There is detailed information on elementary use of a silva-type compass, yet merely the statement concerning the leg glands of deer, that to avoid tainting the meat they should be cut out "before you start to do the skinning and dressing."

Berglund is no extreme purist, but he is obviously a fastidious wilderness gourmet expert. He uses a vast amount of wood (especially birch bark) for shelter, heat, and comfort; he would seem to depend heavily on "meat" for sustenance, from grasshoppers and ants through mice, snakes, and porcupines to bear and moose. "The large black and red ants are especially delightful in making a stew. Of course, you don't pick individual ants from the forest floor, you locate them either in rotten logs or in the centre of an anthill, where they can be gathered by the thousands. I usually prepare them in the same manner as I do white grubs, with wild onion, dandelion and arrowhead tubers. This stew has a sweet and sour taste which the ants give to it." On the other hand his earlier book, *The Edible Wild*, was all about the vegetable kingdom.

He wisely points out that survival off the land in the wild is almost a full-time job, and that, therefore, travel should normally only be undertaken when survival in the initial location "might prove to be difficult or dangerous" and then only to reach a better site and only if you have some idea of where you are. Berglund is not talking about the romantic but impractical idea of a "survival" canoe trip or a long "living-off-the-land" hike.

This is a good book by a wise man, and he is to be congratulated.

BRUCE W. HODGINS

Department of History
Trent University
Peterborough, Ontario

The Arctic Coast

By D. Wilkinson. 1970. N.S.L. Natural Science of Canada Ltd., Toronto. 160 pp. $8.95.

The Arctic Coast is one of a nine-volume series entitled *The Illustrated Natural History of Canada*. In presenting the Arctic region, Wilkinson sticks closely to the format used in discussing each of the other regions of Canada. Each volume discusses natural processes and systems according to five categories. Photographs and diagrams are used extensively, and at the end of each publication there is a list of plants, animals, and rocks present in that region.

For easier written presentation, the first section, the Arctic "Region" is sub-divided into three separate units: the Lowland Arctic, the Mountain Arctic, and the non-land of the Arctic coast. ". . . the thick ice cover on sea, lake, and river is the non-land of the Arctic coast region. (The ice is landlike; it is a major landform during most of the year, in many areas for all of it.)" Each unit is discussed seperately and in such a way that the reader is aware of the diverse physiographic situations within the Canadian Arctic.

As for the "Region" section, the "Geology" section has also been sub-divided into three units: In the beginning, The Birth of the Arctic Coast, and The Tundra Biome — the soil. In this section the author attempts to give us an understanding of the changes occurring through time and of the substrate as it presently exists. He writes, "Much of the Arctic surface is covered with glacial till, messes of unsorted rock, sand, and gravel that have been deposited on the land in a haphazard fashion as the ice melted away." Fundamental to the productivity of any region is the soil. "Arctic soils are relatively infertile especially deficient in nitrogen mainly as a result of low temperatures in the soil." Soils to a large extent dictate plant development.

"Plant Life" is dealt with in the third section of *The Arctic Coast*. Although the plant life of the Arctic is far too sparse and too dwarfed to be considered as a food supply for man, all Arctic plants are edible and contain varying amounts of vitamins, proteins, sugars, and starches. Wilkinson describes "Plant Life" in two separate sections, one dealing with the flora and the other with floral adaptations to the cold.

The "Animal Life" of *The Arctic Coast* includes avifauna and terrestrial mammals, as well as aquatic and marine invertebrates. This fourth section reviews methods of adaptation to the cold, some life histories, use made of sea ice, and interdependence of predators and prey. Although migration may be considered a form of adaptation, ". . . most of the large Arctic mammals have the ability and the opportunity to move south during the winter"; however, "only certain of the mainland herds of caribou turn to migration as a means of escaping the bitter cold of the tundra biome."

The fifth and final section of the text considers man on the Arctic coast. It appears as a warning that, although the Eskimo could and did live in harmony with his environment, modern man's technology is not capable of doing so. The author concludes his text with these boding words. "Here in Canada we have gone from a stage of not thinking about our Arctic at all to a situation in which we think about it quite a bit, but usually in the romantic sense — the land of the Eskimo, of Eskimo art, the true north strong and free."

There are only two minor criticisms of the text. Firstly, too much attention is often given to the more unusual or spectacular life forms, plants and animals, while the less spectacular life forms are quickly brushed over. Secondly, the heavy use of schematic diagrams throughout the text often gives the reader the illusion of reading a textbook and this may at times distract from his pleasure. Generally speaking however, *The Arctic Coast* is well written and attractively presented.

PETER CROSKERY

Ministry of Natural Resources
Chapleau, Ontario

Nature West Coast

Discovery Press, Box 6295, Postal Station "G", Vancouver. 1973. 283 pp. $7.95.

Nature West Coast — As Seen in Lighthouse Park, to give this book its full title, is a cooperative production of the members of the Vancouver Natural History Society. Under the editorial coordination of Kathleen Smith, Nancy Anderson, and Katherine Beamish, *Nature West Coast* represents the results of more than 8 years of observations by members of the Society in Lighthouse Park and the work of nearly 60 artists, writers, advisers, cartographers, and library researchers.

Dedicated to the memory of Professor John Davidson, founder and first president of the Society, the book describes the history, geology, ecology, fauna and flora of a 185-acre park on the north shore of Burrard Inlet, 6 miles west of the Lions Gate. The park occupies part of Point Atkinson, site of the Point Atkinson lighthouse which marks the northern gateway to Vancouver Harbour, thus the name Lighthouse Park.

It is a highly diverse area where differences in topography and rainfall — which are surprisingly variable even for such a small area — produce a microcosm of the natural spectrum found along British Columbia's coast. There are examples of Douglas fir forest, hemlock forest, rocky headland, cliffs, cool moist valleys, dry rock outcrops, wave-washed rocks, and open sea in the park, all of which justify its reputation as a window on the natural history of the west coast.

Leading off with chapters on the complex geology and ecology of the area, *Nature West Coast* nicely sets the stage for the descriptions and illustrations of nearly 400 species of plants and animals which follow. Illustrations are black line-drawings and while their quality varies, they generally add to the attractiveness of this book.

Plants are grouped by general habitat — rocky headlands and outcrops, coniferous forest, trails and roadsides — and an excellent chart is provided showing the periods when each species of bird can be expected in the park, all of which assists naturalists exploring Lighthouse Park for the first time.

There are also chapters on insects, reptiles, amphibians, marine life, and land invertebrates, aspects of natural history which are often overlooked in such guides or, at best, handled rather superficially.

Nature West Coast is a naturalist's guide to the natural history of one of Canada's most stimulating environments and as such can be commended to anyone interested in the fauna and flora of our Pacific Coast.

HAROLD HOSFORD

303 Daniel Place
Victoria, British Columbia

OTHER BOOKS

Canadian Wildlife and Man

By Anne Innis Dagg. 1974. McClelland and Stewart, Toronto. 192 pp. $10.

During the past 10 years I have taught animal ecology and mammalogy at universities in two Canadian provinces. I well remember the fruitless annual search for a text that might contain even a little information on Canadian wildlife, a few Canadian examples for classes in a Canadian university. By spending many extra hours in the library I did manage to give my students some Canadian material.

When Anne Dagg was asked to teach a course in wildlife at Guelph she was equally frustrated. She must have worked as hard as I did to avoid using the American examples so readily available in the texts and journals that crossed our desks. Why were we forced to do this? As Dagg remarks in the introduction to her book: "Canada has disasters, near disasters and success stories too, but they are not well known. It seemed to me that the problem of the Wildlife of Canada had not been adequately considered."

Dagg saw the problem and did something about it. "This book is an attempt to remedy this imbalance by discussing Canadian solutions to Canadian problems relating to Wildlife."

The book is organized into a number of sections:

Historical (chapters 1, 2, and 3), deals with wildlife in Canada from immediately after the Ice Age to the coming of Europeans. Pleistocene overkill of large herbivores, role of early fire in the ecological history of Canada, relationship of early native peoples to wildlife, early exploitation (mainly bison and beaver) by Europeans are all discussed.

Geographical (chapters 4, 5, and 6), discusses "the relationship of Wildlife with the three main geographical entities of Canada," forests, agricultural land, and urban areas. There is comment on fire, lumbering practices, spraying of insecticides, wildlife damage to forests and to agricultural lands.

Management is covered in chapters 7, 8, and 9. There is a chapter on big game, one on waterfowl, and one on other wildlife species (furbearers, non-game, etc.). Aims and techniques of management of these groups, as well as federal and provincial jurisdiction within each group, are discussed.

Following this there are single chapters on extinction, introduction, diseases, and pollution. The final two chapters offer timely comment on wildlife and man-made structures, and wildlife habitat conservation in Canada.

This is an important book. It is the first book to provide a comprehensive overview of Canadian wildlife. For the most part Dagg has the Canadian wildlife scene in good perspective. She deals with most of the major problems of the day in a competent manner. And she documents her comments with an impressive number of references from every region in the country. Fifty-seven percent of the approximately 400 references are post-1965, 31% are 1970 or later. This large volume of literature is handled very well.

There are many positive aspects to the book. The large number of Canadian references represents a valuable compilation for everyone interested in wildlife. Throughout the book the author identifies many problem areas requiring intensified, continuing, or new research programs. She is current in her thinking and recognizes the legitimate place that non-consumptive use of wildlife, and non-game wildlife, has in our time. There are many more problems.

But there are some areas where criticism could be leveled; mainly by way of omissions. For example, I think that the 1971 Science Council of Canada's Special Study Number 15 by Pimlott, Kerswill, and Bider, "Scientific Activities in Fisheries and Wildlife Resources," would have warranted mention. If Dagg had brought some of the findings of this report into her own book it would have strengthened her comments on aims and goals of wildlife management in Canada; goals with respect to the north, for example. This is our largest single land type and the biota there faces ever increasing hazards from human activity. And while the author recognizes its significance she only gives it two pages (plus other occasional brief mention) in her book.

Another omission is related to hydroelectric developments and wildlife. The large-scale engineering works (reservoirs, long distance transmission lines) associated with such developments are not at all pleasant to contemplate. This could have been included in the chapter "Wildlife and Man-made Structures." Perhaps the Quebec and Labrador developments were announced too late for inclusion in the book.

There are omissions in other areas. But there had to be. It must have been very difficult to select what went into this first book of Canadian wildlife.

What is my overall impression of the book? First rate. In clear and uncomplicated prose, Dagg has produced an indispensable reference source for students, teachers, anyone interested in Canadian wildlife. In gathering and presenting this material she has done us all a service. She is not only a scientist, but an integrator and interpreter of science for all. Some material in the book is out of date already. Dagg, at present a Research Assistant Professor at the University of Waterloo will, I am sure, produce an equally competent second edition in due course.

TOM H. NORTHCOTT

Newfoundland Wildlife Service
Building 810, Pleasantville
St. John's, Newfoundland

Children of the Ark

By Barbara M. Solandt. Photography by Norman R. Hatton. 1973. University of Toronto Press, Toronto. 95 pp. $7.95.

In the foreword to this marvellous book, Dr. D. A. Chant, zoologist, points out that the modern zoo is much more than a collection of wild animals on public display; the science and art of breeding zoo animals successfully have made it possible for children, old and young, to see animals in circumstances so well suited to them that they will breed and rear their young in captivity. The author underscores the paramount importance of animal breeding in zoos for species conservation alone, when natural habitats are rapidly diminishing throughout the world by reason of human encroachment and exploitation. The stated purpose of the book is "to show through words and pictures examples of the work in progress and the achievements to date in the effort to breed animals in captivity."

Certainly the informative and stimulating accounts regarding the young of selected zoo-bred species are greatly enhanced by the captivating photographs which accompany these accounts on facing pages. The author has skillfully informed the reader regarding the native haunts of each species, something of its habits and way of life, and has included various intimate happenings during the preparation of this volume. Each text unit ends with the complete scientific classification of the species described.

An account of the life habits of bushbabies in nature and the breeding and rearing of their young in captivity under the watchful care of the author forms a delightful introduction to a series of similar short accounts of the breeding and rearing of young in more than thirty species, chiefly under conditions provided in modern zoos. Birds are represented by the tawny owl and the Gentoo penguin. The latter species breeds freely and rears young in the Edinburgh Zoo under conditions which, but for temperature, simulate those in their native Antarctica.

Other exotic species which have adapted well to rearing their young in captivity include a Tasmanian wallaby, the African yellow baboon, Père David's deer from China, macaque monkeys of Asia, lechwe antelopes of Central Africa, and the chimpanzee. Various members of the cat family, lions, tigers, and leopards, are being bred and reared in captivity, and the puma of the western hemisphere has raised young at Chester Zoo in northern England. The American peccary also breeds freely when provided with a suitable environment. Species which are now being bred in zoos with some success include the Malayan tapir, the gorilla, the ring-tailed lemur, and the sea lion. Included in the book are 'interviews' with the young of such domesticated or semi-domesticated species as the llama, the camel, the elephant, the chinchilla, the bison, highland cattle, and the yak.

Certainly here is a book which presents fresh aspects of the animal world, which is pleasantly informative for all ages, which illustrates the achievements in the breeding of wild animal species in captivity, and which stimulates the concern of the thoughtful reader for the preservation of animal species, at least in captivity, when the natural wilderness areas of the earth are rapidly disappearing.

A. A. WELLWOOD

Department of Biology
Wilfrid Laurier University
Waterloo, Ontario

Alaska Fishing Guide

By Editors of Alaska Magazine. 1974. Alaska Northwest Publishing, Anchorage. 176 pp. \$3.95 + .50 mailing.

If you are going fishing in Alaska, here is a handy guide to the action. Forty-six pages gives you some idea about what kind of countryside to expect, what rates you will pay for accommodation, how to charter aircraft and boats, and where to write for information. There is also the standard advice about the climate, the bears, and seasons, limits, and fees for angling. Then come 54 pages describing Alaska's game fish, with some natural history notes, tips to anglers about tackle, a good assortment of photographs and some line-drawings of fishes (reprinted from the *Illustrated Keys to the Fresh-water Fishes of Alaska*). The last 70 pages gives the prospective angler the trophy-fish contest rules, the major fishing regions of Alaska, and a list of 557 fishing spots in Alaska, accompanied by 33 maps to help locate them.

This is a good production of the usual stereotype of fishing guide and provides full value for the \$3.95 asking price. If I were going on a fishing trip to Alaska, I'd buy a copy. As a matter of fact, having read the guide, I'm tempted to make the trip.

P. A. LARKIN

Institute of Animal Resource Ecology
University of British Columbia
Vancouver, British Columbia V6T 1W5

Human Behavior Aspects of Fish and Wildlife Conservation. An annotated bibliography

By D. R. Potter, K. M. Sharpe, and J. C. Hendee. 1973. United States Department of Agriculture Forest Service General Technical Report PNW–4. Obtainable from Pacific Northwest Forest and Range Experiment Station, Box 3141, Portland, Oregon. 288 pp. No charge.

This bibliography will prove invaluable to anyone working with both fish and wildlife and with human beings simultaneously, as most wildlife managers today are trying to do. In all, 995 articles are considered by alphabetical order of the author, with the information in each described in a short paragraph. Following each paragraph are several descriptive key phrases or key words, including "falconry," "fire," and "France" for example, which are indexed to these and other extracts at the end of the book.

As might be expected in such a compilation, the journals and sources from which the articles were taken are various — theses, state wildlife bulletins, government publications on fish, popular magazines for outdoor people. The *Journal of Wildlife Management* is best represented, with 72 entries abstracted.

A survey of the index gives a good idea of current areas of interest in wildlife and fish conservation. The key word with the most entries is "Management," closely followed by headings such as "Harvest statistics," "Economics," "Preferences," "Historical value," and "Fishing." Many naturalists will be pleased to note that "Anti-hunting" appears as a key word, as well as the phrase "Non-consumptive use" with 86 entries.

Most of this book deals with American problems and situations, but 26 articles deal specifically with Canada and most of the others are pertinent to Canadians and their wildlife. A number of Canadians are listed in the Author Index, but few authors of any nationality have more than one or two entries each.

Anyone working with fish and wildlife or desiring an overview of current research in problems related to such matters should obtain this worthwhile volume.

ANNE INNIS DAGG

Otter Press
Box 747
Waterloo, Ontario

NEW TITLES

Zoology

Animal agriculture. The biology of domestic animals and their use by man. 1974. Edited by H. H. Cole and M. Ronning. Freeman, San Francisco. 788 pp. $15.

Animals and their colors. Camouflage, warning coloration, courtship and territorial display, mimicry. 1974. By M. and P. Fogden. Crown, New York. 172 pp. $9.95.

Biology of the Reptilia. Vol. 4, Morphology. 1974. Edited by D. C. Gans and T. S. Parsons. Academic Press, New York. 540 pp. $39.50.

*__Birds of the Oshawa–Lake Scugog Region, Ontario.__ 1974. By R. G. Tozer and M. Richards. Private printing, Box 28, Whitney, Ontario. 384 pp. $7.50.

Birds of the world. A check list. 1974. By J. F. Clements. Two Continents Publishing Group, New York. 524 pp. $15.

Canaries on the clothesline. 1974. By B. McKeever. Gray's Publishing, Sidney, B.C. 104 pp. $6.50.

The co-operative breeding bird survey in Canada, 1973. 1974. By A. J. Erskine. Canadian Wildlife Service, Ottawa. 15 pp. Free.

*__The countryman bird book.__ 1974. Edited by B. and M. Campbell. Douglas, David and Charles, Newton Abbot, England. 194 pp. $10.50.

The crayfish. An introduction to the study of zoology. 1974. By T. H. Huxley. MIT Press, Cambridge, Mass. 373 pp. $12.50. Reprint of the 1880 edition.

*__Ecology of pomarine, parasitic, and long-tailed jaegers in northern Alaska.__ 1974. By W. J. Maher. Cooper Ornithological Society, Los Angeles, Calif. 148 pp. $3.75.

A field guide to Pacific Coast shells. Including shells of Hawaii and the Gulf of California. 1974. By P. A. Morris. Houghton Mifflin, Boston. 2nd edition. 298 pp. $3.95.

A field guide to the insects of America north of Mexico. 1974. By D. J. Borror and R. E. White. Houghton Mifflin, Boston. 404 pp. $4.95. Reprint of the 1970 edition.

Fisheries of the north Pacific. History, species, gear and processes. 1974. By R. J. Browning. Alaska Northwest Publishing Co., Anchorage, Alaska. 408 pp. $24.95.

Fishes of the Red River drainage. Eastern Kentucky. 1974. By B. A. Branson and D. L. Batch. University Press of Kentucky, Lexington. 68 pp. $4.

Fish-watching and photography. 1974. By K. McDonald and six others. Scribner, New York. 270 pp. $10.

*__A guide to Alberta vertebrate fossils from the age of dinosaurs.__ 1974. By H. Johnson and J. E. Storer. Provincial Museum of Alberta, Edmonton. Publication 4. 127 pp. $5.70.

Handbook of the birds of India and Pakistan. Together with those of Bangladesh, Nepal, Sikkim, Bhutan and Sri Lanka. Vol. 9, Robins to wagtails. 1974. S. Ali and S. D. Ripley. Oxford University Press, New York. 306 pp. $17.25.

Insects. Instructions for collectors. No. 4a. 1974. British Museum of Natural History, London. 5th edition. 170 pp. Paper £1.50.

Insects and other arthropods of medical importance. 1973. Edited by K. G. V. Smith. British Museum of Natural History, London. 562 pp. £6.50.

Living clocks in the animal world. 1974. By M. F. Bennett. Thomas, Springfield, Ill. 222 pp. $11.75.

The mammals of Louisiana and its adjacent waters. 1974. By G. H. Lowery, Jr. Louisiana State University Press, Baton Rouge, Louisiana. 566 pp. $15.

Marine molluscan genera of western North America. An illustrated key. 1974. By A. M. Keen and E. Coan. Stanford University Press, Stanford, Calif. 2nd edition. 208 pp. $8.75.

Marine zoogeography. 1974. By J. C. Briggs. McGraw-Hill, New York. 476 pp. $25.

Master builders of the animal world. 1974. By D. Hancocks. Harper and Row, New York. 144 pp. $8.95.

Northern fishes. With special reference to the upper Mississippi Valley. 1974. By S. Eddy and J. C. Underhill. University of Minnesota Press, Minneapolis. 3rd edition. 414 pp. $17.50.

Notes on the animals of North America (1793). 1974. By B. S. Barton. Edited by K. B. Sterling. Arno Press, New York. $8.

Our wildlife legacy. 1974. By D. L. Allen. Funk and Wagnalls, New York. 2nd edition. 422 pp. $3.95.

Owls. 1974. By T. Angell. University of Washington Press, Seattle. 80 pp. $12.95.

The porpoise watcher. 1974. By K. S. Norris. Norton, New York. 250 pp. $7.95.

Les proies des rapaces. Petits mammifères et leur environnement. 1974. By J. Chaline, H. Baudvin, D. Jammot, and M.-C. Saint Girons. Doin, Paris. 142 pp. Paper, 45F.

The shell makers. Introducing mollusks. 1974. By A. Solem. Wiley-Interscience, New York. 290 pp. $9.95.

The social behavior of the bees. A comparative study. 1974. By C. D. Michener. Belknap Press of Harvard University Press, Cambridge, Mass. 402 pp. $25.

The social primates. 1974. By P. E. Simonds. Harper and Row, New York. 258 pp. Paper, $7.95.

***Song of the north wind.** A story of the snow goose. 1974. By P. A. Johnsard. Anchor Press/Doubleday, New York. 150 pp. $5.95.

A voice for wildlife. 1974. By V. B. Scheffer. Scribner, New York. 246 pp. $8.95.

The world's cats. Vol. 2. Biology, behavior and management of reproduction. 1974. Proceedings of a symposium, Winston, Oregon, May 1973. Edited by R. L. Eaton. Feline Research Group, Woodland Park Zoo, Seattle, Wash. 260 pp. Paper, $12.50.

Botany

***The Alaska-Yukon wild flowers guide.** 1974. Edited by H. A. White. Alaska Northwest Publishing Co., Anchorage. 218 pp. Paper, $7.95.

***The algal bowl.** Lakes and man. 1974. By J. R. Vallentyne. Environment Canada, Fisheries and Marine Service, Ottawa. 186 pp. $3.

Aquatic plants of Australia. 1973. By H. I. Aston. Melbourne University Press, Carlton, Victoria. 368 pp. $34.65.

Biology of plant decomposition. 1974. Edited by C. H. Dickinson and G. J. F. Pugh. Academic Press, London and New York. Vol. 1, 332 pp. $18. Vol. 2, 622 pp. $27.25.

The biology of the algae. 1974. By F. E. Round. St. Martin, New York. 2nd edition. 278 pp. Cloth, $19.95; paper, $8.95.

Canada — a forest nation. 1973. Environment Canada. Enquiry Centre, Ottawa. Pamphlet.

***Carnivorous plants.** 1974. By R. Schwartz. Praeger Publishers, New York and Washington. 128 pp. $8.

Death Valley wildflowers. 1974. By R. S. Ferris. Death Valley Natural History Assoc., Death Valley, Calif. 2nd edition. 150 pp. $2.45.

A dictionary of plants used by man. 1974. By G. Usher. Constable, London. 619 pp.

***A dictionary of useful and everyday plants and their common names.** 1974. By F. N. Howes. Cambridge University Press, New York. 290 pp. $12.50.

Evolution and design in the plant kingdom. 1974. By C. L. Duddington. Apollo Editions (Crowell), New York. 260 pp. $2.95.

A field guide to Rocky Mountain wildflowers from northern Arizona and New Mexico to British Columbia. 1974. By J. J. Craighead. F. C. Craighead, and R. J. Davis. Houghton Mifflin, Boston. 278 pp. $3.95. Reprint of the 1963 edition.

A field guide to wildflowers of northeastern and north-central North America. 1974. By R. T. Peterson and M. McKenny. Houghton Mifflin, Boston. 420 pp. $3.95. Reprint of the 1968 edition.

The figwort family (Scrophulariaceae) of British Columbia. 1974. By T. M. C. Taylor. British Columbia Provincial Museum, Victoria. Handbook No. 33. 238 pp. $1.

500 plants of south Florida. 1974. By J. F. Morton. Seemann, Miami, Florida. 164 pp. $9.95.

***Forestry in Newfoundland.** 1974. By G. Page, W. C. Wilton, and T. Thomas. Environment Canada, Newfoundland Forest Research Centre, P.O. Box 6028, St. John's, Newfoundland. 118 pp.

The geography of the flowering plants. 1974. By R. Good. Longman, London. 4th edition. 558 pp. £9.

Handbook of vegetation science. Part 8, Vegetation dynamics. 1974. Edited by R. Knapp. Junk, The Hague. 364 pp. Dfl. 80.

How to know the non-gilled fleshy fungi. 1973. By H. V. Smith and A. H. Smith. Wm. C. Brown, Dubuque, Iowa. 394 pp.

Leaf prints of American trees and shrubs. 1974. By D. S. Marx and C. B. Dugdale. Littlefield, Adams, Totowa, New Jersey. 290 pp. $4.95.

The lichenologist. 1974. Edited by P. W. James and D. L. Hawksworth. Academic Press, London. $16 plus $1 postage.

Mycologist's handbook. 1974. By D. L. Hawksworth. Commonwealth Mycological Institute, Kew, Surrey, England. £5.50.

Nebraska wild flowers. 1973. By R. C. Lommasson. University of Nebraska Press, Lincoln, Nebraska. 175 pp.

The orchids. 1974. Edited by C. L. Withner. Wiley-Interscience, New York. 604 pp. $22.50.

The pea family (Leguminoseae) of British Columbia. 1974. By T. M. C. Taylor. British Columbia Provincial Museum, Victoria, Handbook No. 32. 252 pp. $1.

***Rocky Mountain wild flowers.** 1974. By A. E. Porsild. National Museums of Canada and Parks Canada, Ottawa. 454 pp. In French and English.

The rose family (Rosaceae) of British Columbia. 1973. By T. M. C. Taylor. British Columbia Provincial Museum, Victoria, Handbook No. 30. 223 pp. $1.

Should trees have standing? Toward legal rights for natural objects. 1974. By C. D. Stone. Kaufman, Los Altos, California. 102 pp. Cloth, $6.95; paper, $2.95.

The trees and shrubs of British Columbia. 1973. By E. H. Garman. British Columbia Provincial Museum, Victoria, Handbook No. 31. 5th revised edition. 131 pp. $1.

***Wild flowers of field and slope in the Pacific northwest; Wild flowers of forest and woodland in the Pacific northwest.** 1974. By L. J. Clark. Gray's Publishing, Sidney, B.C. 80 pp. each. $2.95 each.

***Woody plants of the north central plains.** 1974. By H. A. Stephens. University Press of Kansas, Lawrence, Kansas. 530 pp. $20.

Environment

Arctic and alpine environments. 1974. Edited by J. D. Ives and R. G. Barry. Methuen, London. 980 pp. £28.

***The changing flora and fauna of Britain.** 1974. Edited by D. L. Hawksworth. Academic Press, New York. 462 pp. $23.75.

Coastal ecosystems. Ecological considerations for management of the coastal zone. 1974. By J. Clark. The Conservation Foundation, Washington, D. C. 178 pp. Cloth $7.95; paper, $4.

Environment Information Referral Centre. 1974. Interpretive materials on the environment and renewable resources. Includes 699 items, all indexed and cross-referenced. Environment Canada, Ottawa. 67 pp.

***Fragile ecosystems.** A report of the Institute of Ecology. Evaluation of research and applications in the neotropics. 1974. Springer-Verlag, New York. 258 pp. $7.80.

Freshwater ecology. 1974. By T. T. Macan. Longman Group, London and Halsted (Wiley), New York. 2nd edition. 344 pp. $10.95.

***Freshwater pollution, Canadian style.** 1974. By P. A. Larkin. McGill-Queen's University Press, Montreal. 132 pp. $2.50.

The great barrier reef. 1974. By I. Bennett. Scribner, New York. 184 pp. $17.50. Reprint of the 1971 edition.

***Land use and resource development in the eastern slopes.** Report and recommendations. 1974. Environment Conservation Authority, Edmonton, Alberta. 224 pp.

Man's mark on the land. The changing environment. 1974. By A. S. Gregor. Scribner, New York. 120 pp. $5.95.

Man's responsibility for nature. Ecological problems and western traditions. 1974. By J. Passmore. Scribner, New York. 214 pp. $7.95.

***Natural history in the National Capital Region.** A bibliography. 1974. By A. F. Muhammad and E. Jorgensen. Department of the Environment, Canadian Forestry Service, Ottawa. 97 pp.

The outer lands. A natural history guide to Cape Cod, Martha's Vineyard, Nantucket, Block Island and Long Island. 1974. By D. Sterling. Anchor/Doubleday, New York. 192 pp. $3.50.

***Polar deserts and modern man.** 1974. Edited by T. L. Smiley and J. H. Zumberge. University of Arizona Press, Tucson. 173 pp. $11.50.

Power lines and the environment. 1973. Proceedings of a meeting, Amherst, Mass. Edited by R. Goodland. Cary Arboretum of the New York Botanical Gardens, Millbrook, N.Y. 172 pp. $5.

The singing land. 22 natural environments of Australia from surging ocean to arid desert. 1974. By V. Serventy. Scribner, New York. 96 pp. $6.95.

A tourist guide to Mount McKinley. 1974. By B. Washburn. Alaska Northwest Publishing Co., Anchorage. $3.95. Also Topographic map of Mount McKinley, $4.50.

***Vegetation and environment in the Central Research Forest, Ottawa Greenbelt.** 1974. By J. K. Jeglum, M. J. J. Bik, and J. Salm. Department of the Environment, Canadian Forestry Service, Great Lakes Forest Research Centre, Sault Ste. Marie, Ontario. 70 pp.

Water and landscape — an aesthetic overview of the role of water in the landscape. 1974. By R. B. Litton, Jr., R. J. Tetlow, J. Sorensen, and R. A. Beatty. Water Information Center, Dept. R, 44 Sintsink Dr. E., Port Washington, New York. 314 pp. $11.50.

Water policies for the future. Final report to the President and to the Congress of the United States by the National Water Commission. 1973. Water Information Center, Port Washington, New York. 580 pp. $17.50.

Water pollution. 1974. By J. McCaull and J. Crossland. Harcourt, Brace, Jovanovich, New York. 206 pp. $3.95.

Miscellaneous

Canada. A geographical perspective. 1974. By L.-E. Hamelin. Translated from the French edition (Paris, 1969). Wiley, New York. 234 pp. $7.95.

***Canadian public land use in perspective.** Proceedings of a symposium, Oct. 1973, Ottawa. 1974. Edited by J. G. Nelson, R. C. Scace, and R. Kouri. Social Science Research Council of Canada, Ottawa. 579 pp.

The comedy of survival. Studies in literary ecology. 1974. By J. W. Meeker. Scribner, New York. 218 pp. $8.95.

Conservation activities. 1973. Environment Canada, Enquiry Centre, Ottawa, Ontario. 28 pp. Field trips and projects involving trees.

***Conservation by the people.** The history of the conservation movement in Ontario to 1970. 1974. By A. H. Richardson. University of Toronto Press, Toronto. 154 pp. $8.50.

The ethics of genetic control. Ending reproduction roulette. 1974. By J. Fletcher. Anchor/Doubleday, New York. 218 pp. $1.95.

The food and people dilemma. By G. Borgstrom. 1973. Duxbury Press, North Scituate, Mass. 140 pp. $3.95.

In the human interest. A strategy to stabilize world population. 1974. By L. R. Brown. Norton, New York. 190 pp. $6.95.

Last of the naturalists. The career of C. Hart Merriam. 1974. By K. B. Sterling. Arno Press, New York. $23.

***Low man on a gill-netter.** 1974. By J. P. Tracy. Alaska Northwest Publishing Co., Anchorage. 147 pp. $3.95.

Much is taken, much remains. 1973. By R. Bryan. Duxbury Press, North Scituate, Mass. 325 pp.

The next ten thousand years. A vision of man's future in the universe. 1974. By A. Berry. Saturday Review Press (Dutton), New York. 250 pp. $8.95.

The poisons around us. Toxic metals in food, air, and water. 1974. By H. A. Schroeder. Indiana University Press, Bloomington, Indiana. 144 pp. $6.95.

Superspill. An account of the 1978 grounding at Bird Rocks. 1974. By M. K. Becker and P. Coburn. Madrona Press, Seattle, Washington. 162 pp. $3.95.

***To the arctic by canoe, 1819–1821.** The journal and paintings of Robert Hood, midshipman with Franklin. 1974. Edited by C. S. Houston. McGill-Queen's University Press, Montreal. 217 pp. $17.50.

*Assigned for review.

Instructions to Contributors

Manuscripts

Authors should submit three complete manuscripts with two copies of figures (in addition to the originals) for use by referees. Manuscripts are accepted in either English or French. They should be typewritten on paper measuring $8\frac{1}{2} \times 11$ inches, and if possible, the paper should have numbered lines. Margins should be 1 to $1\frac{1}{2}$ inches wide to allow for copy marking. All text matter, including quotations, footnotes, tables, literature citations and captions for figures should be double-spaced. Only words meant to appear in italics should be underlined. Every sheet of the manuscript should be numbered. In no case should words be abbreviated; this includes references to tables and figures as well as literature citations. Authors are requested, however, to use SI symbols for units of measure.

It is strongly recommended that, before submitting a paper, authors ask qualified persons to appraise it.

An abstract is required for all Articles but is optional for Notes. Authors are requested to use at least one given name. Literature cited should be listed alphabetically according to author and should be placed immediately after the main body of the text, except in Letters to the Editor. If only one or two references are cited, they should be inserted in the text. The tables should be titled and numbered consecutively in arabic numerals, and each should be placed on a separate page after the Literature Cited. Captions for figures should be typed together on one page. The places in the text for tables and figures should be marked in the margin.

Extensive tabular or other supplementary material not essential to the text should be submitted on letter size paper ($8\frac{1}{2}'' \times 11''$) for the Editor to place in the Depository of Unpublished Data, National Science Library, National Research Council of Canada, Ottawa, Canada K1A 0S2. A notation in the published text should state that the material is available, at a nominal charge, from the Depository. Two copies are required for the Depository.

The **CBE Style Manual**, third edition (1972), published for the Council of Biology Editors, Committee on Form and Style, by the American Institute of Biological Sciences, is recommended as a guide to contributors.

Webster's New International Dictionary is the authority for spelling. In a case, however, of difference in the spelling of a common name, and in the use of a variant name, a decision of a learned society is preferred.

The order in which papers are published will be determined by the Editor.

Illustrations

All illustrations should be numbered consecutively in arabic numerals. The author's name, title of the paper, and figure number should be written in the lower left corner of the sheet on which each illustration appears. The caption should **not** appear on the illustration.

Line drawings should be made with India ink on white, good quality drawing paper, blue tracing linen, or good quality blue-lined co-ordinate paper. Co-ordinate lines that are to appear on the reproduction should be ruled in black ink. Descriptive matter should be lettered, not typewritten, and all parts of the drawing should permit easy legibility even if a reduction is made. Photographic reproductions of line drawings are acceptable in lieu of large originals.

Photographs should have a glossy finish and show sharp contrasts. For reproduction as a complete plate they should be mounted with minimal space between prints.

For large drawings and mounted photographs the ratio of height to width should conform to that of the printed journal page (ratio of 45 up to 35 across) or roughly $7\frac{1}{2} \times 5\frac{3}{4}$ inches, but the height should be adjusted to allow for the caption if the caption is to go on the same page.

Special Charges

Authors must share in the cost of publication by paying $40.00 for each page in excess of six journal pages. Page charges are separate from charges for illustrations and tables. Authors will also be charged for excessive changes in proofs.

Illustrations cost $5.00 each for any size (up to a full page). Tables cost up to $40.00 per page, depending upon size. The special charges for illustrations and tables are *in addition* to all charges that are levied for pages in excess of six. Reproduction of color photos is extremely expensive and the full cost must be borne by authors. Price quotations may be obtained from the Business Manager.

Limited journal funds are available to help offset publication charges to authors with minimal financial resources. Requests for financial assistance should be made to the Editor when the manuscript is submitted.

Reprints

An order form for the purchase of reprints will accompany the galley proofs sent to authors.

TABLE OF CONTENTS *(concluded)*

Mailing date of previous issue 17 February 1975

Erratum

1973. Canadian Field-Naturalist 87(2): 169. *Observation of a Greater Scaup at Ellice River, Northwest Territories,* by Robert G. Bromley

The longitude given in the left hand column tenth line from the bottom as 140°42′ W should read 104°42′ W.

TABLE OF CONTENTS

concluded on inside back cover

THE CANADIAN FIELD-NATURALIST published by **The Ottawa Field-Naturalists' Club**
Box 3264, Postal Station C, Ottawa, Canada K1Y 4J5
Second Class Mail Registration No. 0527 — Return postage guaranteed
ISSN 0008-3550

The CANADIAN FIELD-NATURALIST

Published by THE OTTAWA FIELD-NATURALISTS' CLUB, Ottawa, Canada

Volume 89, Number 2

April-June 1975

The Canadian Field-Naturalist

The Canadian Field-Naturalist is published quarterly by The Ottawa Field-Naturalists' Club with the assistance of contributions from the National Research Council of Canada and The Canadian National Sportsmen's Show. Opinions and ideas expressed in this journal are private and do not necessarily reflect those of The Ottawa Field-Naturalists' Club or any other agency.

Subscriptions and Membership

Subscription rates for individuals are $7.00 per calendar year. Libraries and other institutions may subscribe at the rate of $12.00 per year (volume). The annual membership fee of $7.00 includes club publications. Subscriptions, applications for membership, notices of changes of address, and undeliverable copies should be mailed to: The Ottawa Field-Naturalists' Club, Box 3264, Postal Station C, Ottawa, Canada K1Y 4J5.

Back Numbers

Most back numbers of this journal and its predecessors, *Transactions of The Ottawa Field-Naturalists' Club*, 1879-1886, and *The Ottawa Naturalist*, 1887-1919, may be purchased from the Business Manager.

All material intended for publication should be addressed to the Editor:
Dr. Lorraine C. Smith, Department of Biology, Carleton University, Ottawa, Ontario K1S 5B6

Cover photograph: Gannets at Bonaventure Island, Quebec. Photograph taken 29 July 1974 by Philip S. Taylor. See article on Gannet population decline on page 125.

The Canadian Field-Naturalist

VOLUME 89, NUMBER 2 APRIL-JUNE 1975

Migratory and Foraging Behavior of Peregrine Falcons on the Texas Coast

W. GRAINGER HUNT, RALPH R. ROGERS, AND DANIEL J. SLOWE

Chihuahuan Desert Research Institute, 800 North Bird Street, Alpine, Texas 79830

Hunt, W. G., R. R. Rogers, and D. J. Slowe. 1975. Migratory and foraging behavior of Peregrine Falcons on the Texas coast. Canadian Field-Naturalist 89(2): 111–123.

Abstract. Observations of fall migrations of Peregrine Falcons (*Falco peregrinus*) on the Texas coast between 1956 and 1973 (a total of 1477 birds were seen) reveal chronological differences in the occurrence of peak numbers of adults versus immatures and males versus females. Hunting strategies and prey are discussed. The beach environment is noted to be a place where both water-birds and land-birds are especially vulnerable to peregrine attacks and is regarded as similar to conditions in the nesting habitat of *F. p. tundrius*.

Introduction

Large numbers of Peregrine Falcons are seen on the Texas coast during the month of October, and are represented by *Falco peregrinus tundrius* (White 1968) and other darker forms presumably from the forests of northern Canada and Alaska. The occurrence of peregrines on the coast was noted as early as 1890 (Griscom and Crosby 1925), but the discovery in about 1950 of an intense fall migration in Texas, its association with beaches, and its inclusion of peregrines of far northern origin is attributable to the late Colonel R. L. Meredith. Except for two short accounts by Enderson (1965, 1969) based on seven days of observation during October of 1964, no study of the Texas peregrine migration has been published.

In this paper we provide information on the details of the chronology of the migration, age and sex ratios, banding data, and predatory activities of peregrines on Texas beaches.

Habitat

Padre Island is typical of the habitat of migrant peregrines in Texas. It is approximately 115 miles in length, and is less than 1 mile wide in many places. A narrow bay, the Laguna Madre, separates it from the mainland. The island's geological origin dates back some 4500 years with the establishment of a constant sea-level (Bernard and LeBlanc 1965). The interior of the island is a grassland dominated by seacoast bluestem (*Schizachyrium scoparium*), salt meadow cordgrass (*Spartina patens*), seashore dropseed (*Sporobolus virginicus*), and gulf-dune paspalum (*Paspalum monostachyum*) (Woodard et al. 1971). As one moves west across the island from the Gulf to the Laguna Madre, four physiographic features are encountered: (1) beach, (2) gulf-side dune formation, (3) mud-grassland flats, and (4) lagoon-side dune formation. There are a number of large flats devoid of vegetation every few miles along the length of the island where dune formation has been destroyed by storm surges. Observations of peregrines are especially easy to make in these locations because of increased visibility and perhaps because peregrines prefer these vast open areas.

Methods

Observational and trapping data for our study are derived from numerous visits to the Texas coast in the area between Galveston and Brownsville during the period 1956 – 1973. For comparison (see Figure 1), we have divided our observation area into three parts: (1) the "northern beaches," from Freeport through Matagorda Peninsula, (2) North Padre Island, from Port Aransas to "Little Shell," and (3) South Padre Island, from Mansfield Channel to Port Isabel. The numbers of observation

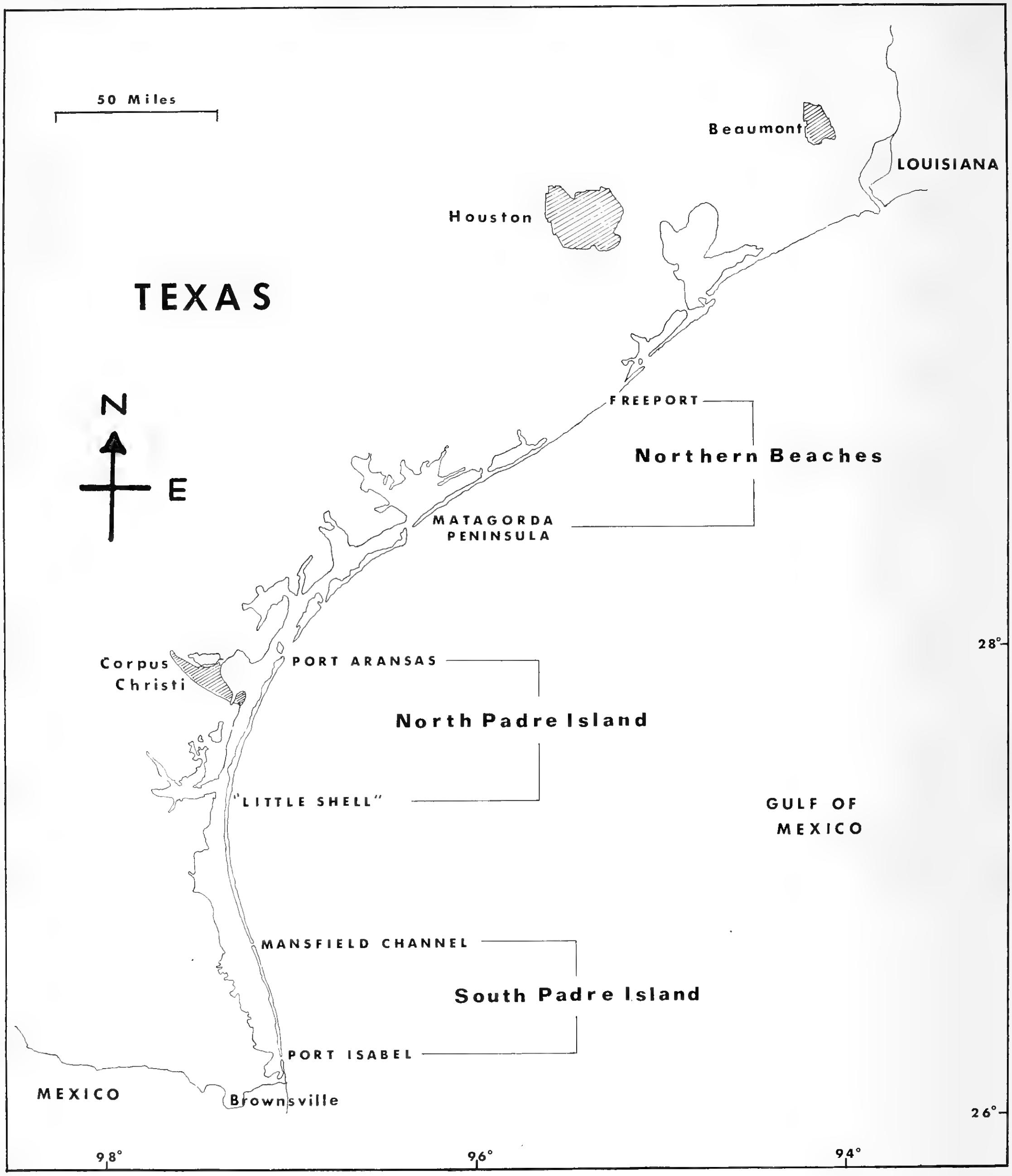


FIGURE 1. Map of Texas coast showing the locations of the three observation areas.

days during fall migrations for each year in the three areas are summarized in Table 1. During all years (fall only), 310 peregrines were seen on the northern beaches, 321 on North Padre Island, and 829 on South Padre Island. An additional 17 birds were observed elsewhere in Texas during the fall migration period and 36 peregrines were sighted during the winter months. In all, our records contain 1513 peregrine sightings, of which 1014 were made by

TABLE 1—Number of observation days (fall migration only) for three areas of the Texas coast during the period 1956–1973

Area	Years																		Area totals
	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	
Northern beaches				10		2	9	7			11		5		2	3	6		55
North Padre Island									19	26	22	16	13	16	4	3	2		121
South Padre Island	16	25		10	14	15	1		2	14	2		1	7	6	9	9	7	138
Yearly totals:	16	25		20	14	17	10	7	21	40	35	16	19	23	12	15	17	7	
Grand total																			314 days

the authors, 446 by R. L. Meredith, and 63 by B. Watson and others elsewhere acknowledged.

Our procedures and experiences in finding and trapping peregrines are similar to those described by Enderson (1965) and by Ward and Berry (1972) except that our observations have been restricted to the morning hours only, from dawn until about 1300 hours. Briefly, our technique has been to drive along the Gulf (East) shores of the various beaches attempting to catch each falcon seen. Each day's observation was made from one vehicle in which there were usually two people. On South Padre Island each day's sampling involved driving north to Mansfield Channel, and back to the starting point at South Padre Island settlement, adjacent to Port Isabel. On North Padre Island, Slowe would enter the island at Corpus Christi, drive to "Little Shell," then to the portion adjacent to Aransas Pass, then back (still on the beach) to Corpus Christi. The shorter beaches, in the "northern beaches" area, were traveled more than once during a morning. Overall numbers of sightings were pooled for the entire morning periods (both to and from the starting points); little attention was paid to the possibility of duplicate sightings except for the elimination of the obvious ones.

For calculations which compare daily and yearly numbers of sightings we have deleted 22 days on which observations were made from a fixed location or when the observation time did not span the entire morning or did include the afternoon, or when exceptionally high tides or other adverse conditions prevented the observers from traveling the major portion of the beach. We argue that the remaining days are grossly comparable within each beach area in terms of sampling effort.

One source of bias arises from the fact that during the time one spends attempting to trap a bird, observations of others are not being made. Trapping and banding time per bird varies greatly while the likelihood of observing peregrines is not constant through the morning hours. The numbers of other vehicles driving on the beach, which increase on weekends, probably affect the numbers of peregrines seen, as does wind direction and other weather factors discussed later.

A complete listing of peregrine banding and recovery data processed through 31 August 1973 was obtained from the United States Fish and Wildlife Service.

Observations of Peregrines

Although peregrines may be present on the beach at first light (Enderson 1965), our experience has been that they do not appear in numbers until about an hour after dawn. About 79% of a sample of 249 birds (1968–1972) seen between 0700 hours and 1300 hours were observed after 0800 hours and before 1100 hours. The most productive hour was 0900 to 1000 hours. White (1969) has made similar observations of migrants in Alaska.

Individual peregrines are sometimes, though rarely, seen on the beach early in September. W. D. Stine (personal communication) records seeing an adult on 1 September. Slowe took 13 trips over several years on North Padre Island between 11 and 21 September, but saw no peregrines.

Our conception of the period of the migra-

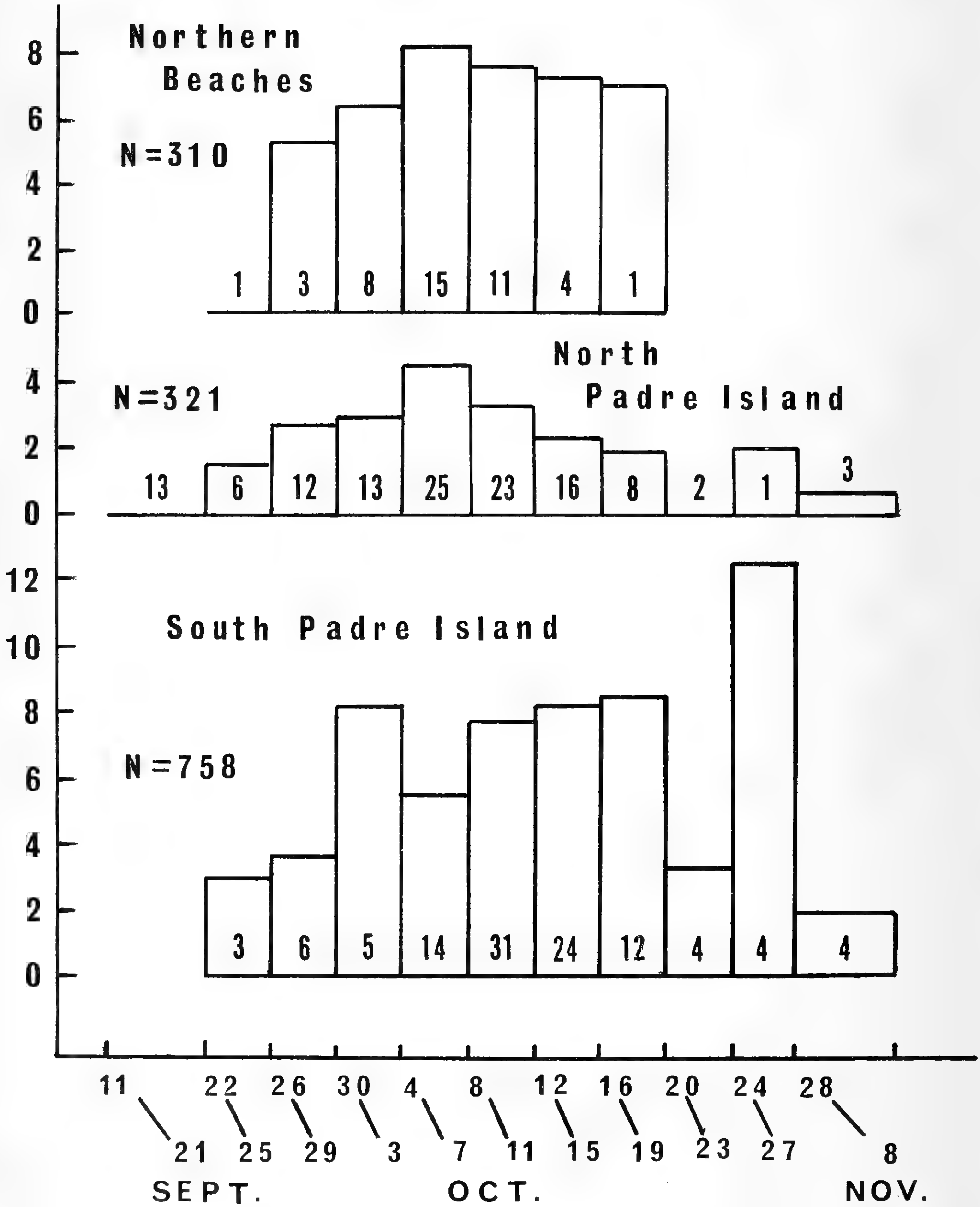


FIGURE 2. Average numbers of peregrines seen per day in the three study areas from 11 September through 8 November (data pooled for all years). The numbers of observation days are indicated for each period.

tion is given in Figure 2, which shows the average numbers of peregrines seen per day on each of the three observation areas from 11 September through 8 November for all years. The relatively low numbers of birds seen on North Padre Island is probably a function of the greater amount of human disturbance and development there and because the island is much wider in the north. The large peak during 24–27 October on South Padre Island is unexplainable at present, but 3 of the 4 days of observation are from one year. The timing of the peregrine migration in Texas appears to be about the same as on Assateague Island, Maryland (Ward and Berry 1972) and Hawk Mountain, Pennsylvania (Haugh 1972). In some years, such as 1957, 1965, and 1966, birds have arrived in numbers during the last week in September, but in other years (e.g., 1959, 1962, 1968) no falcons were seen until 4 October despite prior searching.

It is of interest to know whether the numbers of peregrines visiting the Texas coast have declined during the period for which we have data. Certainly this might be expected in view of the many declines elsewhere during the past 25 years. Rogers and Hunt (1975) compared the average numbers of peregrines seen per day from 1959 through 1965 with a later period, 1969 through 1972. They found, as did Ward and Berry (1972) for the East Coast migration, that no change had occurred, nor was there a change in adult-to-immature ratios. Ward and Berry did report a reduction in current numbers when compared to other researchers' data from the 1940s, but for the Texas migration there is no information available for such a comparison.

For the purpose of evaluating yearly differences in the abundance of peregrines observed, we have compared each year's average number of sightings (1–15 October) from each observation area with the all-year mean for that area. Our results suggest that 1961, 1968, 1971, and 1973 were good years, while 1964 and 1969 were particularly poor years for peregrines.

Haugh (1972) has recently discussed the effects of weather on the movements of migrating diurnal raptors in eastern North America. To investigate the effects of weather on the Texas peregrine migration, we assembled daily averages in temperature, wind speed, wind direction, and cloud cover from the nearest U.S. weather station to our points of observation. We then compared these variables with the numbers of falcons seen per day. Our results were similar to those of the East Coast studies of Ward and Berry (1972). More falcons were seen on days of heavy cloud cover, low wind speed, and low temperatures. Figure 3 shows the effect of wind direction on daily numbers of October sightings on South Padre Island for all years. The fewest numbers of peregrines were seen when the wind blew from the south and east. On South Padre Island in 1971, Rogers observed a number of peregrines which seemed to be migrating immediately ahead of a squall line (cold front). On the northern beaches, peregrine numbers are highest about two days before the arrival of cold fronts (Hunt 1966).

There is the possibility that during certain kinds of weather the numbers of sightings recorded may not indicate the actual numbers of birds present in the area. The observation of falcons depends on their movement to the east side of the island, and weather conditions which discourage them from doing so must result in erroneously low counts. In 1969, for example, we experienced very strong daily SSE winds which blew sand along the gulf side of the beach. We saw very few falcons during this period, but they might have been present on the bay side of the island, protected from the wind and impossible to observe.

Age Classes

Peregrines under and over one year of age are easily distinguished. The young-of-the-year are recognized by their vertically streaked, brownish breast plumage and, assuming an Arctic origin (see section *Origin of Migrants*), they are about 3 months old when they arrive in Texas (see Cade 1960 for hatching dates). Birds about 15 months old, on their second migration, or those which are older, are readily identified at a distance by the familiar horizontal black bars on light breasts, and their backs of blue or black. In this paper, the term "adult" will refer to any peregrine in barred plumage,

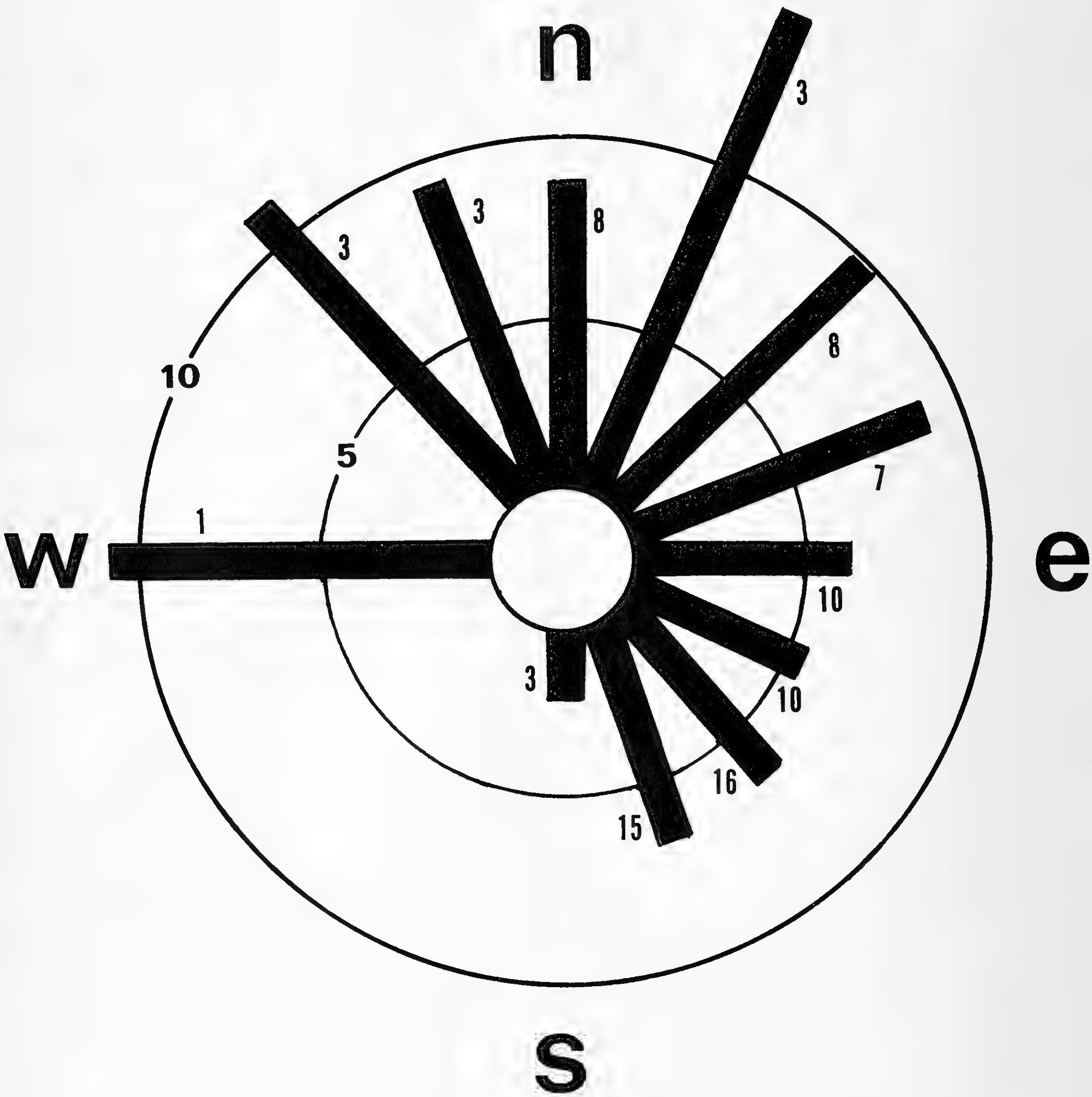


FIGURE 3. The effect of wind direction on peregrine numbers on South Padre Island during October for all years. The lengths of the wind direction lines are proportional to the average numbers of falcons seen per day, and the numbers indicate the numbers of observation days when the wind blew predominantly from each direction. Example: during 8 days of observation when the wind blew from the north, a daily average of about nine peregrines was seen.

and will, as a rule, apply only to adult females, unless otherwise stated, since adult males are only occasionally identified on the Texas beaches and have never, to our knowledge, been trapped there.

The transformation in plumage begins 1 year after hatching, and the entire molt takes about 6 months, beginning in June or July for Arctic birds (Cade 1960) and being completed in December or January. The actual stage of the molt is most reliably indicated by the condition of each of the fourth through the tenth primaries, the tenth being the outermost. Normally, the fourth primary is the first feather to be molted, and when its substitute is almost fully grown, the fifth primary drops, and so on, until the replacement of the tenth primary marks the end of the yearly molt. The other three pairs of primaries, the third, second, and first, usually fall with the sixth, eighth, and tenth pairs, respectively. This information on the molting sequence is based on records from captive birds of several races of peregrines including birds trapped on the Texas coast. Contrary to the findings of Enderson et al. (1973), we have observed no differences in the molting sequence between the sexes except that males normally begin molting later than females.

When a falcon is trapped and examined, the new and old feathers stand in contrast; the former are shiny, dark, and resilient, while the old ones are bleached and worn. Since the fall migration occurs roughly halfway through the molt, 15-month-old birds have eclipsed plumage, retaining numerous juvenile feathers, and can thus be distinguished from older individuals.

Among the fall migrants, the stage of the molt may indicate, within broad limits, their latitudinal origin, since the onset of the molt in females occurs during incubation (Cade 1960; Stresemann 1967), and laying generally begins later with increases in latitude (Bent 1937). We have not gathered data on molting chronology on the summer ranges, though this information presumably can be obtained by examining museum specimens. As for the migration, we have noted that, of seven eclipsed-plumage females trapped between 21 September and 16 October, six had the three outer (eighth through tenth) primaries remaining of the juvenile plumage. The other bird was similar except that the eighth pair had been replaced by adult feathers. An old female trapped on 23 December had the tenth primary remaining from the previous year. A female, approximately 19 months old, trapped on 3 February, had replaced all primaries, but the tenth pair had about 1¼ inches more to grow.

Despite the fact that the molt is incomplete during September and October, very few of the falcons with eclipsed-plumage or those older were actually growing or missing major feathers (primaries or rectrices). Thus, these birds migrate with a full sail, a condition of obvious adaptive value (see Stresemann 1967). A brief interruption of molt in females may also occur during the nesting period when females resume foraging to feed the young (Enderson et al. 1973).

Our data (total of 1406 birds seen) for the period 22 September to 8 November (1954–1973) contains 733 sightings in which peregrines were classified as to age, that is whether they had streaked or barred plumage. Of these, there were 149 adults (20.3%) and 584 immatures (79.7%), or an approximate ratio of one adult to four immatures. The actual ratio is probably larger than our figures indicate since adults, being the minority class and being more conspicuous, are more likely to be noted when seen. Ward and Berry (1972) report a ratio of one adult to about six immatures from their studies on Assateague Island, Maryland, and Berry (1971) suggests that an even higher overall ratio may exist in the migrant sample. Rice (1969) and Enderson (1965) record similar unbalanced ratios of adults and young for peregrine migrations in Virginia and Wisconsin.

Actually, the observed age ratios of migrating peregrines are far afield of their actual values in the population as a whole. As Hunt (1966) and Shor (1970a) have pointed out, peregrine populations always contain more adults than post-fledgling individuals under 1 year of age. This fact, obtained by viewing average nesting productivity, indicates that there is differential migratory behavior among the age classes.

A chronological listing of adult to immature ratios (1954–1972) is given in Table 2 where the migratory season has been divided into seven 4-day periods and one longer period at the end of the migration. It can be seen that adults arrive first and their proportions rapidly dwindle relative to immature numbers. Berry (1971) found a similar trend during the 1969 East Coast migration where 11 of the 13 adults sighted were observed during the early portion of the migratory season. He justifiably maintains that adults, being stronger and more experienced in foraging, travel more directly to the wintering grounds. It is reasonable that

TABLE 2 — Chronological listing of the numbers of adult and immature peregrines classified during the fall migration period on the Texas coast. Data from sightings only are pooled for all years (1954–1973) and all beaches. The difference in occurrence through time of the two age classes is highly significant by *chi* square

Period	Adults	Immatures	Adult frequency
22–25 Sept.	23	0	1.00
26–29 Sept.	21	27	0.43
30 Sept.–3 Oct.	15	42	0.26
4–7 Oct.	30	130	0.19
8–11 Oct.	42	154	0.21
12–15 Oct.	12	149	0.07
16–19 Oct.	4	66	0.06
20 Oct.–8 Nov.	2	16	0.14
Totals	149	584	

immature falcons should have a tendency to linger on the beach, if indeed they do, since the beach habitat, as discussed later, is ideally suited to a falcon learning to catch prey.

We had expected to see the differential temporal occurrence of adults and young reflected in our trapping data (see Table 3, discussed later). That is not the case, however, and we can offer little explanation other than sampling error, which arises from the fact that only 10 of 250 birds trapped were caught in September when adults reach peak numbers. It is also probable that the majority of the adults, especially early in the migration, are more suspicious, not as hungry, and more difficult to trap. Our experiences trapping adults later in the season, however, have been that they are easily caught.

Age ratios in our sample of winter sightings show a greater proportion of adults than in the migrant sample. Of 36 peregrines, there were 14 adults, 14 immatures, and 8 unclassified. The majority of these sightings were made several miles inland from the Laguna Madre by R. L. Meredith.

Sex Ratios

Although peregrines are highly dimorphic with respect to size, it is our opinion that accurate sex ratios cannot be estimated on the basis of sightings. At a distance we usually speculate as to the sex of each bird we are attempting to trap and often later discover, when the bird is in hand, that our guesses were incorrect. While we will not deny the possibility of other more astute observers, we have eliminated all data on sex ratios in calculations based merely on sightings. The exception to this argument occurs on occasions when a bird is seen flying with an individual of the opposite sex.

Sex ratios can be estimated from the trapping data (Table 3), although there is surely a sex differential in trap-response favoring females. Of 250 birds trapped, 164 were immature females, 50 were immature males, and 36 were adult females. Excluding the adults, males made up 23.4% of the immature sample (N = 214). Ward and Berry (1972) found about 30% males (N = 539) in the immature portion of their Maryland trapping data pooled from 1939 to 1971. During this period, eight adult males were trapped in contrast to none trapped on the Texas coast.

TABLE 3 — Chronological listing by sex and age class of 250 peregrines trapped on the Texas coast during the period 1954–73

Period	Adult females	Immature females	Immature males	Frequency of males in immature sample
22–25 Sept.	0	0	0	—
26–29 Sept.	0	7	3	0.30
30 Sept.–3 Oct.	2	9	10	0.52
4–7 Oct.	15	45	14	0.23
8–11 Oct.	12	45	11	0.20
12–15 Oct.	4	33	6	0.15
16–19 Oct.	3	13	5	0.28
20 Oct.–8 Nov.	0	12	1	0.07
Totals	36	164	50	0.23

There is no reason to believe that tertiary (immature) and quaternary (adult) sex ratios in peregrines are unbalanced. The preponderance of females in trapping samples is probably caused by a combination of greater trapping susceptibility of females and perhaps a differential migratory or foraging behavior of the sexes. To test this latter possibility, a *chi*-square contingency test was applied to the immature segment of the Texas trapping sample (Table 3). The results suggest significant heterogeneity in the distribution through time of immature females and males ($P < 0.05$). It appears that the high point in the density of immature males occurs during the first week in October, just after the peak of adult females and before that of immature females. The indicated temporal difference in the occurrence of males on Texas beaches could be a result of their being more capable of exploiting inland small bird populations than are the larger females. It is interesting to note that Assateague Island, Maryland, is partly forested and that greater overall proportions of both young and adult males, as discussed above, occur in the Maryland sample. With this in mind, we thought it relevant to compare the sex ratios of birds trapped on each of the three Texas observations areas, since the inland region of only the northern part of the Texas coast is forested. Our results were not significant. We then pooled the sex-ratio data from North Padre Island and the northern beaches and compared them with those from South Padre Island. At first we had considered the entire migratory period (23 September – 8 November) but recognized a bias in the fact that the South Padre Island samples represented a greater span of time than the other two areas (see Figure 2), thereby predictably increasing the sex ratio in favor of females on South Padre Island. We therefore limited the analysis to the period 30 September through 16 October. During this period, on North Padre Island and the northern beaches, 26 immature males and 59 immature females were trapped, while the ratio on South Padre Island was 15 males to 71 females. A significant difference in sex ratios of the two samples was suggested by *chi*-square ($P < 0.05$). Again, our results suggest a difference in migratory and/or habitat preference between the sexes.

Origin of Migrants

Since there is no known conspicuous migration of peregrines on the Pacific coast, one may speculate that Texas receives its birds from Alaska and northwestern portions of Canada where relatively large breeding populations exist. A migratory path along the eastern side of the Rocky Mountains would channel northwestern peregrines to the Gulf Coast, as is the case in some shorebirds (A. Sprunt, personal communication). Peregrines banded in Alaska and the Canadian northwest show a net migratory flow toward the Gulf Coast (R. Fyfe, personal communication; Enderson 1965). As for the peregrine migration on the eastern seaboard, a principal source is probably Greenland (Shor 1970b) and northeastern Canada (see Enderson 1965).

About 200 autumn migrant peregrines have been banded on the Texas or western Louisiana coasts between 1952 and 1973. There have been 17 recoveries, but 14 of these were reported near the areas of banding or elsewhere in Texas. Of the remaining three, two were recovered in more southerly locations, one in Panama (November) and another in northwestern Brazil (December). The remaining long-distance recovery occurred above the Arctic Circle in the District of Franklin, Northwest Territories (69.2°N, 8.4°W).

Foraging Behavior

We have had the opportunity on many occasions to observe the hunting behavior of migrant peregrines. The strategies they employ seem to be specifically adapted to the beach habitat and to the general types of prey that occur there.

The scarcity of protective cover on the beach, especially on the large flats described earlier, is of immense advantage to a hunting peregrine. A bird being pursued by a falcon in these conditions has little chance to escape except by dodging or outflying its attacker. When the prey is downwind of the peregrine, the pursuit covers a large distance very quickly and permits only momentary observation. Upwind chases, especially in a heavy wind, cover ground rather slowly. In a typical flight of this type the peregrine is seen about 10–15 m high flying hard into the wind attempting to catch a small land-bird directly upwind and somewhat lower in altitude. The falcon eventually achieves a position directly above the prey from where it stoops. If the attack fails, the peregrine loses its advantage, and the coursing procedure begins anew. If another passerine or shorebird is encountered during the chase and appears more vulnerable to attack, the falcon will sometimes shift to the new quarry. This flight is especially observable during a strong north wind since the chase then runs parallel to the direction of the beach, and one can follow it by car. We have observed upwind flights of this type which covered a mile of beach.

An expanse of water is similar to the open beach in the respect that it provides no refuge for many types of birds being pursued by peregrines. Waterfowl and certain shorebirds find safety in water by their ability to submerge just as a falcon is about to catch them, but other species (e.g., passerines) flounder on the surface when forced into the water (Cade 1960; Herbert and Herbert 1965).

Falcons will intentionally and repeatedly miss in their stoops at Rock Doves (*Columba livia*) which we release for them to chase on the beach. When the pigeon takes to the air, the falcon will guide it toward the ocean and often force it into the surf. A falcon may grab a pigeon, carry it over, drop it into the surf, and stand by the edge of the water for the bedraggled prey to wash ashore.

Since the wind normally blows from the direction of the sea, the practice of driving prey toward and over the water is simply another way of coursing into the wind, with the added advantage that if the prey falls into the water it is readily caught. If the pigeon, as in the above description, escapes being forced into the water, it will be chased out to sea by the peregrine. After a few minutes the pigeon comes winging back over the beach and is often caught by the falcon in a long, flat, downwind stoop. W. F. Jamison told us of an incident in which he and his wife were standing by the surf's edge when a "woodpecker," closely pursued by a male peregrine, came flying in from the direction of the sea. Heading straight for Mrs. Jamison, the woodpecker struck her and clung to her jacket as the peregrine shot up overhead. A. L. Wehner (personal communication) witnessed a Blue Jay (*Cyanocitta cristata*) which was forced into the surf and subsequently taken by a peregrine.

Peregrines often fly along the edge of the surf or tidal puddles at heights of 10 to 25 m, making stoops in passing at small shorebirds. We have never seen a successful flight of this type, but have noted several near misses. We comment later on the importance of shorelines to foraging peregrines.

In many areas of the beach there are dunes a short distance from the edge of the surf. By flying low behind the dunes, peregrines may get quite close to their prey before being seen. Rogers has observed some successful surprise attacks of this kind. The strategy is similar to that employed by gyrfalcons (*Falco rusticolus*) in Alaska (White and Weeden 1966). Fyfe (personal communication) has observed peregrines using this method on tundra.

There have been a number of observations of peregrines leaving a perch to attack prey. An immature tiercel was observed to fly at some swallows which were flitting about at approximately 40 m above his perch on the beach. He cocked his head and eyed them for a while and then took off, climbing into the wind at about a 30-degree angle. When he reached a point at which he was slightly higher than the prey and several hundred yards upwind, he suddenly reversed his course and stooped downwind at the swallows. Although he was not successful in catching one, he appeared to have touched a swallow with his feet. He then dropped down and landed on the sand close to where he had launched his attack. W. D. Stine and C. E. Hall told us of two similar incidents where Horned Larks (*Eremophila alpestris*) were taken by immature peregrines of both sexes. We saw an adult male fly from a telephone pole in pursuit of some ducks flying very high and far away. The falcon climbed steadily toward the ducks and repeatedly stooped through the flock.

Prey

Table 4 lists 89 records of prey species taken by peregrines on Texas beaches. The term "shorebirds" is used in this paper as an ecological rather than a taxonomic category (see Cade 1960). The sample is incomplete since little is known of the prey in coastal marshes and other areas which the falcons frequent. All of the larger quarry (e.g., gulls) were killed by adult females. Immatures hesitate to take large birds, while adults are recognizably direct in their attacks.

C. E. Hall (personal communication) of Galveston, Texas, gives an interesting account of a peregrine specializing on larger shorebirds:

TABLE 4 — Prey of peregrines on the Texas coast. (Here the heading "Shorebirds" is used as an ecological [ie., birds that frequent the shore] rather than a taxonomic category)

Species	Number	Species	Number
Shorebirds		Unidentified duck	1
Cattle Egret (*Bubulcus ibis*)	1	Total waterfowl	8
American Coot (*Fulica americana*)	1		
Green Heron (*Butorides virescens*)	2	Land birds	
Royal Tern (*Thalasseus maximus*)	2	Horned Lark (*Eremophila alpestris*)	2
Snowy Egret (*Leucophoyx thula*)	2	Brown-headed Cowbird (*Molothrus ater*)	4
Laughing Gull (*Larus atricilla*)	1	Great-tailed Grackle (*Cassidix mexicanus*)	1
Herring Gull (*Larus argentatus*)	1	Rusty Blackbird (*Euphagus carolinus*)	1
Ring-billed Gull (*Larus delawarensis*)	1	Meadowlark (*Sturnella magna*)	4
Golden Plover (*Pluvialis dominica*)	1	Mourning Dove (*Zenaidura macroura*)	12
Willet (*Catoptrophorus semipalmatus*)	3	White-winged Dove (*Zenaida asiatica*)	1
Black-crowned Night Heron		Rock Dove (*Columba livia*)	1
(*Nycticorax nycticorax*)	1	American Kestrel (*Falco sparverius*)	1
King Rail (*Rallus elegans*)	1	Flicker (*Colaptes* spp.)	2
Unidentified Gull (*Larus* spp.)	2	Gray Catbird (*Dumetella carolinensis*)	1
Unidentified small shorebirds	7	Sparrows	11
Total shorebirds	26	Unidentified small passerines	12
		Total land birds	53
Waterfowl			
Shoveler (*Spatula clypeata*)	4	Mammals	
Redhead (*Aythya americana*)	1	Unidentified mammals	2
Green-winged Teal (*Anas carolinensis*)	1	Total mammals	2
Lesser Scaup (*Aythya affinis*)	1		

"We had a resident bird (adult female) on the island several years ago who favored a particular log. Around it were the wings, heads, and legs of Royal Terns, Laughing Gulls, Ring-billed Gulls, and also Willets." W. E. Stine, with a group of birders near Rockport, was observing a small flock of Herring Gulls (*Larus argentatus*) flying about 20 m over the bay. Suddenly, an adult peregrine struck one of the gulls from a terrific stoop. The gull tumbled into the water while the peregrine flew from sight.

Passerines and other small land-birds, which make up 60% of our records, are especially vulnerable to peregrine predation both on the beach and over water since their main tactic of escape lies in reaching protective cover. Of this group, Mourning Doves (*Zenaidura macroura*) and sparrows are the most commonly observed prey taken.

Shorebirds (ecologically defined) are our second most frequently noted group of prey birds, making up 29% of the sample. Although shorebirds are the most common prey to be seen on the beach, most are difficult for peregrines to catch or kill. The small shorebirds are shifty and evasive flyers and are generally able to dodge the peregrine's stoop as well as to take some advantage of water as cover. Some of the larger species such as Long-billed Curlews (*Numenius americanus*) are fast flyers, while others, like the larger gulls, are probably difficult to kill, at least for immature peregrines. Egrets and small herons are often common on the beach and are very easily caught by peregrines.

The low number of waterfowl (9%) recorded as prey of peregrines on the Texas coast may be misleading because of the inaccessibility of waterfowl habitat to the observer. There are vast marshes located slightly inland and many ponds just behind the beach which usually contain a supply of ducks. We believe that ducks are ordinarily caught by surprise when flying high or away from water. Coots (*Fulica americana*) are probably utilized to a great extent by peregrines since they are common, extremely slow, put up little struggle when caught, and have a habit of foraging away from water.

Table 5 compares the percentages of prey types in Texas with those given by Cade (1960) for peregrines in Alaska and by Meng (1967) for the East Coast migration. The percentages are quite similar between Texas and Alaska, while the East Coast data show a higher percentage of small land-birds, predominately flickers (*Colaptes auratus*).

TABLE 5 — Comparison of the prey of peregrines in Alaska (Cade 1960), the east coast (Meng 1967), and the Texas coast

Prey	Taiga zone of Alaska	Tundra zone of Alaska	East coast	Texas coast
Land birds	53%	43%	91%	60%
Waterfowl	11%	5%	1%	9%
Shorebirds	30%	32%	6%	29%
Upland game birds	1%	16%	—	—
Mammals	6%	4%	—	2%
Number of records	119	246	222	89

Discussion

A generalization suggested by our observations of peregrines foraging on the beach is that the niche of these northern falcons is based on the existence of environmental discontinuities across which prey becomes vulnerable. Shorebirds, in the shallow water along the edge of the ocean and bays are fairly immune to peregrine attacks while a few feet inland they are exposed. Just across the beach, beyond the dunes, begins the coastal prairie grassland, an area rich in passerines and other land-birds, but these are quite vulnerable to peregrines either on the beach, or over water. Lastly, there is a patchy distribution of waterfowl habitat with intervening spaces affording no protection. To summarize the advantages which the beach environment provides to hunting peregrines, there is water over which land-birds are vulnerable, and there are terrestrial expanses with no protective vegetation for any bird being pursued by a falcon to take refuge.

Photographs by Cade (1960, pp. 275, 279, 289) of the nesting habitat along the floodplains of the Colville and Yukon Rivers in Alaska seem to be quite similar to the environment where peregrines are seen in Texas. Spring runoff and high tides are the factors producing the coverless terrain in the two areas, respectively.

We regret to report that our most productive observation area, South Padre Island, has recently fallen into the hands of "developers." A paved road down the middle of the island is under way and will be crisscrossed with streets lined with houses. We doubt that, with such habitat destruction, the peregrines will continue to be seen in anything like their former numbers.

Acknowledgments

We express our appreciation to Charles Hall, Marianne Meyers, Harry McElroy, Tony Joern, Tom Ray, M. K. Rylander, Robert Selander, Eric Skov, John Smith, Doug Stine, Tony Warnock, and Barry Watson for the use of their unpublished notes or helpful suggestions. We are indebted to D. A. Klebenow, the Texas Parks and Wildlife Department, and the U.S. Fish and Wildlife Service for their help with the necessary permits, bands, and banding information. James Enderson generously provided his band recovery data. We thank James Enderson and Heinz Meng for their critical review of the manuscript and Deidre Bird Hunt for its preparation. We are especially grateful to Clayton M. Whyte for his constructive criticisms of this and earlier manuscripts and for his continuing encouragement.

We dedicate this paper to the late Colonel R. L. Meredith, a falconer, whose memory we hold in highest respect and admiration.

Literature Cited

Bent, A. C. 1937. Life histories of North American birds of prey. Part II. United States National Museum Bulletin 170.

Bernard, H. A. and **R. J. LeBlanc.** 1965. Résumé of the quaternary geology of the Northwestern Gulf of Mexico Province. *In* The Quaternary of the United States. *Edited by* M. E. Wright and D. G. Frey. Princeton University Press. pp. 137–185.

Berry, R. B. 1971. Peregrine falcon population survey, Assateague Island, Maryland, fall, 1969. Raptor Research News 5: 31–43.

Cade, T. J. 1960. Ecology of the peregrine and gyrfalcon populations in Alaska. University of California Publications in Zoology 63: 151–290.

Enderson, J. H. 1965. A breeding and migration survey of the peregrine falcon. Wilson Bulletin 77: 327–339.

Enderson, J. H. 1969. Coastal migration data as population indices for the peregrine falcon. *In* Peregrine falcon populations, their biology and decline. *Edited by* J. J. Hickey. University of Wisconsin Press, Madison. pp. 275–278.

Endersen, J. H., S. A. Temple, and **L. G. Schwartz.** 1973. Time-lapse photographic records of nesting peregrine falcons. Living Bird 11: 113–128.

Griscom, L. and **M. S. Crosby.** 1925. Birds of the Brownsville region — southern Texas. Auk 42: 519–537.

Haugh, J. R. 1972. A study of hawk migration in eastern North America. Search, Cornell University Agricultural Experiment Station 2(16): 1–60.

Herbert, R. A. and **K. G. S. Herbert.** 1965. Behavior of peregrine falcons in New York City region. Auk 82: 62–94.

Hunt, W. G. 1966. Observations of peregrines on the Texas coast. M.Sc. thesis, Sul Ross State University, Alpine, Texas.

Meng, H. 1967. Notes on food habits of east coast peregrines (*Falco peregrinus*) during fall migrations, 1941–1967. Journal of the North American Falconers Association 6: 41–42.

Rice, J. N. 1969. A peregrine population index on the Maryland-Virginia coast. *In* Peregrine falcon populations, their biology and decline. *Edited by* J. J. Hickey. University of Wisconsin Press, Madison. pp. 279–280.

Rogers, R. R. and **W. G. Hunt.** 1975. Peregrines on South Padre Island: recent years. *In* Population status of raptors. *Edited by* J. R. Murphey et al. Raptor Research Report 3: 61–65.

Shor, W. 1970a. Peregrine falcon population dynamics deduced from band recovery data. Raptor Research News 4: 49–59.

Shor, W. 1970b. Banding recoveries of arctic migrant peregrines of the Atlantic Coast and Greenland populations. Raptor Research News 4: 125–131.

Stresemann, E. 1967. Inheritance and adaptation in moult. *In* Proceedings of the XIV International Ornithological Congress, Oxford, 24–30 July, 1966. *Edited by* D. W. Snow. Blackwell Science Publications. 405 pp.

Ward, F. P. and **R. B. Berry.** 1972. Autumn migrations of peregrine falcons on Assateague Island, 1970–71. Journal of Wildlife Management 36: 484–492.

White, C. M. 1968. Diagnosis and relationships of the North American tundra-inhabiting peregrine falcons. Auk 85: 179–191.

White, C. M. 1969. Breeding Alaskan and arctic migrant populations of the peregrine. *In* Peregrine falcon populations, their biology and decline. *Edited by* J. J. Hickey. University of Wisconsin Press; Madison. pp. 45–51.

White, C. M. and **R. B. Weeden.** 1966. Hunting methods of gyrfalcons and behavior of their prey (Ptarmigan). Condor 68: 517–519.

Woodard, D. W., L. C. Otteni, B.E. Dahl, and **R. L. Baker.** 1971. The use of grasses for dune stabilization along the gulf coast with initial emphasis on the Texas coast. Gulf Universities Research Consortium, Report Number 114: 22–23.

Received 19 August 1974
Accepted 11 January 1975

A Recent Decline of Gannets, *Morus bassanus,* on Bonaventure Island, Quebec[1]

DAVID N. NETTLESHIP

Canadian Wildlife Service, 2721 Highway 31, Ottawa, Ontario K1A 0H3

Nettleship, D. N. 1975. A recent decline of Gannets, *Morus bassanus,* on Bonaventure Island, Quebec. Canadian Field-Naturalist 89: 125–133.

Abstract. A comparison of the results of recent surveys of Gannets on Bonaventure Island shows that after increasing greatly over the previous 80 years, the breeding population decreased from 20 511 pairs in 1969 to 17 281 pairs in 1973, a 16% decline. Reduced fertility because of contamination by toxic chemicals (chlorinated hydrocarbons) and disturbance at the colony by tourist boats and visitors on land seem likely to be prime causes. Past population data are reviewed.

Abstrait. Une comparaison des résultats de relevés récents des fous de Bassan sur l'île Bonaventure démontre que cette population qui avait grandement augmentée depuis environ 80 années aurait diminuée de 20 511 paires en 1969 à 17 281 paires en 1973, un déclin de 16%. Leur fécondité aurait été réduite par la contamination de produits chimiques toxiques (hydrocarbons chlorurés) ainsi que par des dérangements à la colonie causés par les bateaux touristiques et les visiteurs sur l'île. Des données sur les populations passées sont revues.

Introduction

The Gannet (*Morus bassanus*) population of Bonaventure Island, Gaspé Peninsula, Quebec (48°30′ N, 64°09′ W) has been known to exist since about 1860, and its history has been documented by ornithologists both in the past (e.g., Lucas 1890; Taverner 1918; Wynne-Edwards et al. 1936) and in recent times (e.g., Peakall 1962; Poulin 1968; Poulin, J.-M. and G. Moisan 1968[2]). The numbers of nesting Gannets at Bonaventure Island have increased very greatly during the last hundred years and reached a population high about 1966. Recent detailed studies of Bonaventure Island Gannets by Poulin (1968), however, show that hatching success (38%) and fledging success (78.3%) are much lower than in colonies elsewhere (e.g., Bass Rock, Scotland (Nelson 1966a, b), hatching success = 82%, fledging success = 92.3%), and that toxic chemical levels (DDE) in both breeding birds and their summer foods (chiefly mackerel, *Scomber scombrus*, and herring, *Clupea harengus*) are significantly higher than those at colonies along the Atlantic coast of Newfoundland (Keith 1969; Pearce et al. 1973). Moreover, egg-shell thinning was detected amongst Bonaventure Island birds in 1969 to an extent, about 17% thinner than pre-1915 eggs) that has been associated with reproductive failure in other birds (Keith and Gruchy 1972; Pearce et al. 1973).

These facts, combined with the knowledge that the Bonaventure Island colony represents about 53% of the total North American breeding population (Nettleship 1975), that it is situated where contamination is most concentrated, and that the island has recently been made a provincial park, have prompted the Canadian Wildlife Service to initiate accurate censusing of breeding pairs by standardized procedures to monitor population size, and to begin detailed studies of the species' reproductive ecology. The purpose of this paper is to reassemble and review past population data

[1]An investigation associated with the program "Studies on northern seabirds," Canadian Wildlife Service, Environment Canada (Report Number 28).

[2]The Gannets (*Sula bassana*) of Bonaventure Island, Quebec. Paper presented at the 1968 Northeast Fish and Wildlife Conference, Manchester, N.H., 14–17 January 1968. 17 pp.

and to report the results of surveys made in 1969 and 1973 in an attempt to provide an insight into current and possible future population performance and trends.

Methods and Procedures Used in 1969 and 1973

Procedures used to cenus Gannets at Bonaventure Island in the past have varied widely, ranging from simple visual impressions of bird numbers to ground counts of nests. This variation in census reliability and accuracy has made it impossible to make precise comparisons between population estimates made in different years. To avoid similar difficulties in the collection and interpretation of data in the future, a standardized census method is required to reduce individual observer bias to a minimum and to provide a permanent and precise record of the distribution and numbers of nesting birds. The technique of population analysis from aerial photography, similar to that pioneered by Acland and Salmon (1924) and used to count Gannets in Great Britain (e.g., Salmon and Lockley 1933; Barret and Harris 1965), provides the most effective solution.

The census method used in 1969 and 1973 was basically the same: a series of overlapping aerial photographs was taken on a single visit during the incubation period in early July from a single-engined fixed-wing aircraft. In 1969 a 35-mm camera with a 50-mm lens was used; in 1973 the photographs were taken with a 70-mm camera and 100-mm lens. In both years the film used was Kodak Plus-X black-and-white. The distance from the colony was about 1800 to 2000 feet (549–610 m). The disturbance of nesting birds appeared slight, and no unusual movement from nest territories was detected.

Nesting areas on the cliff-face and on flattish ground at the cliff-top were both easily delimited on the photographs (7 × 10-inch or 9 × 13-inch glossy enlargements) by the extremely regular spacing of white dots (see Figure 1). Occupied nests were systematically counted under a hand lens (8×) using a plastic grid overlay (1 × 1-cm quadrats), following procedures similar to those outlined by Barrett and Harris (1965). Photo quality not only allowed individual nests to be counted, but often made it possible to determine whether one or two birds were associated with each nest. The only sources of error in the colony analyses appear to be in the demarcation of nesting areas on the prints and in accurately counting nests back from the cliff-top on flattish ground towards the inland edge of the cliff-top nesting groups; both are estimated to be low, probably less than 2%. Since only attended nests were counted, and the status of each nest was unknown, this assessment of breeding population represents the number of 'nest-site holders' rather than the number of 'true breeders' (i.e., pairs that built a nest and laid one egg).

Description of the Colony

Bonaventure Island is approximately 1.7 miles (2.7 km) long and 1.6 miles (2.6 km) broad at its widest point and is roughly circular in shape with an area of about 1140 acres (460 hectares). The cliffs, made up of a conglomerate-red sandstone mixture, reach a height of 300 feet (91 m) on the southeastern coast where the Gannets nest (Figure 1). The nesting area can be divided topographically into five parts (Poulin 1968; Lafleur, Y. 1969[3]), which together occupy some 3600 feet (1097 m) of cliff. Nests are presently located on ledges on the cliff-face (cliff-ledge habitat) and on flattish ground at the top of the cliffs (cliff-top habitat), although this was not always the case (see next section). The eastern and southern cliffs were made a federal migratory bird sanctuary in 1919.

Previous Estimates of Colony Size

Estimates of the numbers of Gannets breeding at Bonaventure Island since its existence as a colony was established are given in Table 1 and Figure 2. Although it appears that the colony was present in 1860 and consisted of large numbers by 1881, it was not until 1887 that an attempt was made to estimate the number of breeding pairs. The methods of conducting the surveys varied considerably between years, making it difficult to identify real changes in the total nesting population. It

[3]Ile Bonaventure 1968. Canadian Wildlife Service Report, Ottawa. 102 pp.

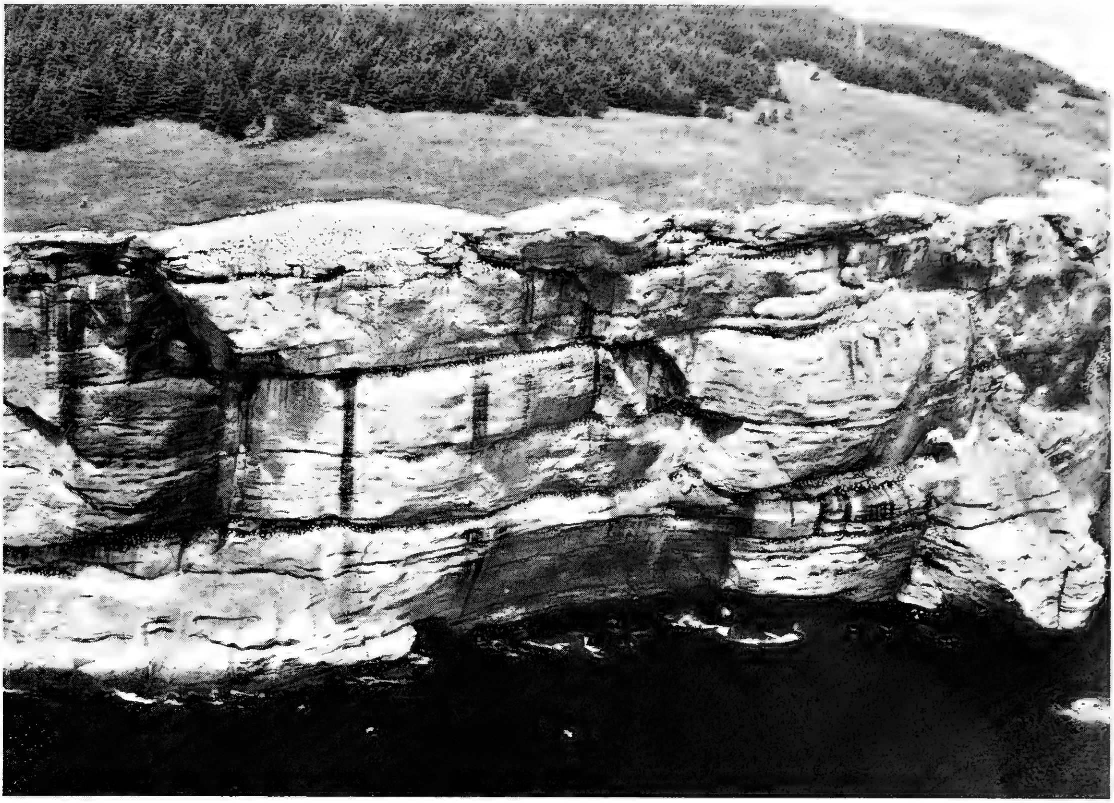


FIGURE 1. Aerial view of a portion of the Gannet colony on Bonaventure Island, 7 July 1973, showing the two principal nesting habitats: ledges on the cliff-face (cliff-ledge) and flattish ground at the top of the cliffs (cliff-top).

seems likely, however, that the colony increased substantially in size between 1887 and 1898, remained fairly stable to 1919, and then increased to about 6000 pairs by 1932, increasing only a little further by 1940.

The first record of a nest on the flat ground at the tops of the cliff was made in 1934 (Poulin and Moisan 1968[2]); by 1940 the numbers nesting on flat ground were substantial (Fisher and Vevers 1943). Figure 3 shows nesting Gannets on the flat ground.

No additional information on the breeding population was collected until 1961, when Peakall (1962) estimated it to be 13 250 pairs, of which 6800 were on cliff-ledges and 6450 were in groups at the top of the cliffs (cliff-top sites). A further increase in numbers occurred between 1961 and 1966, with a total in 1966 (Poulin 1968) of 21 215 pairs, comprising 8967 on cliff-ledges and 12 248 on the top. Both of these increases can be explained by an annual increment of less than 10%, which falls within the reproductive capacity of the colony during the periods of maximum increase (see Fisher and Venables 1938; Capildeo and Haldane 1954; Nelson 1966a).

1969 and 1973 Counts

The procedures and method of analysis used to census the breeding population in 1969 and 1973 were virtually identical. The results given in Table 1 show that the total number of breeding pairs has decreased by roughly 16% since 1969. Much of the decrease seems to have occurred amongst birds breeding on ledges on the cliffs: in 1969, the population comprised 11 854 cliff-ledge pairs and 8657 cliff-top pairs (total: 20 511 pairs), whereas in

TABLE 1 — Estimates and counts of Gannets nesting at Bonaventure Island

Census date	Number of pairs[1]	Census method	Authority
ca. 1860	breeding, no count	—	Fisher and Vevers (1943)
1881	'large colony'	—	Brewster (1884)
1887	*ca.* 1500	boat count	Lucas (1890)
July 1898	3500	boat count	F. M. Chapman *in* Gurney (1913)
1914, 1915	4000	boat count	Taverner (1918)
10, 18 July, 3 Aug. 1919	4000	boat count	Townsend (1920)
1923–1925	'numbers increasing'	boat count	Duval (1925), Bond (1926)
1932	6000	boat and ground count	H. F. Lewis *in* Wynne-Edwards (1935)
1934	*ca.* 6500	boat and ground count	Wynne-Edwards et al. (1936)
Aug. 1938	7000	boat and ground count	V. C. Wynne-Edwards *in* Fisher and Vevers (1940)
May, July 1939	6600–7000	boat and ground count	W. Duval and L. I. Grinnell *in* Fisher and Vevers (1943)
May 1940	*ca.* 6680	boat and ground count	H. F. Lewis *in* Fisher and Vevers (1943)
10–13 July 1961	13 250	combined ground count and boat photography	Peakall (1962)
July 1966	21 215	combined aerial photography, boat and ground count	Poulin (1968), Poulin and Moisan (1968[2])
13 July 1969	20 511	aerial photography	this study
7 July 1973	17 281	aerial photography	this study

[1] Represents the number of 'nest-site holders.'

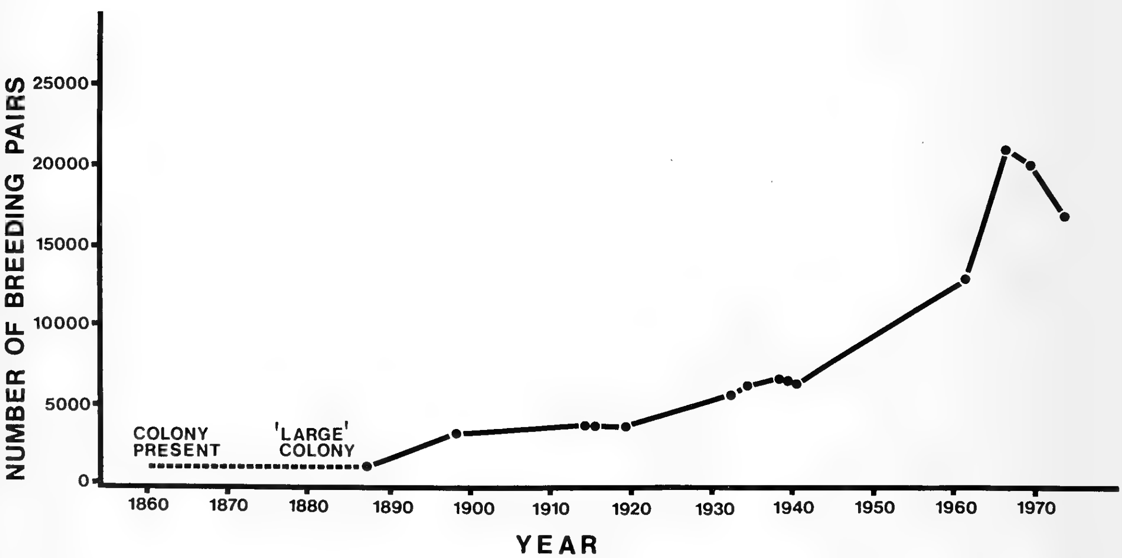


FIGURE 2. Pattern of population changes of Gannets at Bonaventure Island (based on data given in Table 1). Broken line indicates period of known breeding, but no precise counts were made.

FIGURE 3. Gannets nesting on Bonaventure Island, Quebec. Photograph by Philip S. Taylor taken on 29 July 1974.

1973 there were 9274 and 8007 pairs (total: 17 281 pairs), respectively. Thus there was a total loss of 3178 breeding pairs between the two breeding seasons, with 81% of the loss from cliff-ledge habitat and 19% from the top.

The difference between the 1969 and 1966 counts may be due to different methods of counting and estimating the colony, but it may simply indicate that numbers remained relatively unchanged during the period (see Discussion).

Discussion

Population Changes

The history of Gannets on Bonaventure Island is well known only from 1887, and quite unknown before 1860. The periods of steady (1919 to 1938) and rapid (1940 to 1961, 1961 to 1966) growth of the Bonaventure colony (see Table 1, Figure 2) coincide with the substantial increase in world Gannet numbers, which has been in progress over much of this century (see Nelson 1966b). But although Gannets appear to be still increasing in numbers in most parts of the North Atlantic (Nelson 1966b; Cramp et al. 1974; Nettleship 1975), a serious decrease has begun at Bonaventure Island.

Although there were differences in census procedures used in 1966 and 1969, both estimates of the size of the total breeding population are reliable and should be acceptable as an accurate representation of population events. This means that a maximum in the size of this population was reached in 1966 or within one or two years of that date (based on projections of population size using established potential annual increment rates (Fisher and Venables 1938)). It is, however, impossible to assess the differences, if any, in the distribution of birds on cliff-ledge and cliff-top nesting habitats. Even though a change in habitat utilization is suggested by the data, as measured by the number of pairs found nesting in the two habitats, it seems quite likely that the difference is an artifact of differing habitat delineations and classification made during the analyses rather than an actual change in the extent of use of the habitats themselves. Only an exact comparison of the nesting areas can resolve the question.

The most accurate and comparable surveys of the Gannet colony (1969 and 1973) show that about 16% of the population that was breeding in July 1969 was not present in the summer of 1973. No comparable large reduction is known to have occurred at any time in the preceding 80 years.

There is no obvious reason why the total number of breeding pairs has decreased so significantly, or why most of the loss appears to have occurred from birds nesting on cliff-ledge habitat. Because Gannets are still increasing in numbers in other parts of the North Atlantic (see first paragraph of Discussion), and historically were present in larger numbers in the Gulf of St. Lawrence than at present (Bent 1922; Brown, R. G. B. and D. N. Nettleship 1973[4]; Nettleship 1974), it seems unlikely that recent events at Bonaventure Island can be accounted for by any of the usual explanations associated with a decrease in a bird population or growth curve. Nor can the decline be explained by changes in the physical structure of the cliff-face (produced by erosion and other similar factors) making it less suitable for nesting; the physical features of all the nesting areas appear unchanged (based upon examination of aerial photographs and ground observations). There is also little evidence to indicate an increased emigration of Bonaventure-reared birds to other Gannet colonies in eastern Canada (see Moisan and Scherrer 1973) as has been suggested for the growth of certain colonies in east Newfoundland (Tuck 1960). Two main classes of factors seem possible to explain the decrease: either changes in certain properties at the colony, and/or changes in the food supply (quantity and/or quality) at sea.

Disturbance by Tourists

The progressive increase in the number of tourists visiting the colony during the breeding season and the much higher volume of boat traffic viewing the colony from the sea at the

[4]Seabirds in the Gulf of St. Lawrence. Proceedings of the Canadian Society of Fisheries and Wildlife Biologists, Canadian Society of Zoologists Symposium: Renewable resource management of the Gulf of St. Lawrence, 5 January 1973, Halifax, Nova Scotia.

base of the cliffs might have had some effect. Precise figures are not available to allow a detailed assessment of the increase in human disturbance, but the increase is almost certainly at least 100% since 1965. In 1973, the Percé Boat Association transported about 71 000 people around the island from mid-June to the end of September to view the Gannet cliffs (L. Brochet, personal communication). Allowing 25 people per boat-trip, this means that at least 2800 trips were made. What influence this large volume of boat traffic has on the cliff-nesting Gannets is impossible to estimate at this time, but it is unlikely to be beneficial. But even if it does not influence the outcome of breeding attempts, observations made in 1974 indicate that it probably seriously disturbs non-breeding birds which are trying to establish sites on the cliff-face. A related factor, the exhaust fumes from the boats, might also have an adverse effect on Gannets. Both these factors either alone or together could conceivably lower annual production and reduce the rate of recruitment into the cliff-ledge sites.

There is also the disturbance factor created by people visiting the Gannet colony on foot on top of the cliffs. While the increase in visitation on land is poorly documented, it too appears to have increased dramatically since 1965. At least 18 000 visitors landed on Bonaventure Island in 1973 (C.W.S. Bonaventure files), most of whom visited the Gannet colony during the critical periods of incubation and early chick growth (mid-June to mid-August). Ground surveys at the colony in 1974 with J.-M. Poulin indicate that cliff-top areas which receive heavy visitation have receded (i.e., Gannets absent in areas where they nested in 1966 and 1967), whereas some areas with little or no visitation are expanding (i.e., Gannets now nesting in areas which were without nests in 1966 and 1967). All this refers to tourists on foot on the top of the cliffs. Moreover, 1974 data of the behavior of people visiting the colony indicate that up to 25% of visitors do cross the rope fences and by doing so disturb nesting birds (e.g., interrupt incubation, brooding and feeding of young, and cause the dispersion of chicks away from their nest-sites resulting in an increase in pre-fledgling mortality).

Combined, these factors alone could account for the observed decline in Gannet numbers and the differential loss in the two habitats. But there also remains the question of the importance of a changing food supply and other factors at sea.

Food Supply and Toxic Chemicals

Less obvious factors away from the colony which might explain the decrease include changes in the distribution and numbers of mackerel and herring (the main summer foods of Gannets at Bonaventure Island) due either to over-fishing by man or to man-made alterations to water characteristics in the Gulf of St. Lawrence (e.g., rate of water run-off (Neu 1970)). Our lack of knowledge makes it impossible to assess these parameters adequately, although the annual catch of mackerel is known to have decreased in recent years in the Gulf region.

A more immediate contributory cause of the Gannet population decline might be environmental contamination by toxic chemicals. If the relatively high DDE levels found in the eggs (Keith and Gruchy 1972), young (Keith and Gruchy 1972; Pearce et al. 1973), and brain tissue of adult Gannets (Pearce et al. 1973) and in their summer foods at Bonaventure Island (Pearce et al. 1973; Duffy and O'Connell 1968; Sprague and Duffy 1971) were responsible for the low breeding success recorded in 1966 and 1967 by Poulin (1968) and the egg-shell thinning, and annual production remained low in subsequent years, the population decrease might be explained by reduction in the number of young produced and a correspondingly low rate of annual recruitment insufficient to maintain population size. The difference in the extent of the losses in the two nesting habitats might then also be associated with the age structure of the population, especially if a fairly large number of breeding adults reaches maximum longevity at more or less the same time. In other words, if annual production and recruitment are insufficient to maintain population size, and a large proportion of the birds nesting on the cliff-face consists of older birds (as suggested by population events since the 1930s), it is conceivable that losses due to a lengthy low annual reproductive rate in both habitats may first become evident on the cliff-face as older birds die from old age more or less simultaneously and are not replaced, whereas a disproportionate number of breeding birds on cliff-top habitat might be in a younger age class. The average life expectancy of a breeding adult Gannet is poorly known, but Nelson (1966a) gives 16.2 years for birds at a colony in Scotland, though individual Gannets are believed to have lived for as long as 40 years. If this is the case, we can expect a continuing low breeding success, especially hatching success, followed by further decreases in population size. Alternatively, if contamination levels become much lower and breeding success markedly improves, the population might recover and return to its former size.

Conclusions

Much more, however, needs to be known about the factors mentioned above if causal relationships are to be elucidated. At present, it is only possible to conclude that the Gannet population decline at Bonaventure Island may be due partly to contamination by toxic chemicals at sea originating from the polluted St. Lawrence River, partly from an unmanaged visitation at the colony by people on foot and on the water by boat, and to one or more undetermined factors, possibly including changes in the availability of summer food. All this indicates that further studies are required and that any increase in tourism (especially now that the island has been made a provincial park) must be carefully designed and implemented to prevent further deterioration of this uniquely rich seabird area.

Acknowledgments

I am very grateful to J. A. Keith and S. M. Teeple for providing me with their Gannet photographs taken in 1969 for analysis and comparison with our 1973 survey results, and to A. R. Lock for photographing the colony in 1973. Thanks are also due to M. Channing for his careful analyses of all the 1969 and 1973 photographs. H. J. Boyd, R. G. B. Brown, J. E. Bryant, R. I. G. Morrison, W. T. Munro, and P. S. Taylor read the manuscript and made numerous useful suggestions.

Literature Cited

Acland, C. M. and **H. M. Salmon.** 1924. The Grassholm Gannets in 1924 — a great increase. British Birds 18: 178–185.

Barrett, J. H. and **M. P. Harris.** 1965. A count of the Gannets on Grassholm in 1964. British Birds 58: 201–203.

Bent, A. C. 1922. Life histories of North American Petrels and Pelicans and their allies. Reprinted by Dover Publications, Inc., New York, 1964. 335 pp.

Bond, J. 1926. Ornithology of northern New Brunswick. Canadian Field-Naturalist 40: 85–87.

Brewster, W. 1884. Notes on the birds observed during a summer cruise in the Gulf of St. Lawrence. Proceedings of the Boston Society of Natural History 22: 364–412.

Capildeo, R. and **J. B. S. Haldane.** 1954. The mathematics of bird population growth and decline. Journal of Animal Ecology 23: 215–223.

Cramp, S., W. R. P. Bourne, and **D. Saunders.** 1974. The seabirds of Britain and Ireland. Collins, London. 287 pp.

Duffy, J. R. and **D. O'Connell.** 1968. DDT residues and metabolites in Canadian Atlantic coast fish. Journal of the Fisheries Research Board of Canada 25: 189–195.

Duval, W. M. 1925. Gannets of Bonaventure Island, Quebec. Canadian Field-Naturalist 39: 173.

Fisher, J. and **L. S. V. Venables.** 1938. Gannets (*Sula bassana*) on Noss, Shetland, with an analysis of the rate of increase of this species. Journal of Animal Ecology 7: 305–313.

Fisher, J. and **H. G. Vevers.** 1940. The world distribution and numbers of breeding Gannets. Bulletin of the British Ornithologists' Club 60: 39–41.

Fisher, J. and **H. G. Vevers.** 1943. The breeding distribution, history and population of the North Atlantic Gannet (*Sula bassana*). Part 1. A history of the Gannet's colonies, and the census in 1939. Journal of Animal Ecology 12: 173–213.

Gurney, J. H. 1913. The Gannet. A bird with a history. Witherby and Company, London. 567 pp.

Keith, J. A. 1969. Some results and implications of pesticide research by the Canadian Wildlife Service. Transactions of the 33rd Federal-Provincial Conference, Edmonton, Alberta, 8–10 July 1969. pp. 27–30.

Keith, J. A. and **I. M. Gruchy.** 1972. Residue levels of chemical pollutants in North American birdlife. Proceedings of the XVth International Ornithological Congress, The Hague, 1970. pp. 437–454.

Lucas, F. A. 1890. The expedition to the Funk Island with observations upon the history and anatomy of the Great Auk. United States National Museum, Annual Report 1887–88. pp. 493–529.

Moisan, G. and **B. Scherrer.** 1973. Déplacements saisonniers des Fous de Bassan de L'Isle Bonaventure (Canada) (*Sula bassana*). Terre et Vie 27: 414–434.

Nelson, J. B. 1966a. Population dynamics of the Gannet (*Sula bassana*) at the Bass Rock, with comparative information from other Sulidae. Journal of Animal Ecology 35: 443–470.

Nelson, J. B. 1966b. The breeding biology of the Gannet (*Sula bassana*) on the Bass Rock, Scotland. Ibis 108: 584–626.

Nettleship, D. N. 1975. Gannets in North America: present numbers and recent changes. Studies on northern seabirds, Number 25. Wilson Bulletin. (*In press.*)

Neu, H. J. A. 1970. A study on mixing and circulation in the St. Lawrence estuary up to 1964. Atlantic Oceanographic Laboratory Report 1970–9. 31 pp.

Peakall, D. B. 1962. Gannet population of Bonaventure Island. Canadian Field-Naturalist 76: 179–180.

Pearce, P. A., I. M. Gruchy, and **J. A. Keith.** 1973. Toxic chemicals in living things in the Gulf of St. Lawrence. Pesticide Section Manuscript Report 25. Canadian Wildlife Service. 28 pp.

Poulin, J.-M. 1968. Réproduction du Fou de Bassan (*Sula bassana*) Ile Bonaventure (Québec). M.Sc. thesis, l'Université Laval, Province de Québec. 110 pp.

Salmon, H. M. and **R. M. Lockley.** 1933. The Grassholm Gannets: a survey and census. British Birds 27: 142–152.

Sprague, J. B. and **J. R. Duffy.** 1971. DDT residues in Canadian Atlantic fishes and shellfishes in 1967. Journal of the Fisheries Research Board of Canada 28: 59–64.

Taverner, P. A. 1918. The Gannets of Bonaventure Island. Ottawa Naturalist 32: 21–26.

Townsend, C. W. 1920. Notes on the summer birds of the Gaspé Peninsula. Canadian Field-Naturalist 34: 78–80, 87–95.

Tuck, L. M. 1960. The murres. Canadian Wildlife Series 1. 260 pp.

Wynne-Edwards, V. C. 1935. The Newfoundland Gannet colony: with recent information on the other North American gannetries. Ibis 5 (Series 13): 584–594.

Wynne-Edwards, V. C., R. M. Lockley, and **H. M. Salmon.** 1936. The distribution and numbers of breeding Gannets (*Sula bassana* L.). British Birds 29: 262–276.

Received 3 September 1974
Accepted 16 December 1974

New Records of Birds in West-Central Mackenzie District, Northwest Territories

Nicholas A. Roe

The Lombard North Group, The Penthouse, 1135 – 17 Avenue S.W., Calgary, Alberta T2T 0B6

Present Address: Institute of Animal Resource Ecology, University of British Columbia, Vancouver, British Columbia V6T 1W5

Roe, N. A. 1975. New records of birds in west-central Mackenzie District, Northwest Territories. Canadian Field-Naturalist 89: 135–142.

Abstract. New or confirmatory information was gathered on 29 species of birds during the summer of 1973 in west-central Mackenzie District, Northwest Territories. These species fall into five categories: (A) recorded in the area for the first time and definitely breeding: Yellow-bellied Sapsucker; (B) recorded in the area for the first time and possibly breeding: Blue-winged Teal, Ring-necked Duck, Barrow's Goldeneye, Bufflehead, Rock Ptarmigan, Swainson's Thrush, Water Pipit; (C) recorded in the area for the first time without evidence of breeding: Oldsquaw, Common Merganser, American Bittern, American Coot, Common Nighthawk, Mourning Dove, Least Flycatcher, Western Wood Pewee, Dipper, Hermit Thrush, Tennessee Warbler, Bay-breasted Warbler (hypothetical), Western Tanager, Harris' Sparrow; (D) first evidence of breeding in the area: Upland Sandpiper, Red-winged Blackbird; (E) confirmatory records of occurrence in the area and (*i*) possibly breeding: Eastern Kingbird, Swamp Sparrow, and (*ii*) with no evidence of breeding: Killdeer, Townsend's Solitaire, Palm Warbler. Records are compared with the published status of the species.

Few areas remain in Canada that have not had their summer avifauna at least partially listed. My study area, mostly along the east bank of the Mackenzie River, between Old Fort Point and Fort Good Hope (Figure 1), is no exception. Preble (1908) and Williams (1922, 1933) reported earlier on the birds of the area. More recently Godfrey (1965) augmented these earlier lists. But these authors and their co-workers remained in the study area at various river stops for only a few days. In contrast, areas to the south (Seton 1908; Soper 1957; Scotter and Erickson 1963; Weller et al. 1969), north (Porsild 1943), west (Rand 1946), and east (Clarke 1940) are better documented. It is not surprising, therefore, for an ornithologist resident throughout an entire summer to find several species of birds ranging through this area that were missed by previous investigators. For the same reason, several of these species probably have ranges that extend further north than has been presumed.

West-central Mackenzie District lies entirely within the subarctic taiga. Lowland vegetation consists primarily of black spruce (*Picea mariana*) muskeg. Associated species are larch (*Larix laricina*), labrador tea (*Ledum groenlandicum*), white birch (*Betula papyrifera*), dwarf birch (*B. glandulosa*), and various mosses, among which *Sphagnum* spp. are abundant. Upland vegetation is characterized by white spruce (*Picea glauca*) and trembling aspen (*Populus tremuloides*) on well-drained sites. Timberline is around 1900 feet in this area; *Dryas* sp. communities are found above this altitude.

Methods

The observations listed were made during systematic nesting surveys for waterfowl by canoe, or in transect counts along cut-lines, or casually during reconnaissance trips to different habitat types. Intensive study was not constant throughout the period of observations. Neither was it possible to visit all parts of the study area during critical times. Consequently, some areas, particularly south of Fort Norman, may yet reveal evidence of range extensions in addition to those given here.

Active nests, or (as in the case of the Upland Sandpiper) unambiguous parental behavior, are considered to constitute a *breeding* range extension. Where only suggestive evidence was observed, the species in question is designated as *possibly breeding*.

Avian nomenclature follows the American

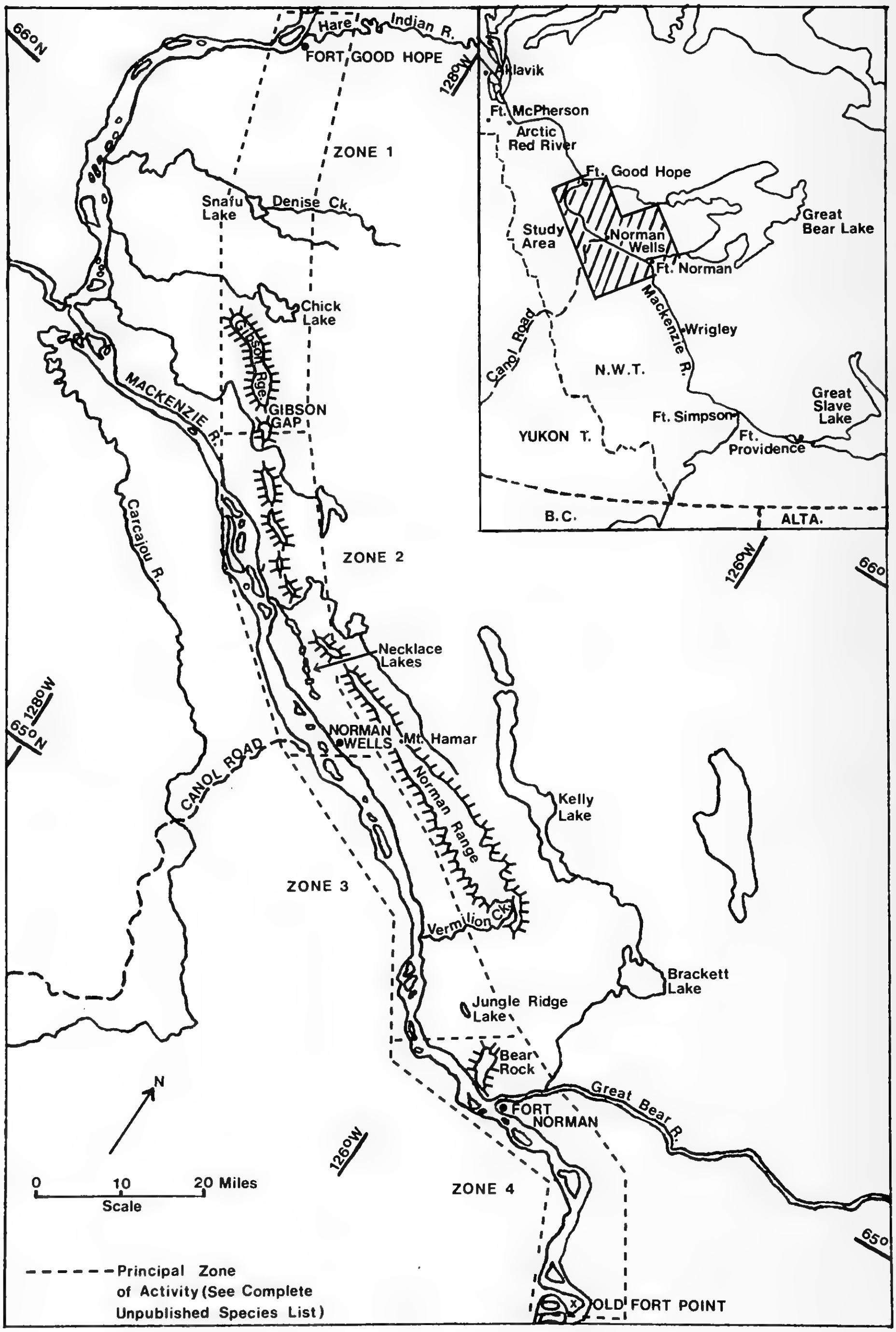


FIGURE 1. The study area in west-central Mackenzie District, Northwest Territories.

Ornithologists' Union Check-list (1957) with revisions from the 32nd Supplement (1973).

Species Accounts

A complete list of the species recorded in the study area is available, at a nominal charge, from the Depository of Unpublished Data, National Science Library, National Research Council of Canada, Ottawa, Canada K1A 0S2.

A. *Recorded in the Area for the First Time and Definitely Breeding*

YELLOW-BELLIED SAPSUCKER. *Sphyrapicus varius.* Four were observed, all on 25 May, approximately 20 miles south of Fort Norman. All were in white birch forest. A pair was observed by Dan Carruthers and myself at a nest hole 1 foot below the top of a 16-foot-high dead birch trunk, the crown of which had recently been blown off. Godfrey (1966) gives the breeding range as including "southwestern Mackenzie (Fort Simpson, Great Slave Lake)." My record extends the breeding range approximately 200 miles north along the Mackenzie Valley.

B. *Recorded in the Area for the First Time and Possibly Breeding*

BLUE-WINGED TEAL. *Anas discors.* Observed on five occasions, four of which were during the breeding period. 29 May, a single male at Gibson Gap. 21 and 22 June, a pair were at the same location. 23 June, a solitary male at the same location. Godfrey (1966) states that the species ranges through "southwestern Yukon . . . southwestern Mackenzie (Great Slave Lake)." These records extend the known range 400 miles to the north.

RING-NECKED DUCK. *Aythya collaris.* Observed on five occasions. 25 May, three males and two females east of Old Fort Point, with males courting females. 31 May, a pair in one of the many small lakes at the south end of Chick Lake. 1 June, a group of two males and one female, and later two males east of Fort Norman. 3 June, a pair and a solitary male on lakes east of Fort Good Hope. 8 August, one female east of Old Fort Point. Godfrey (1966) gives the breeding range as "southwestern Mackenzie (Fort Simpson, Lower Slave River)." A female with four young has been reported from Arctic Red River (Houston 1973) north of my study area. My records are approximately 400 miles north of the range given by Godfrey (1966).

BARROW'S GOLDENEYE. *Bucephala islandica.* Observed on five occasions. 24 May, two males and one female at Necklace Lakes. 29 May, a pair at Gibson Gap. 23 June, two solitary females on different ponds at Gibson Gap at different times of the day. Both exhibited anxiety at my presence, were vocalizing and being aggressive towards other ducks (Lesser Scaup, *Aythya affinis* and Bufflehead, *Bucephala albeola*) as if a nest or young were nearby. One of these females was on the same pond as that where the pair was seen on 29 May. 27 June, two males at Snafu Lake. 28 June, four males and one female at Snafu Lake.

It should be noted that I did not observe any Common Goldeneyes (*Bucephala clangula*) during 1973, although of the two goldeneyes, it is the only one known to breed (Godfrey 1966). Godfrey (1966) states that the nearest recorded breeding range of Barrow's Goldeneye is from Canol Road, southern Yukon, approximately 200 miles southwest of Norman Wells. Williams (1933), however, states that Barrow's Goldeneye was at that time "the common species in the Mackenzie Valley," at least as far as Wrigley. This does not accord with the experience of Preble (1908) and Porsild (1943).

BUFFLEHEAD. *Bucephala albeola.* Observed on 12 occasions and photographed. The following observations are suggestive of breeding. 29 May, one solitary male on a deep pond at Gibson Gap, showing reluctance to fly as if it was on a territory; a pair was seen on a different pond on the same day at the same location. 31 May, in the ponds and lakes at the south end of Chick Lake there were solitary males on almost all lakes and ponds investigated. 21 June, two males and two females at Gibson Gap; courtship flights, displays, and aggression between the males was observed. 29 July, a female with seven young estimated to be 7–10 days old at Jungle Ridge Lake.

Godfrey (1966) states that breeding takes place "probably" at Fort Norman as the northern limit. Preble (1908) recorded a female with young at Fort McPherson, and noted the species 75 miles below Fort Good Hope, but Preble is known to have misidentified a downy specimen in the hand that turned out to be a goldeneye (Erskine 1971). Erskine (1971) also states that female Buffleheads have been seen with broods of young goldeneyes. For this reason, my record of a female with young is considered inconclusive breeding evidence, and the species is therefore considered a probable breeder in my study area.

ROCK PTARMIGAN. *Lagopus mutus.* The breeding range map given by Godfrey (1966) does not include the Mackenzie Valley for this species. On 26 May, I observed and photographed two males at Bear Rock, north of Fort Norman, in complete winter plumage occupying vantage points which, from the amount of time spent by the birds feeding and watching, suggested territorial behavior. These vantage points were investigated and there was much evidence (scats) of continued use. Two other such sites were discovered nearby, although I do not know whether these were used by Rock Ptarmigan or Willow Ptarmigan (*Lagopus lagopus*). All of the sites were above timberline in areas dominated by *Dryas* sp., and had been partly scraped clear of vegetation to approximately 2 square feet in one case. All sites were on promontories that overlooked valleys, or on ridge crests with excellent views, and were liberally sprinkled with scats of both summer and winter types. This evidence is suggestive of a breeding population, and it seems probable that locations with a similar habitat along the Mackenzie Valley may support this species.

SWAINSON'S THRUSH. *Catharus ustalatus.* Recorded on 11 occasions throughout the study area, and seen but not noted on many other occasions. I have little doubt that the species is breeding, but I observed only suggestive evidence. Godfrey (1966) gives the breeding range as including "western Mackenzie (Fort Norman, Fort Simpson . . .)." The species was common around Fort Good Hope in white spruce and mixed white spruce/white birch forests.

WATER PIPIT. *Anthus spinoletta.* On 2 July, three were observed, one of which was photographed, around and above timberline on the west-facing slopes of Mount Hamar, 10 miles east of Norman Wells. The birds all showed marked anxiety at my presence, following me as I walked and alighting only 5–10 feet in front of me. Two of them were carrying insects as if feeding young. Other records were made east of Norman Wells on 17 August, and on 17 September when four were observed at Norman Wells airport. Godfrey (1966) excludes the Mackenzie Valley from his map of the breeding range, but mentions Manitou Island, western Great Bear Lake, nearby.

C. *Recorded in the Area for the First Time without Evidence of Breeding*

OLDSQUAW. *Clangula hyemalis.* On 1 June, Norbert Kondla and I observed a pair on a large deep lake 10 miles east of Fort Norman. Also on 1 June, while in Fort Norman, Dan Carruthers and Leo Bouckhout heard the distinctive calls of the species over the Mackenzie River. Preble (1908, p. 290) recorded the species along the Mackenzie River from Fort Simpson to Fort Good Hope in June "moving northward." Godfrey (1966) does not describe the migratory routes of the Oldsquaw.

COMMON MERGANSER. *Mergus merganser.* Observed twice, both on Denise Creek at Snafu Lake. 31 May, Dan Carruthers reported what he believed to be a male. 1 June, Norbert Kondla and I observed two males at close range feeding in Denise Creek. I saw no evidence of breeding; all subsequent observations of mergansers were of the Red-breasted (*Mergus serrator*). Godfrey (1966) states that the Common Merganser has been "recorded in summer, but not known to breed, north to central Mackenzie (Thelon River)." My record appears to be the first for the Mackenzie Valley at this latitude (66°N), and may be the most northerly record in North America.

AMERICAN BITTERN. *Botaurus lentiginosus.* This species was heard twice and observed once; all records were probably of the same individual. 27, 28 June, while canoeing I heard a bittern "booming" in the evening at Snafu Lake. On 30 June, at 00:45 h, Leo Bouckhout and I attempted to locate the bird and flushed it from the border of a swampy pond near the mouth of Denise Creek. The bird was unmistakeably a bittern, and both of us observed it in bright sunlight. Godfrey (1966) gives the breeding range as "southwestern Mackenzie (Great Slave Lake)" and as having been "recorded north to near Fort Norman." The location of my observation, approximately 100 miles north of Fort Norman, is thus the northernmost record for the species.

AMERICAN COOT. *Fulica americana.* Observed twice. One was photographed. 28 June, one was seen among waterlogged sedges (*Carex* sp.) and horsetail (*Equisetum* sp.) at Snafu Lake. 8 July, one was seen at Necklace Lakes in a marsh area of a beaver pond complex. On both occasions the birds were seen by both Dan Carruthers and myself. Godfrey (1966) gives the breeding range as including "central southern Mackenzie (Little Buffalo River)" while it is "casual in southern Yukon" and "accidental in Franklin District." The species has been recorded in central Alaska (Gibson 1972). My records are further evidence of the casual occurrence of coots in northern Canada.

COMMON NIGHTHAWK. *Chordeiles minor.* Observed on six occasions. 8 July, one 10 miles south of Norman Wells. 23 to 26 July, one seen nightly 4 miles east of Norman Wells. 8 August, one seen 20 miles south of Fort Norman. Godfrey (1966) gives the breeding range as including "southern Mackenzie (Fort Simpson, perhaps somewhat further north in Mackenzie Valley)." Preble (1908, p. 389), however, describes the species as "of regular occurrence in the Mackenzie Valley north to the region of Fort Good Hope." My records lend credence to Preble's observations.

MOURNING DOVE. *Zenaida macroura.* On 7 July, David Paton, who is familiar with the species from southern Manitoba, observed one 5 miles east of Norman Wells in a 14-year-old burned black-spruce forest area. Godfrey (1966) mentions sight records from Yukon and southern Mackenzie. Kuyt (1967) has reported the species near Fort Smith, Northwest Territories. Weeden and Johnson (1973) report 17 records from Alaska, the northernmost being 65°50′ N, 144°27′ W. Paton's observation is the northernmost record of the species' wandering in Canada.

LEAST FLYCATCHER. *Empidonax minimus.* Recorded twice, but one uncertain (3 July near Norman Wells townsite). A positive sight record was made on 10 July at Necklace Lakes, 10 miles north of Norman Wells, where the distinctive song separated it from other possible *Empidonax* species. Godfrey (1966) gives the breeding range as including "central-western and central-southern Mackenzie (Fort Norman, Fort Simpson . . . perhaps Norman Wells. . . .)."

WESTERN WOOD PEEWEE. *Contopus sordidulus.* Recorded on five occasions. 22 June, one was heard at Gibson Gap by Norbert Kondla and me. 27 and 29 June, three were observed singing in a burned area consisting of dwarf birch, willow (*Salix* sp.), and young black spruce at Snafu Lake. 1 August, one was heard singing in willows bordering the Hare Indian River near Fort Good Hope. Godfrey (1966) gives the breeding range as north to "southern Yukon . . . southern Mackenzie (Hill Island Lake)." My records are approximately 275 miles further north from the area in the Yukon that Godfrey mentions.

DIPPER. *Cinclus mexicanus.* On 6 June Dan Carruthers and David Paton reported seeing five of these distinctive birds while walking along the canyon of Vermilion Creek, approximately 35 miles south of Norman Wells. I visited the creek in late July, but failed to observe the species. The habitat at that location, however, appears to be typical for the species, and evidence (droppings) of birds regularly using large stones in mid-stream was plentiful. Godfrey (1966) gives the breeding range as including the mountainous regions of central and southern Yukon, more than 150 miles west of Norman Wells.

HERMIT THRUSH. *Catharus guttatus.* On 2 July I observed two birds singing approximately 400 yards apart in a burned area, with thick, low white birch and willow growth intermingled with black spruce, 6 miles east of Norman Wells. Godfrey (1966) gives the breeding range as including "southern Mackenzie (Fort Simpson . . .)." My records are 280 miles farther north along the Mackenzie Valley.

TENNESSEE WARBLER. *Vermivora peregrina.* Recorded on seven occasions, the most notable being near Fort Good Hope on 6 July, when one was observed singing. One bird was photographed. Godfrey (1966) gives the breeding range as including "central-western Mackenzie and southern Mackenzie (Brackett Lake, Norman Wells . . .)." My record at Fort Good Hope is 90 miles north of Norman Wells.

[BAY-BREASTED WARBLER. *Dendroica castanea.* Hypothetical. On 27 May, 10 miles south of Norman Wells, I observed a bird that was possibly this species. My field description reads "chestnut on sides contrasting with pale underside — warbler." This description might also fit the Chestnut-sided Warbler (*D. pensylvanica*), but of the two species the Bay-breasted seems the most likely to be found in my study area on the basis of proximity to its known breeding range given by Godfrey (1966). This includes "southwestern Mackenzie (probably Wrigley, Fort Simpson)." My observation was approximately 200 miles north of the known range.]

WESTERN TANAGER. *Piranga ludoviciana.* On 25 May, 30 miles south of Fort Norman, I observed a singing male on the crown of a 70-foot-high white spruce. This was the only record, and the only visit to the area before August. Godfrey (1966) gives the breeding range as including "southern Mackenzie (. . . perhaps Fort Simpson, where several times recorded in summer)." Keith (1967) has recorded the species in Mount McKinley National Park, Alaska. My record is the northernmost in Canada.

HARRIS' SPARROW. *Zonotrichia querula.* This species was not recorded during the breeding season. It was observed twice during migration on 8 and 10 September, 2 miles east of Norman Wells. Godfrey (1966) gives the breeding range as including Great Bear Lake, but otherwise skirting the perimeter of my study area.

D. *First Evidence of Breeding in the Area*

UPLAND SANDPIPER. *Bartramia longicauda.* Observed twice. One bird was photographed. 2 July, two were encountered just below timberline on Mount Hamar, east of Norman Wells. I searched a sedge-lichen-moss meadow area dotted with very small black spruce trees in an attempt to find the nest. The birds followed me continuously at close range for a period of about 15 min, giving agitated cries and regularly alighting within 20 feet of me. I was unable to locate a nest, but the agitation of the birds left no doubt in my mind that either a nest or young were in the vicinity. One of the birds continued following me down a dry creek bed for some 200 yards as I left the meadow area, calling continuously and approaching closely. 19 August, David Paton reported seeing one on a cut-line through the black spruce forest near Norman Wells. Godfrey (1966) gives the breeding range as including "southern Mackenzie (. . . recorded in summer near Norman Wells)." A sighting of 19 was made on the Kutuk River, Brooks Range, Alaska (Gibson and Byrd 1972). This record and my own suggest that the species ranges further north than most sources indicate.

RED-WINGED BLACKBIRD. *Agelaius phoeniceus.* Recorded on four occasions, the first being on 21 June at Gibson Gap, when 20 individuals were observed. On 22 June a nest with five young was found on a sedge island near the edge of a lake at Gibson Gap, and they were photographed. Other records were made on 8 and 13 July. Godfrey (1966) gives the breeding range as including "central-western and central-southern Mackenzie (Fort Norman, eastern Great Bear Lake . . .)." My record extends the breeding range 100 miles further north along the Mackenzie Valley from Fort Norman.

E. *Confirmatory Records of Occurrence in the Area*

(*i*) *Possibly breeding*

EASTERN KINGBIRD. *Tyrannus tyrannus.* Observed twice and heard once. A pair was photographed. 21 June, I observed what appeared to be a pair at Gibson Gap, 45 miles north of Norman Wells, that called alarmedly at my presence. Moving away, I watched the birds for 20 min, during which time there were courtship displays and aggression was directed towards Red-winged Blackbirds in the vicinity. 22 June, a pair at the same location. 9 July, I heard one calling several times at Jungle Ridge Lake. Godfrey (1965) recorded what appeared to be a family group at Norman Wells.

SWAMP SPARROW. *Melospiza georgiana.* Observed twice. 22 June, one singing in scattered willows on the sedge border of a lake at Gibson Gap. 8 July, one agitated at my presence and carrying insects as if feeding young, at Necklace Lakes. The 22 June observation was 45 miles north of the breeding range given by Godfrey (1966), which includes Norman Wells, but excludes the area between Norman Wells and Fort Good Hope.

(*ii*) *With no evidence of breeding*

KILLDEER. *Charadrius vociferus.* This species was heard on five occasions and observed once. All of these birds were in or near Norman Wells townsite at the airport. Aural records were made on 22 May (twice), 30 May, 3 July, and 25 July. On 30 June, Norbert Kondla observed two birds near the airport. This site appears to incorporate habitat necessary for the species to breed. It is a flat site cleared of trees with many bare areas between grassy cover. Godfrey (1966) gives the breeding range as "Mackenzie (Fort Simpson . . . perhaps Fort Norman; possibly Aklavik . . .)."

TOWNSEND'S SOLITAIRE. *Myadestes townsendi.* On 26 May, four were seen in twos and several single birds were heard singing on Bear Rock, a mountain overlooking the Mackenzie River a few miles north of Fort Norman. On 19 July a single bird was observed. The birds were all observed around timberline in craggy areas. Godfrey (1966) gives the breeding range as including "southern Yukon . . . and southwestern and central-western Mackenzie (probably Carcajou River near Canol Road . . .)." The latter is on the west side of the Mackenzie River and is perhaps 30 miles west of Bear Rock.

PALM WARBLER. *Dendroica palmarum.* This species was not observed during the breeding season, but in small flocks on five occasions during fall migration. It was first recorded on 19 August near Norman Wells, and the last record was on 12 September. This species is known to breed at Fort Norman and has been recorded at Norman Wells (Godfrey 1965). I recorded neither suggestions of breeding by the species nor its presence at any place except Norman Wells.

Acknowledgments

I am indebted to the Department of Public Works of Canada for giving permission to publish these records and for providing accommodation; I thank also The Lombard North Group Ltd. of Calgary, Alberta, under whose aegis the records were made. Dan Carruthers, Leo Bouckhout, Norbert Kondla, and David Paton gave assistance in the field and reported sightings. M.T. Myres of the Department of Biology, University of Calgary, kindly criticized the draft manuscript.

Literature Cited

American Ornithologists' Union. 1957. Check-list of North American birds. 5th Edition. Baltimore, Maryland.

American Ornithologists' Union. 1973. Thirty-second supplement to the American Ornithologists' Union Check-list of North American birds. Auk 90: 411–419.

Clarke, C. H. D. 1940. A biological investigation of the Thelon Game Sanctuary. National Museum of Canada Bulletin Number 96.

Erskine, A. J. 1971. Buffleheads. Canadian Wildlife Service Monograph Series Number 4. Information Canada, Ottawa. 240 pp.

Gibson, D. D. 1972. Alaska Region. American Birds 26(1): 104–106.

Gibson, D. D. and **G. V. Byrd.** 1972. Alaska Region. American Birds 26(5): 890–892.

Godfrey, W. E. 1965. Range extensions of some birds in western Mackenzie. Canadian Field-Naturalist 79(1): 34–38.

Godfrey, W. E. 1966. The birds of Canada. National Museum of Canada Bulletin Number 203. 428 pp.

Houston, C. S. 1973. Northern Great Plains. American Birds 27(5): 882–886.

Keith, S. 1967. New bird records from Alaska and the Alaska Highway. Canadian Field-Naturalist 81: 196–200.

Kuyt, E. 1967. Mourning Dove near Fort Smith, N.W.T. Blue Jay 24(1): 25.

Porsild, A. E. 1943. Birds of the Mackenzie Delta. Canadian Field-Naturalist 57: 19–53.

Preble, E. A. 1908. A biological investigation of the Athabasca–Mackenzie region. North American Fauna 27. 575 pp.

Rand, A. L. 1946. List of Yukon birds and those of the Canol road. National Museum of Canada Bulletin Number 105.

Scotter, G. W. and **L. E. Erickson.** 1963. Birds of the Taltson River region, N.W.T. Blue Jay 21(2): 64–67.

Seton, E. T. 1908. Bird records from the Great Slave Lake Region. Auk 25: 68–74.

Soper, J. D. 1957. Notes on wildfowl of the Slave River Delta and vicinity, Northwest Territories. Canadian Field-Naturalist 71: 74–81.

Weeden, R. B. and **L. Johnson.** 1973. New records of Mourning Doves in south-central and interior Alaska. Condor 75(3): 353.

Weller, R. B., D. L. Trauger, and **G. L. Krapu.** 1969. Breeding birds of the West Mirage Islands, Great Slave Lake, N.W.T. Canadian Field-Naturalist 83: 344–360.

Williams, M. Y. 1922. Biological notes along fourteen hundred miles of the Mackenzie River System. Canadian Field-Naturalist 36(4): 61–66.

Williams, M. Y. 1933. Biological notes, covering parts of the Peace, Liard, Mackenzie and Great Bear River Basins. Canadian Field-Naturalist 47(2): 23–31.

Received 5 July 1974
Accepted 28 January 1975

An Unusual Habitat for *Drosera rotundifolia* L., Its Over-wintering State, and Vegetative Reproduction

DOROTHY E. SWALES

Macdonald Campus of McGill University, Ste. Anne de Bellevue, Quebec H0A 1C0

Swales, D. E. 1975. An unusual habitat for *Drosera rotundifolia* L., its over-wintering state, and vegetative reproduction. Canadian Field-Naturalist 89: 143–147.

Abstract. An unusual association of plants with a large stand of *Drosera rotundifolia* L. was found on moderately dry, abandoned pasture land on Ile Perrot, Quebec. The association included 27 species of plants, 11 of which were known to prefer dry habitats. A soil analysis indicated that low mineral content restricted the growth of all flowering plants except the carnivorous sundew; competition for space was thus reduced. The ability to float for extended periods may be responsible for some of the spring dispersal over the field of the autumn-ripened, inflated seeds of *Drosera.* The protection of winter buds by stipules, and the development of adventitious plants in the greenhouse is described.

According to American and European floras, the most common habitat of *Drosera rotundifolia* L., the sundew, is a bog or swamp, or less often a floating rotting log, or more rarely damp sand on the margin of a stream or pond. A check of the herbarium specimens in the McGill University Herbarium added two less common habitats, a beaver meadow at Mont Tremblant, Quebec, and sand dunes on Sable Island, Nova Scotia. In most cases *Drosera* is associated with various species of *Sphagnum,* Cyperaceae, or acid-loving Ericaceous plants. My personal experience collecting *Drosera* extends from Grand Manan Island, in the Bay of Fundy, to the establishment of its northernmost record (A. E. Porsild, personal communication) in 1965 at Inuvik, Northwest Territories, 68°39′ N. I found it usually in sphagnum bogs, but twice on rotting logs, and once on the fine wet sand of a pond shore.

A new and very different habitat for *Drosera rotundifolia* was discovered in 1974 by the Macdonald College greenhouse technician, Richard Smith, on a strawberry-picking expedition to the east end of Ile Perrot, 45°22′05″ N, 73°57′ W, altitude 30 metres. He brought a tray of plants to the greenhouse in late June, again on 22 October and 18 November, so that their development could be followed. A detailed study of the plant association and seasonal changes in the plants was started 6 July 1974. The *Drosera* plot measured 27 × 57 metres within a flat, old pasture-field, bordered on the west by a mixed forest. It had been originally swampy land, reclaimed by large drainage ditches dug in the nineteenth century. It was put to agricultural use until 1944, after which it was held for a housing development. The soil was a well-drained very fine reddish-gray loamy sand, with a pH of 6.1. By 1974 the field had been invaded by weeds, a scattering of low shrubs, and in one section by a heavy growth of *Drosera rotundifolia.*

The sundew plants were so numerous that the whole surface of the earth had a reddish glow from the pigment plumbagin ($C_{11}H_8O_3$) in the petioles, glandular hairs, and tentacles. Soil samples were taken and a list was made of the plants on the plot; these were later separated into three categories based on their known moisture preferences.

Plants Associated with *Drosera*

The margin of the woods some 10 metres west of the *Drosera* plot included *Populus grandidentata, P. tremuloides,* and *Prunus pensylvanica,* all usually found on dryish soil; *Tsuga canadensis, Prunus virginiana,* and *Tilia americana,* all wide-ranging as to moisture; a few shrubs of *Salix* sp.; and *Alnus rugosa,* which is definitely moisture-loving. Large trees of *Acer saccharum* and *Quercus rubra* grew within the woods.

Twenty-seven species, from mosses to Compositae were collected in the *Drosera* plot itself and assigned to the three categories according

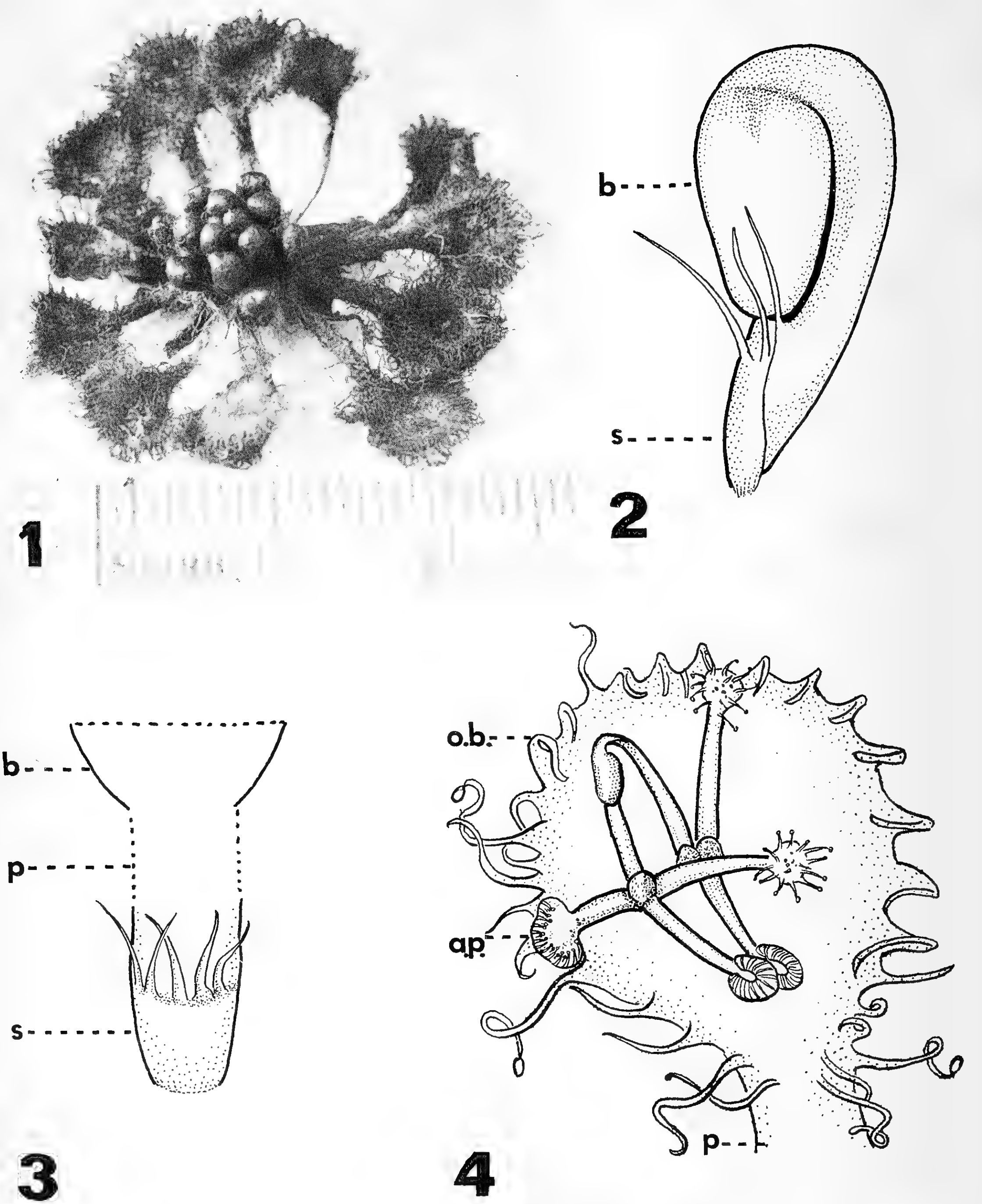


FIGURE. *Drosera rotundifolia* L. 1. Autumn condition showing winter bud. 2. Rudimentary leaf with blade applied to petiole; b. blade, s. adnate fringed stipule. 3. Semi-diagrammatic drawing of leaf from adventitious plant; b. blade, p. petiole, s. adnate fringed stipule. 4. Tip of autumn leaf (central tentacles omitted) showing o.b. old blade, a.p. two adaxial adventitious plants, p. upper portion of petiole.

to their moisture preferences: (1) dry—11 species; (2) wet to dry—7; (3) moist—9. The four moss species were scattered, and so small they could be of no protection to *Drosera* in winter. *Bryum creberrinum* and *Ditrichum lineare* are known to be mosses of sandy habitats, while *Polytrichum commune* and *Hypnum lindbergii* are plants usually found in boggy or swampy areas.

The vascular plants, particularly those in the "dry" category, associated with *Drosera*, were so surprising as to merit listing. These were as follows. (1) Dry—*Populus tremuloides*, scattered, around 3 feet tall; *Quercus rubra*, one seeding, 6 in tall; *Polygonum cilinode* and *Rumex acetosella*, a few widely scattered; *Trifolium pratense*, rare; *Chrysanthemum leucanthemum*, *Erigeron strigosus*, and *Solidago nemoralis*, all very common; *Hieracium florentinum*, occasional. (2) Wide-ranging—*Juncus tenuis* and *Agrostis alba*, occasional; *Panicum lanuginosum*, very common; *Betula populifolia*, several, around 3 feet tall; *Fragaria virginiana*, very common; *Vicia cracca*, occasional; *Oenothera perennis*, fairly common. (3) Moist—*Equisetum variegatum*, occasional; *Lycopodium inundatum*, two patches; *Spiranthes cernua*, common; *Alnus rugosa*, at margin only; *Drosera rotundifolia*, numerous; *Spiraea latifolia*, occasional; *Cornus stolonifera*, occasional, small.

Soil

Botanists frequently have reported on the low fertility of the soil or substrate on which *Drosera rotundifolia* is able to grow. It can invade the freshly-cut surfaces of peat as a pioneer plant (Lloyd 1942), flourish in bogs of low mineral content, or grow in the hollows between sand dunes by the sea. An analysis of the soil in the *Drosera* plot was made in order to see if its mineral content would shed light on the exceptional development of the sundew in this pasture. The results, calculated as pounds per acre to a depth of 6⅔ in, with a soil density of 1.3, were as follows: Mg 30; P 75; K 60; Ca 295; NO_3–N 9; organic matter 4%. Dr. A. F. Mackenzie, Chairman of the Department of Soil and Land Resources, Macdonald College, commented that it was a "basically infertile soil" (i.e., low in bases), and in more detail, said that magnesium was low, available phosphorus moderate, potash medium in amount, calcium extremely low, (most fertile agricultural soils contain 5 000–15 000 lbs per acre), nitrogen nitrate extremely low (but subject to great seasonal variations), and the organic matter was low to normal.

The fact that there was not a closed or continuous vegetation covering the ground, and that the flowering plants were of low stature, supported the evidence of the soil analysis. The surface soil was relatively dry. The sundew roots were shallow, never more than an inch in depth. *Drosera*, however, being a carnivorous plant, is able to secrete enzymes capable of digesting the bodies of insects and absorbing nitrogen in organic form and to some extent, inorganic salts through its leaves (Lloyd 1942). Therefore, the size of the roots and the fertility of the soil need not be related to the size of the resulting plants.

The humid summer atmosphere of Ile Perrot, surrounded by the Ottawa River, Lake St. Louis, and the St. Lawrence River, coupled with a long-time average yearly rainfall of 93 cm, produces a lush growth on the island wherever the soil is fertile. The soil was drier and less acid (pH 6.1) than in the usual *Drosera* habitats, but it is doubtful if either factor accounted for its particularly aggressive growth here. Calcium, if too high, may be somewhat toxic to *Drosera* (Lloyd 1942), a species missing in limestone areas. The extremely low content of calcium in this soil, as well as fairly high humidity and rainfall, plus a plentiful supply of small insects, would tend to favor good growth in the sundew. The presence of *Lycopodium inundatum* and *Drosera rotundifolia* indicates they either survived from a stand in the original swamp over years of cultivation and grazing, or were washed into the field by occasional spring floods from an unknown source after cultivation ceased. The lack of competition from the flowering plants, due to the infertile soil, seems to be in part responsible for the successful spread of the sundew.

Over-Wintering State

The next objective was to find out how *Drosera* managed to survive the winter in an open field protected only by sparse vegetation. The leaves, averaging 15 in number per plant, lay flat on the ground in the manner of many Arctic plants. When I visited the plot on 22 October all the reddish pigment in the leaves had disappeared and these appeared brown and dead. Every plant, however, had a unique reddish-brown winter bud in the center of the rosette of leaves. These rudimentary shoots were so compressed as to be almost flat, only slightly raised in the center to a height of 3–4 mm. The bud ranged from 4–10 mm wide and included 5–12 (average 8) shiny, glabrous, leathery-looking rudimentary leaves, clearly visible without a hand lens, the outer ones measuring about 4 mm long (Figure 2). The innermost three could not be seen externally, were less leathery, greenish instead of reddish, and the one at the axis tip as small as 0.4 mm in length. Even the smallest had a perfectly differentiated petiole and blade, the former bent so that the upper face of the blade was closely applied to the petiole. This is brought about by the hyponasty of a narrow zone in the flattened petiole at the base of the blade (Lloyd 1942). There was a fragile fringe of trichomes, 2–2.5 mm long, issuing from the top of the adnate stipule on the adaxial surface of each bud leaf, providing little winter protection. During the summer, however, the individual trichomes elongated to about 4 mm, while the base of the fringe further developed as either a lacerate or continuous membrane, the trichomes remaining fused in groups or as one unit. This shaggy-looking stipule of the mature leaves provided efficient protection to the winter bud. The petiole of each leaf of the parent plant took a sharp curve downwards near the point of attachment to its axis (the part covered by the adnate portion of the stipule), the fringed membrane moved upwards so that both were closely applied to the base of the winter bud, effectively cutting off the possible entrance of water. Several leaves were removed from the plant seen in Figure 1 in order to show individual leaves more clearly. In the untouched plant the stipules formed a complete protecting circle around the bud. The exposed parts of the rudimentary leaves were guarded against weathering by a tough leathery-looking epidermis, and the inner bud leaves were protected by being tightly packed together.

The Development of *Drosera*

Changes in the plants brought in from the field in late June and kept in open trays were noted periodically. The inflorescence, a narrow one-sided raceme, elongated further, and in July occasional single flowers opened at the highest point, just below the nodding tip. Most of the flowers never opened, and those which did, closed after a few hours, confirming the statement in various floras that the flowers are largely cleistogamous.

Plants brought in from the field on 18 November were shedding abundant fusiform seeds measuring $1.5–1.8 \times 0.2$ mm, with a dark central spot 0.3–0.4 mm long, the endosperm showing through an inflated, transparent, longitudinally-striate testa. The air trapped within the loose testa produced a buoyant seed capable of floating for days (by laboratory test) on the surface of the water.

It is probable that in nature some seeds will fall upon snow, to be carried away some distance from the parent plant as the snow melts and runs off as little rivulets. The ability to float for long periods could be a factor in the spread of *Drosera* over the large area it covered on Ile Perrot, both from snow-melt and from the occasional spring flooding of the field.

The Production of Adventitious Plants

Few people have observed adventitious plants in *Drosera rotundifolia* because they tend to develop towards autumn, when the petiole may rot away from the main stem, and they may be hidden in the center of deep moss cushions where the humidity is high. They have, however, been known for well over 100 years (Hegi 1961).

The plants brought to the greenhouse in June were brown by late September and had formed winter buds. By early October a scattering of bright green plantlets, from 0.8–3 cm had developed on the dead-looking blades (Figure 4). Two blades were still attached by their petioles to the main axis, but most had become independent. Plants brought from the field 22 October also developed adventitious plants in the humid atmosphere of the greenhouse, but even by 18 November none of the plants in the field showed signs of vegetative reproduction, probably because the humidity was not high enough in such an exposed habitat.

The individual leaves were removed from the larger adventitious plants and the structure at the base examined closely. Small (*fide* Lloyd 1942) thought the apparent membrane was merely a linear cluster of trichomes, similar to the ones found abundantly on the rest of the petiole. In the young leaves examined, however, the trichomes above the fringe were still only minute papillae, refuting the idea that they are part of the same structure. Bergdolt (*fide* Hegi 1961) said they began as lateral appendages which later fused together, appearing as ligule-like intrapetiolar stipules. The reason for this confusion was evident in the variation in the young leaves of the adventitious plants. Some bore no trichomes at all, others had two or three at the margins, but most had a fringe of trichomes just 2 mm above the point of attachment, that is, above the adnate portion of the stipule (Figure 3). The fringed, clasping stipule of *Polygonum hydropiper* L. bears a striking resemblance to that of *Drosera* if viewed from one side only, the former differing in that no part is adnate to the stem. It is interesting to note that Agnes Arber (1920) illustrated stipules that may be either in pairs, or fused to form one membrane, protecting the apical bud of *Castalia alba* (L.) Wood (=*Nymphaea alba* L.), and mentions that in *Nymphaea lutea* L. (=*Nuphar lutea* (L.) Sm.) the stipules seem to be replaced by a silky fringe of hairs. I saw no evidence of pairs of stipules in the many leaves examined.

The presence of the same type of fringed stipule in all the rudimentary leaves of the winter bud (Figure 2) suggests that the leaves which developed from them will be less variable than those from the adventitious plants. This will be checked in the field next spring.

Acknowledgments

My thanks are due to Robert R. Ireland of the National Museum of Natural Sciences, for the identification of the mosses, to A. F. Mackenzie for the soil analysis and comments, to my brother, J. D. Newton, formerly head of the Department of Soils, University of Alberta, for discussion on the Ile Perrot soil type, and to C. C. Hsiung for the drawings.

Literature Cited

Arber, Agnes. 1920. Water plants. University Press, Cambridge. pp. 1–436.

Hegi, Gustav. 1961. Illustrierte Flora von Mittel-Europa. Band IV, Teil 2. Carl Hanser Verlag, München. pp. 1–448.

Lloyd, Francis E. 1942. The carnivorous plants. Chronica Botanica Company, Waltham, Mass. pp. 1–270.

Received 16 January 1975
Accepted 24 January 1975

Play Activities of Black-tailed Deer in Northwestern Oregon

Frank L. Miller

Division of Wildlife Research, Oregon State Game Commission, Corvallis, Oregon

Present address: Canadian Wildlife Service, Eastern Region, 2721 Highway 31, Ottawa, Ontario, Canada

Miller, F. L. 1975. Play activities of black-tailed deer in northwestern Oregon. Canadian Field-Naturalist 89(2): 149–155.

Abstract. Play behavior of black-tailed deer (*Odocoileus hemionus columbianus*) was observed on 42 different occasions on the Cedar Creek area of northwestern Oregon. Play patterns were categorized as (1) contagious, (2) exploratory, (3) care-soliciting, (4) sexual, and (5) agonistic. A total of 23 deer exhibited contagious play patterns during eight events. Seven male fawns performed exploratory play patterns on seven occasions. Two female and two male fawns exhibited care-soliciting play patterns on four occasions. Sexual play in the form of playful mounting was observed on 13 occasions. Ten deer exhibited agonistic play patterns on 10 occasions. The dominance hierarchy seemed to break down completely during play. Sexual play among fawns was without regard to sex, whereas yearlings and older deer of only the same sex were observed in sexual play.

I watched play by black-tailed deer on 42 occasions on the Cedar Creek study area in northwestern Oregon. The deer were observed for a total of 1411 h during 1964 and their activities and distribution patterns related to measured environmental factors (Miller 1968a, 1970).

Study Area

The study area is approximately 29 km inland from Tillamook, on the Cedar Creek watershed in the Tillamook Burn area of Tillamook County (45°36′ N, 123°36′ W). The enclosure contains about 138 horizontal hectares, but because of rough terrain the actual surface area is nearly 250 square hectares. The enclosure contains the typical seral plant growth that follows fires of clear-cut logging in the Coast Range Mountains of northwestern Oregon (Crouch 1968). Bailey and Poulton (1968), Crouch (1968), Miller (1968a, 1970), and Bailey and Hines (1971) have given detailed descriptions of the study area.

Animals and Methods

Black-tailed deer were captured in areas surrounding the study enclosure from 1 July to 21 November 1963 (Miller 1968b). Each deer was released in Cedar Creek enclosure on the same day as captured. Four were captured in July, 5 in August, 8 in September, 7 in October, and 10 in November 1963. By January 1964 when periodic observations began the herd numbered 30 animals: 10 adult does, 5 adult bucks, 4 female yearlings, 3 male yearlings, 4 female fawns, and 4 male fawns.

All deer except fawns were marked with collars and ear streamers (Harper and Lightfoot 1966, Figures 1A, 2A); fawns wore ear streamers only. The color code of the streamers and collars and painted symbols on the collars identified individual deer. The deer were observed daily with 10×50 binoculars and a 15–60× Balscope Zoom spotting scope from three huts located on prominences outside of the enclosure. Time intervals were determined with the sweep second-hand of a wrist watch and were rounded to the nearest minute.

Play patterns were categorized as follows (Scott 1963).

1. *Contagious:* tag and gambolling; groups of deer running, jumping, and turning in erratic patterns with the chasers often becoming the chased. I categorized only those events as contagious play which I judged to have originated from, and were dominated by, mutual stimulation. Chase during contagious play involved frolicking and the participants did not appear as agonists.
2. *Exploratory:* fawns exploring surrounding terrain, investigating other deer and inanimate objects in a brisk and playful manner, and exhibiting excessive and exaggerated movements and postures throughout.

3. *Care-soliciting:* female or male fawns running wildly around the dam and on occasion standing on, pawing at, or jumping over the bedded dam.
4. *Sexual:* pairs of deer of both sexes or of either sex, exclusive of mature males, exhibiting mounting.
5. *Agonistic:* fawns and yearlings engaged in head-pushing or sparring, and other seemingly agonistic acts which often lead to chases. The most obvious characteristic of agonistic play was that the aggressor–respondent roles of attacker and victim sometimes switched back and forth without regard to social rank. Also, the subordinate animals participated willingly in the activity. I categorized only those events which were predominated by series of pseudo-agonistic acts as agonistic play. No switch from agonistic to contagious play, or vice versa, was seen.

Observations

Contagious play involved from two to six deer on any one occasion. The deer raced about, jumping over logs and bushes, often twisting and turning in mid-air during a chase. The pursued often halting in its tracks with its pursuer stopping only centimetres away, the roles would then be reversed. Although they were never seen to touch each other, I have termed this role reversal as being "tagged." A total of 23 deer (four female and four male fawns, six female and four male yearlings, and five mature females) were observed exhibiting contagious play during eight events (Table 1).

The most vivid example of deer playing tag was on 28 March 1964, at 9:10 a.m. when two mature does, two yearling females, one female fawn, and one male fawn began a game of tag which lasted for 12 min. The yearlings gambolled about the adult females. The dominant doe

TABLE 1 — Contagious play exhibited during eight events by black-tailed deer on the Cedar Creek study area, Oregon, 1964.

Sex and ages of participants	Play patterns	Hour of day	Duration of event (min)	Month of year
Females 2ad[a], 2y[b], 1f[c] Male 1f	tag	0910	12	March
Female 1f Males 3f	tag	1050	19	April
Males 3f	tag	0755	7	May
Females 1f Male 1f	tag and gambolling	1815	3	May
Females 1ad, 1f	gambolling	0920	4	July
Females 1ad, 1y	tag	0730	11	September
Females 1ad, 1y	tag	0740	15	November
Females 1ad, 1f	gambolling	0908	4	December

[a] ad = mature deer (3 yr or older).
[b] y = yearling deer.
[c] f = fawn.

chased one yearling and when the yearling ran close to the other deer they scattered as though to avoid being "tagged." When the chased yearling stopped, the doe stopped. They stood side by side for a brief period before the doe became the pursued and scattered the other deer by running among them. The yearling broke from the doe's trail and began chasing the other yearling, which was "tagged" and in turn chased and "tagged" the subordinate mature doe. The subordinate mature doe appeared to tire of the game after being unsuccessful in catching the yearling or any other deer. The fawns were only chased for short distances and were never "tagged" or pursued, except by each other. They appeared to play their own game while attempting to be a part of the main game.

The two yearlings continued to play tag with each other for 7 min after the does began foraging and the two fawns had moved out of sight. They attempted to entice the two does into further play, but the does had lost interest, and would not re-enter the game.

Seven male fawns were observed exhibiting exploratory play on seven occasions (Table 2). The fawns briskly explored their nearby areas, investigating both deer and inanimate objects. They ran in circles, leapt in the air, and rushed to and from the maternal does; they often returned to the same objects or new objects several times in succession; they frequently pawed at the earth with their forefeet while gambolling about.

TABLE 2 — Exploratory play exhibited by seven black-tailed deer fawns on the Cedar Creek study area, Oregon, 1964

Play patterns	Hour of day	Duration of event (min)	Month of year
Exploring in a brisk	0750	7	June
manner, investi-	0824	24	June
gating other deer	1945	11	July
and inanimate ob-	2001	13	July
jects, gambolling	2035	17	July
and racing around	1956	5[a]	August
in circles	0908	7	September

[a] Animal engaged in play when first observed.

On 18 June at 8:19 a.m. a doe and her male fawn appeared from the cover in a lateral drainage and the doe began foraging on an exposed ridge. The fawn stood watching the doe forage, then bedded some 5 m to the upgrade side of her.

A group of two mature bucks and one yearling male foraging on the ridge came within 30 m of the doe and fawn. Suddenly, at 8:24 a.m. the fawn leaped from its bed and ran out to a red huckleberry (*Vaccinium parvifolium*) bush and back to the doe several times. He darted out toward the group of males, stopped halfway, and returned to the doe. The doe stood looking at the other deer, then returned to foraging; the three males stood watching the fawn. The fawn ran to the males, ran around them, occasionally jumping in the air and reversing his direction. The fawn ran beneath one of the adult males and "punched him for milk." The buck jumped away, but the fawn followed and ran back and forth between his legs, and then darted under the yearling male. Next, he tried to pass under the adult buck by going between his forelegs. The buck prostrated the fawn by a hard blow on the top of the skull with his right front foot. After a few seconds the fawn leaped to his feet, darted under the yearling male (which almost fell over trying to jump out of the way), then ran and jumped at the side of the other adult buck. He circled the whole group for the last time, and returned to the doe. Meanwhile the doe had moved to within about 10 m of the male group and was standing watching her fawn's actions. The fawn, tired by its frolicking, stood by the doe, turned around again, walked behind the huckleberry bush and bedded down. The doe resumed foraging and the males moved up the ridge.

Two female and two male fawns were observed exhibiting care-soliciting play behavior on four occasions in June, July, August, and early September. The duration of play ranged from 3 to 9 min and averaged about 4 min. On all four occasions the fawns raced and gambolled about the bedded does, playfully soliciting their care.

One female fawn ended her frolicking by another terminated her play by pawing at the jumping over the bedded doe's head and bedded doe's head. One male fawn stood on his dam's side and another stood in front of his bedded dam and put his left forefoot on her head. In all four cases the dams arose and attended to their fawns. On three occasions the does licked and nursed their fawns and on the fourth the doe groomed the fawn vigorously before both of them moved out of sight.

Playful mountings were observed on 13 occasions (Table 3). These mountings involved both uni-directional and bi-directional activities between fawns. Only the younger or subordinate deer of the pair mounted or attempted to do so and the mature deer never held for the act. The mountings often occurred as a part of some other activity or as a break in the continuity of a series of behavior patterns.

Agonistic play was observed on 10 occasions (Table 3). The agonistic play activities took the form of head-pushing or sparring, chases, and other agonistic acts (Miller 1974, pp. 649–650) involving only fawns and yearlings. The willingness of both the aggressor and the victim to participate and the changing of roles set those events apart from true agonistic behavior.

Eighty percent of the observed play periods occurred during the summery months, May through October (Figure 1). The pattern of occurrence of play periods by hour of the day (Figure 1) in May through October followed the overall activity pattern for deer at Cedar Creek (Miller 1970). The greatest number of observed play periods occurred in July through September (Figure 1) and was probably related to the increased socialization by fawns with both fawns and other members of the herd (Miller 1968a, 1970).

TABLE 3 — Sexual and agonistic play by black-tailed deer, Cedar Creek study area, Oregon, 1964 (Aggressor $\xrightarrow{\text{uni}}$ Recipient, Aggressor–recipient $\xleftrightarrow{\text{bi}}$ Recipient–aggressor)

Participants[a] Aggressor–recipient	Hour of day	Duration of event (min.)	Month of year
Sexual			
Ff ⟶ Ff	1712	1	September
	1715	1	
	1720	1	
Ff ⟶ Mf	0805	1	September
Mf ⟷ Ff	0707	2	August,
	0650	2	October
Mf ⟶ Mf	0655	1	October
Mf ⟷ Mf	1620	4	August
Fy ⟶ Fad	1745	1	May
	1805	2	
My ⟷ My	0851	2	July,
	1005	2	August
F2-yr⟶ Fad	0610	1	May
Agonistic			
Mf ⟶ Ff	1530	3	February
Mf ⟶ Mf	0740	7	March
Mf ⟷ Mf	1100	10	February,
	1230	7	December
My ⟶ My	0856	4	July,
	0910	4	August,
	1130	5	September
My ⟷ My	0925	8	July,
	1150	11	August,
	1903	9	September

[a]F = female, M = male, f = fawn, y = yearling, 2-yr = 2-year-old deer (only known 2-yr-old seen participating in play activities), and ad = mature deer (3 yr or older).

Discussion

Play by all species of North American cervids has been reported: for deer of genus *Odocoileus* by Caton (1877, pp. 296, 297, 301), Skinner (1929, p. 114), Townsend and Smith (1933, pp. 307, 308), Clark (1953, p. 64), Linsdale and Tomich (1953, pp. 183–193), Severinghaus and Cheatum (1956, p. 164), Dasmann and Taber (1956, pp. 151–162), Anderson (1959, pp. 59–60), and Michael (1968, pp. 535–537); for elk (*Cervus*) by Seton (1929, p. 42), Murie (1951, pp. 261–262), and Altmann (1963, pp. 238, 245, 248); for moose (*Alces*) by Altmann (1958, p. 157) and Geist (1963, pp. 400–405); for caribou (*Rangifer*) by de Vos (1960, p. 253), Lent (1966, pp. 721–722 and 728–739), and Skoog (1968, pp. 559–560).

I use the term 'play' to classify activities that seemingly could not be of immediate contribution to the survival of animals engaged in them.

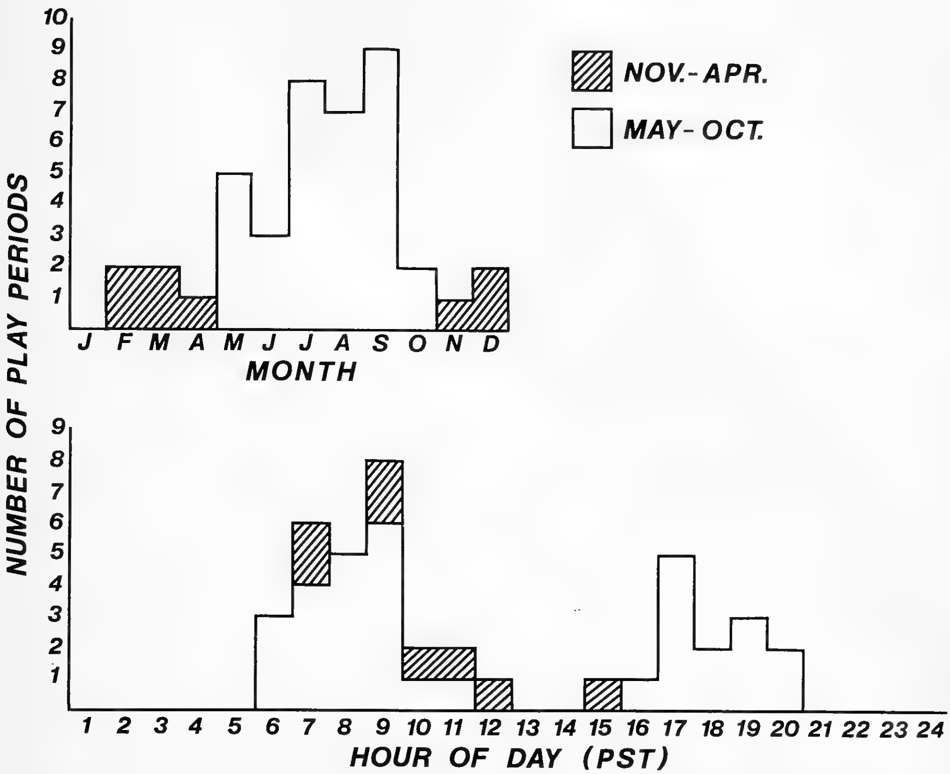


FIGURE 1. Play periods by hour of the day and month of the year, Cedar Creek deer study area, northwestern Oregon, 1964.

This excludes incomplete sexual activities sometimes associated with the early stages of flight behavior (e.g., mounting without copulation). As there is no generally accepted definition of play, I have termed those activities which meet all of the following contditions as play: (1) occurred abruptly, (2) was short-lived, (3) was out of context with immediately prior and subsequent behavior, (4) had no immediate physiological benefits, (5) was not true aggression or a sexual act, and (6) could not be perceived by me as any form of "serious" behavior. I believe, however, that much of the play functions as a releaser of activities that results in deer learning more about their environment and developing their skills of flight. Geist (1971, p. 253) views play as a means by which young sheep can be programmed and preadapted to survival.

Muller-Schwarze (1968) and Muller-Schwarze and Muller-Schwarze (1969) initiated the quantitative study of play deprivation and play behavior with two and three captive black-tailed deer fawns, respectively. Muller-Schwarze found that play deprivation did not lead to an increased readiness to play. His findings support the hypothesis "that play is not due to a specific motivation on its own but is closely related to a general readiness to be active."

Contagious behavior patterns, in the form of games of tag and gambolling, are the easiest to recognize as play. There appears to be a complete breakdown in the dominance hierarchy while the deer are at play and their movements are very brisk and often exaggerated. Play activity such as jumping over logs, twisting and turning, or dodging other animals would increase survival among deer by speeding up their reaction to fear stimuli and by developing their awareness of surroundings. The lack of familiarity of surrounding objects may elicit a response in the form of contagious play activities which possibly would be reiterated because of the pleasure derived from participation. Although Marler and Hamilton (1966, p. 192) caution that "Equivalence of function cannot be equated with equivalence of mechanism," I think that for the newborn fawn any form of exploratory behavior that results in its becoming better acquainted with the surroundings should increase its chances of survival in later life. Such exploratory behavior often takes the form of play.

The roles of the aggressor and the victim can vacillate between the participants in sexual and agonistic play (Table 3). Sexual play in the fawn class was carried out with complete disregard to sex and dominance of the participants. Yearlings and other deer of the same sex only, however, were observed in sexual play, the subordinate member of the pair always attempting to mount the dominant animal. The dominant deer of the pair showed no signs of aggressive reaction to the subordinate's act. Mounting attempts always occurred as an interruption of some other non-sexual behavior. Among fawns it was often introduced while they were performing agonistic play patterns (Geist 1971, p. 220). In older deer the act was both spontaneous and isolated, often occurring while the deer were foraging or just standing. In older deer the sexual play sometimes appeared to be the result of a sudden high level of excitation (Geist 1971, p. 220).

In yearlings there were some clear-cut distinctions between the patterns of agonistic play and actual agonistic behavior. During agonistic play either participant initiated the head-pushing or sparring, and often the roles were reversed. In true agonistic behavior the subordinate yearling never chased the dominant one and the dominant yearling always initiated the head-pushing or sparring. The subordinate animals were either unwilling to participate, or entered the contest half-heartedly, as though they sensed defeat before it came. Therefore, I suggest that agonistic play occurs only when the socially dominant participants have made some ritualized signals or gestures (Thorpe 1966, pp. 311–318) allowing subordinate players to assume aggressive roles. I did not recognize the pre-play signals that allowed aggressive play between subordinate and dominant deer. I suggest, however, that the willingness of subordinate deer to participate in aggressive play with dominant deer demands some form of assurance of acceptance of their behavior — therefore, the essence of pre-play signalling.

Play periods were greatest during the summery periods when the deer's energy budget is most favorable (Figure 1). The energy demands of play activities are considered to be such that only animals with an abundance of food can play (Altmann 1959, p. 328). Dasmann and Taylor (1956, pp. 161–162) believed that play by black-tailed deer probably indicated an excess of energy, because play decreased as density of the deer increased. Michael (1968, p. 536), however, suggests that his observations on the Welder Wildlife Refuge in Texas show that play cannot be used as an indicator of condition of white-tailed deer (*O. virginianus*). He saw only 11 events of play during 1711 h of observation and thinks that white-tailed deer are not playful animals. Caton (1877) observed that among the mule deer (*O. h. hemionus*), black-tailed deer, and white-tailed deer on his estate, only the mule deer showed a clear and decided disposition for play. An interesting question for cervid biologists remains unanswered: are there specific and subspecific differences in the playfulness of deer of the genus *Odocoileus*?

Acknowledgments

I thank V. Geist (Environmental Design, The University of Calgary), H. Boyd, D. R. Flook, A. Gunn, C. J. Jonkel, R. H. Russell, and G. Tessier (Canadian Wildlife Service) for review of the manuscript and for their helpful suggestions. This work was part of a co-operative project of the Division of Wildlife Research Oregon State Game Commission, The Oregon State Board of Forestry, and the Department of Fisheries and Wildlife, Oregon State University. It was partially financed with Federal Aid to Restoration Funds under Pittman-Robertson Project W-51-R.

Literature Cited

Altmann, M. 1958. Social integration of the moose calf. Animal Behavior 6(3–4): 155–159.

Altmann, M. 1963. Naturalistic studies of maternal care in moose and elk. *In* Maternal behavior in mammals. *Edited by* H. L. Rheingold. John Wiley and Sons Incorporated, New York. pp 233–253.

Altmann, S. A. 1959. Field observations on a howling monkey society. Journal of Mammalogy 40(3): 317–330.

Anderson, C. F. 1959. Nocturnal activities of the Columbian black-tailed deer (*Odocoileus hemionus columbianus* Richardson) affecting spotlight census results in the Oregon Coast Range. M.Sc. thesis, Oregon State College. 86 pp.

Bailey, A. W. and **W. W. Hines.** 1971. A vegetation soil study of wildlife forestry research area and its application to management in northwestern Oregon. Oregon Game Commission, Game Research Report No. 2. 36 pp.

Bailey, A. W. and **C. E. Poulton.** 1968. Plant communities and environmental inter-relationships in a portion of the Tillamook Burn, northwestern Oregon. Ecology 49(1): 1–13.

Caton, J. D. 1877. The antelope and deer of America. Forest and Stream Publishing Company, New York. 426 pp.

Clark, E. D. 1953. A study of the behavior and movements of the Tucson Mt. mule deer. M.Sc. thesis, University of Arizona. 111 pp.

Crouch, G. L. 1968. Forage availability in relation to browsing of Douglas-fir seedlings by black-tailed deer. Journal of Wildlife Management 32(3): 542–553.

Dasmann, R. F. and **R. D. Taber.** 1956. Behavior of Columbian black-tailed deer with reference to population ecology. Journal of Mammalogy. 37(2): 143–164.

de Vos, A. 1960. Behavior of barren-ground caribou on their calving grounds. Journal of Wildlife Management 24(3): 250–258.

Geist, V. 1963. On the behavior of the North American moose (*Alces alces andersoni* Paterson 1950) in British Columbia. Behavior 20(3–4): 377–416.

Geist, V. 1971. Mountain sheep (A study in behavior and evolution). The University of Chicago Press, Chicago and London. 383 pp.

Harper, J. A. and **W. C. Lightfoot.** 1966. Tagging devices for Roosevelt elk and mule deer. Journal of Wildlife Management 30(3): 461–466.

Lent, P. C. 1966. Calving and related behavior in the barren-ground caribou. Zeitschrift für Tierpsychologie 23(6): 701–756.

Linsdale, J. and **P. Q. Tomich.** 1953. A herd of mule deer. University of California Press, Berkeley and Los Angeles. 567 pp.

Marler, P. and **W. J. Hamilton.** 1966. Mechanisms of animal behavior. John Wiley and Sons Incorporated, New York, London, and Sidney. 771 pp.

Michael, E. D. 1968. Playing by white-tailed deer in south-Texas. American Midland Naturalist 80(2): 534–537.

Miller, F. L. 1968a. Observed use of forage and plant communities by black-tailed deer. Journal of Wildlife Management 32(1): 142–148.

Miller, F. L. 1968b. Immobilization of free-ranging black-tailed deer with succinylcholine chloride. Journal of Wildlife Management 32(1): 195–197.

Miller, F. L. 1970. Distribution of black-tailed deer (*Odocoileus hemionus columbianus*) in relation to environment. Journal of Mammalogy 51(2): 248–260.

Miller, F. L. 1974. Four types of territoriality observed in a herd of black-tailed deer. *In* The behavior of ungulates and its relationship to management. Volume 2. *Edited by* V. Geist and F. Walther. International Union for Conservation of Nature and Natural Resources, Morges, Switzerland. IUCN Publication New Series, Number 24. pp. 644–660.

Muller-Shwarze, D. 1968. Play deprivation in deer. Behaviour 31: 144–162.

Muller-Shwarze, D. and **C. Muller-Shwarze.** 1969. Spielverhalten und allgemeine Aktivität bei Schwarzewedelhirschen (Playing behavior and general activities in black-tailed deer). Bonner Zoologische Beitrage 20(1/3): 282–289.

Murie, O. J. 1951. The elk of North America. The Stackpole Company, Harrisburg, Pennsylvania. 376 pp.

Scott, J. P. 1963. Animal behavior. Doubleday and Company Incorporated, New York. 331 pp.

Seton, E. T. 1929. Lives of game animals. Volume 3. Doubleday, Doran and Company Incorporated, New York. 780 pp.

Severinghaus, C. W. and **E. L. Cheatum.** 1956. Life and times of the white-tailed deer. *In* The deer of North America. *Edited by* W. P. Taylor. The Stackpole Company, Harrisburg, Pennsylvania. pp. 57–186.

Skinner, M. P. 1929. White-tailed deer formerly in the Yellowstone Park. Journal of Mammalogy 10(2): 101–115.

Skoog, R. O. 1968. Ecology of the caribou (*Rangifer tarandus granti*) in Alaska. Ph.D. thesis, University of California. 698 pp.

Thorpe, W. H. 1966. Ritualization in ontogeny. I. Animal play. Philosophical Transactions of the Royal Society of London, Series B 251: 311–319.

Townsend, M. T. and **M. W. Smith.** 1933. The white-tailed deer of the Adirondacks. Syracuse University, Roosevelt Wildlife Bulletin 6(2): 161–385.

Received 22 July 1974
Accepted 8 January 1975

Investigations of Heavy Metals in Common Tern Populations

PETER G. CONNORS,[1] VICTOR C. ANDERLINI,[1] ROBERT W. RISEBROUGH,[1]
MICHAEL GILBERTSON,[2] AND HELEN HAYS[3]

[1] University of California, Bodega Marine Laboratory, Bodega Bay, California 94923

[2] Canadian Wildlife Service, Department of the Environment, Ottawa, Canada K1A 0H3

[3] American Museum of Natural History, Central Park West at 79th, New York City, New York

Connors, P. G., V. C. Anderlini, R. W. Risebrough, M. Gilbertson, and H. Hays. 1975. Investigations of metals in Common Tern populations. Canadian Field-Naturalist 89: 157–162.

Abstract. In investigating the possible causes of the low hatchability observed in colonies of the Common Tern (*Sterna hirundo*) and other aquatic birds breeding in Lake Ontario, we have analyzed adult body tissues of Common Terns from Hamilton Harbour for nine of the heavy metals (Ag, Cd, Co, Cr, Cu, Hg, Ni, Pb, and Zn). For comparison, adult body tissues of Common Terns from Great Gull Island in Long Island Sound, where hatching success has consistently been higher than 90%, were also examined for these metals. No significant differences in the connections of any of these metals were found in the tissues; mercury levels reported in other studies of Common Tern eggs from Hamilton Harbour were considerably higher than those found in eggs from Long Island Sound, but were equivalent to levels in eggs from a colony in northwestern Ontario reported to have normal fledging success. It is unlikely that the metals examined are the primary cause of embryonic mortality or other factors which lower hatching success of the Hamilton Harbour colony.

Introduction

In recent years reproductive success of several species of aquatic birds breeding in Lake Ontario has been low; poor hatchability of the eggs rather than a failure to breed has been the principal cause (Gilbertson 1974; Gilbertson and Hale 1974). In part, the low hatchability has been caused by embryonic mortality: 20% of the embryos of the Herring Gull (*Larus argentatus*) in eastern Lake Ontario were found to die during the first week of incubation in 1973 (Gilbertson and Hale 1974). This mortality could not be explained by human disturbance or disturbance by predators; nor could it be related to any meteorological factors.

In Hamilton Harbour, an industrial area at the western end of Lake Ontario, only 29% of the eggs laid in 1970 by a colony of Common Terns (*Sterna hirundo*) hatched. In 1972, hatching success in this colony and in a colony of Common Terns on the Toronto Islands in northwestern Lake Ontario was less than 40% (R. D. Morris, personal communication). In contrast, hatching success in Massachusetts coastal colonies has been approximately 90% (Nisbet and Drury 1972), and on Great Gull Island in Long Island Sound hatching success of eggs of both Common Terns and Roseate Terns (*Sterna dougallii*) has consistently been in excess of 90% (H. Hays, unpublished results). Intensive studies, including the marking of nests and eggs and the recording of hatching and fledging success, have been carried out on Great Gull Island since 1966 (Hays and Risebrough 1972).

Although habitat characteristics and other ecological parameters may contribute to the hatching and reproductive failures, the geographic pattern of low reproductive success in the Great Lakes is correlated with areas of intense industrial and agricultural activities (Gilbertson 1974). Thinning of the egg-shells now occurs among many species of fish-eating birds breeding in the Great Lakes region (Faber and Hickey 1973). The observed embryonic mortality may therefore be an indirect effect of the shell-thinning which may influence the exchange of gases or of water (Peakall et al. 1973). Alternatively, embryonic mortality may be a result of the presence of toxic chemicals in the egg which had been accumulated by the female from residues in prey and subsequently passed to the egg. These compounds include both synthetic organics and the heavy metals.

DDT and PCB compounds are particularly abundant in Great Lakes ecosystems (Gilbertson and Reynolds 1974); also present in Great Lakes food chains are hexachlorobenzene, an industrial byproduct, the pesticides dieldrin and heptachlor epoxide (Gilbertson and Reynolds 1972; Gilbertson, in press), and a number of organic compounds of assumed pollutant origin which have been detected in eggs of Herring Gulls but which have not yet been identified (Bowes et al. 1973).

In the present paper we examine the hypothesis that toxic metals cause the low hatchability observed in the colony of Common Terns in Hamilton Harbour. Unlike synthetic organic compounds, metals are natural components of ecosystems and are not necessarily indicators of pollution. In areas of industrial activity where metals enter local ecosystems from the atmosphere or from waste-water outfalls, the anthropogenic contribution may increase the amounts of metals in food chains to concentrations above the natural background levels, or above the threshold levels which are toxic to sensitive species (Fimreite 1974). Since comparatively few studies have so far reported on the natural levels in any ecosystems, it is difficult to assess whether the concentrations measured in organisms of an industrial area such as Hamilton Harbour include a significant anthropogenic contribution. Moreover, it is not possible, with data from only one such ecosystem, to attribute observed deleterious effects to heavy metal pollution. Elsewhere we have approached this problem by comparing heavy metal and chlorinated hydrocarbon levels in resident Antarctic species with those in related species from the Northern Hemisphere (Anderlini et al. 1972; Risebrough and Carmignani 1972). The Antarctic species contained very low levels of industrial organic chemicals such as the polychlorinated biphenyls; they have therefore only marginally been exposed to pollution and the heavy metal concentrations recorded in these species are assumed to have no significant anthropogenic contribution.

In the present study, levels of nine heavy metals, lead (Pb), cadmium (Cd), mercury (Hg), silver (Ag), cobalt (Co), chromium (Cr), copper (Cu), nickel (Ni), and zinc (Zn), in tissues of adult Common Terns from Hamilton Harbour are compared with those in tissues of Common Terns from Great Gull Island in Long Island Sound. In addition, we have analyzed nine eggs of Common Terns obtained from Great Gull Island. If heavy metal burdens in tissues of the Hamilton Harbour terns are comparable to concentrations in the tissues of terns from Great Gull Island, the hypothesis that heavy metals are the primary cause of the low reproductive success may be rejected.

Materials and Methods

In 1971, six adult Common Terns were on these dates: one on 5 May; three on 19 May; one on 5 June; and one on 24 June. Ten adult Common Terns and nine eggs were collected from Great Gull Island on 20 June 1971.

Contents of eggs and samples of liver, breast muscle, leg bones (distal half of femur and entire tibiotarsus and fibula), and kidney from whole birds were prepared for analysis according to procedures described by Anderlini et al. (1972). For Ag, Cd, Co, Cr, Cu, Ni, Pb, and Zn, these procedures consist of grinding the oven-dried tissue samples with mortar and pestle and digesting the resultant powders with nitric acid. Separate fresh tissue samples are digested in a 2:1 mixture of concentrated sulfuric and nitric acids and analyzed for Hg content following a modification of the flameless absorption techniques developed by Uthe et al. (1970) and Stainton (1971).

Analyses for all these metals were performed on a Perkin-Elmer Model 303 atomic absorption spectrophotometer. Interfering background scatter occurs in the analysis of some metals (Pb, Co, Ni, Ag) from solutions of bone digests. Corrections were applied by comparison to scattering from solutions of calcium carbonate. This method permits some inaccuracy in the resultant calculated metal absorption, as with Pb and Co. The values listed in this paper for Pb and Co in bones are useful, therefore, for comparison of levels in the two populations, but are liable to a greater uncertainty in absolute value than are the concentrations listed for other analyses.

Standards and blanks were included in all analytical steps and were treated as samples in the analysis of all metals. Average absorption from solutions of blanks, when measurable, was considered background concentration of the pertinent metal, and appropriate corrections were made in the analysis of sample solutions. Duplicates of 18 fresh-tissue samples were prepared and analyzed for Hg and duplicates of 16 dry-tissue samples were analyzed for Cu, Zn, and Cd as a check on precision. The coefficient of variation (standard deviation/mean $\times$ 100) was calculated for each duplicate analysis. The mean coefficient of variation of mercury determinations in soft tissues was 7.5; precision of mercury determination in bone was considerably less with a mean coefficient of variation of 36.7. Precision was considerably greater in the determination of copper, zinc, and cadmium: the mean coefficient of variation for all tissues was 4.4. These values provide an indication of the contribution to the variance by the measurement error (Sokal and Rohlf 1969).

Results and Discussion

Results of the analyses of tissues of adult Common Terns are presented in Table 1 as parts per million (ppm) dry weight for all metals except mercury, which because of the analytical procedure employed is expressed as ppm wet weight.

Table 2 presents copper, zinc, mercury, and chromium levels from the nine Common Tern eggs from the Great Gull Island colony. Levels of silver, cadmium, cobalt, nickel, and lead were below the detection limits of the procedures used.

Among the four metals measured in all tissues, mercury and cadmium showed relatively high coefficients of variation and the physiologically important metals, copper and zinc, consistently showed lower coefficients of variation. Nickel and chromium determinations in bone and kidney also yielded high coefficients of variation.

The greatest difference between the two populations was found for nickel levels in kidney: the arithmetic mean in the Great Gull Island sample was 2.3 times that of the Hamilton Harbour sample. The difference, however, is not significant ($P > 0.20$), and a comparable difference was not found in bone. In all other instances differences between the two populations were less than a factor of 2. Lead levels were 1.5 times higher in the bone samples from Great Gull Island ($P = 0.05$). Mercury levels among the four tissues were consistently higher in the Hamilton Harbour samples, ranging from 1.3 to 1.9 times those of Great Gull Island ($P > 0.20$ for all tissues). Among the other comparisons, the only significant difference was found for copper levels in liver, which were 30% higher in the Great Gull Island birds ($P = 0.01$). Among the other tissues, however, the arithmetic mean concentrations were virtually identical in the two populations. The significant difference between the levels in liver cannot therefore be considered indicative of different copper levels in the two populations.

The wide range of individual variation, with coefficients of variation frequently ranging from 30 to 90, would necessitate much larger samples to determine whether these relatively small differences are statistically significant. For conservation reasons, and also because of the considerable expense in obtaining these determinations, we consider that the taking of larger sample sizes from these populations would have been unacceptable. Moreover, we believe that the data obtained from large samples would not have differed greatly from those presented here. The data appear sufficient, however, to show that there are no pronounced differences in the concentrations of these metals in the tissues of adults of the two populations.

To date, only mercury among the metals has been determined in eggs of the Common Terns from Hamilton Harbour (Gilbertson, in press). A sample size of 32 eggs obtained in

TABLE 1 — Concentrations of heavy metals in tissues of adult Common Terns from Great Gull Island (GGI) and Hamilton Harbour. Hg concentrations in parts per million (ppm) wet weight; other metals in ppm dry weight

		Cd		Cu		Hg	
Tissue		GGI	Hamilton	GGI	Hamilton	GGI	Hamilton
Bone	$\bar{X}$	1.61	1.47	5.43	6.06	0.32	0.41
	Range	1.33–1.89	1.05–1.83	4.15–8.87	5.15–8.14	0.15–0.66	0.14–1.20
	C.V.	11	18	26	20	53	94
	n	10	6	10	6	10	6
	P^1	>0.20		>0.10		>0.20	
Breast	$\bar{X}$	0.38	0.69	17.7	17.8	0.69	0.93
	Range	0.21–0.72	0.25–0.92	14.2–21.1	15.9–19.8	0.35–0.91	0.44–1.84
	C.V.	43	42	13	10	34	63
	n	10	6	10	6	10	6
	P^1	0.10		>0.20		>0.20	
Liver	$\bar{X}$	3.82	3.69	23.5	17.6	1.77	2.28
	Range	2.05–6.87	1.28–5.29	17.9–27.5	12.9–21.6	1.19–2.85	1.24–4.74
	C.V.	43	45	14	20	34	60
	n	9	6	9	6	10	6
	P^1	>0.20		0.01		>0.20	
Kidney	$\bar{X}$	21.3	29.5	19.2	20.6	1.41	2.68
	Range	10.4–46.1	11.2–53.9	17.2–21.6	18.2–23.8	0.74–2.43	1.04–7.59
	C.V.	48	57	8	11	40	93
	n	9	6	9	6	9	6
	P^1	>0.20		>0.20		>0.20	

		Zn		Cr		Ni	
		GGI	Hamilton	GGI	Hamilton	GGI	Hamilton
Bone	$\bar{X}$	197	232	9.40	9.81	14.5	13.8
	Range	135–318	137–351	4.83–28.3	4.13–13.6	6.00–35.6	8.20–19.0
	C.V.	33	37	81	43	58	30
	n	10	6	10	6	10	6
	P^1	>0.20		>0.20		>0.20	
Breast	$\bar{X}$	44.2	42.7	<1.0	<1.0	<2.0	<2.0
	Range	34.7–56.9	34.9–57.6				
	C.V.	14	19				
	n	10	6				
	P^1	>0.20					
Liver	$\bar{X}$	118.9	91.6	<2.0	<2.0	<5.0	<5.0
	Range	86.4–213.7	69.4–114.8				
	C.V.	32	24				
	n	9	6				
	P^1	>0.20					
Kidney	$\bar{X}$	100.5	105.3	3.94	3.14	10.41	4.53
	Range	89.7–126.8	80.8–138.0	1.10–8.63	0.65–7.48	2.41–26.4	1.65–8.79
	C.V.	12	21	75	82	72	68
	n	9	6	7	6	9	6
	P^1	>0.20		>0.20		>0.20	

		Co		Ag		Pb	
		GGI	Hamilton	GGI	Hamilton	GGI	Hamilton
Bone	$\bar{X}$	4.4	4.5	1.92	1.97	18.1	12.2
	Range	3.2–5.9	3.0–6.1	1.23–2.50	1.36–2.47	11.2–32.8	9.70–15.9
	C.V.	20	25	20	22	40	19
	n	10	6	10	6	10	6
	P^1	>0.20		>0.20		0.05	
Breast	$\bar{X}$	<1.0	<1.0	<0.5	<0.5	<1.0	<1.0
Liver	$\bar{X}$	<5.0	<5.0	<1.0	<1.0	<10.0	<10.0
Kidney	$\bar{X}$	<5.0	<5.0	<1.0	<1.0	<10.0	<10.0

[1]P: probability of the null hypothesis that the distribution of metal concentrations is equivalent in the two populations, Mann-Whitney test (Sokal and Rohlf 1969).

TABLE 2 — Concentrations of heavy metals in nine Common Tern eggs from Great Gull Island. Cr, Cu, Zn in ppm dry weight; Hg in ppm wet weight

	Cr	Cu	Zn	Hg
Arithmetic mean	2.15	4.89	70.5	0.09
Range	0.92–4.26	3.41–5.47	53.9–89.5	0.02–0.27
Coefficient of variation	45	13	14	74

1971 contained a mean of 1.075 ppm total mercury on a wet-weight basis, a level 10 times higher than that found in the Great Gull Island eggs. The Hamilton Harbour region appears, therefore, to be more contaminated by mercury than is Long Island Sound. A comparison of the mercury levels in breast muscle of the adults from Hamilton Harbour with season date suggested an increase of mercury levels with time spent in the area (Gilbertson, in press), but mercury concentrations in the eggs showed no relationship with season date. The failure to find significantly higher levels in the tissues of the Hamilton Harbour birds may reflect the relatively short time spent in the area after their return from the wintering grounds. Mercury residues in food, however, might pass directly to the eggs, accounting for the higher levels found in the eggs and the absence of a relationship with season date.

In a study of the distribution of mercury in fish-eating and aquatic birds from an area of northwestern Ontario with elevated mercury levels believed to have been derived from a chlorine plant, Fimreite (1974) compared fledging success of a Common Tern colony in the area exposed to mercury pollution with the fledging success in an adjacent, less contaminated area. Average total mercury levels in eggs of the less contaminated colony were 1.00 ppm wet weight, of which 82% consisted of methyl mercury. Fledging success of this colony was considered to be normal, with a large number of fledged young observed in the area. Fledging success of the colony exposed to higher levels of mercury pollution was much lower; hatching success was less than 27% and the fledging success was estimated to be 10–12%. The mean total mercury level in eggs from this colony was 3.65 ppm, of which 2.40 ppm was methyl mercury. The threshold of level of toxic effects by mercury consisting predominantly of methyl mercury was therefore estimated to be between 1.0 and 3.6 ppm wet weight in eggs of the Common Tern (Fimreite 1974). Although the mercury levels reported in Common Tern eggs from Hamilton Harbour are higher than those in eggs from Great Gull Island, they are equivalent to the concentrations recorded in the colony in northwestern Ontario which had normal fledging success. Mercury and the other metals examined in the present study do not, therefore, appear to be the primary cause of the low reproductive success shown by the colony in Hamilton Harbour.

Acknowledgments

Research was supported by National Institutes of Health Postdoctoral Fellowship 1-FO2-ES51971-01 (Connors) from the National Institute of Environmental Health Sciences; by the National Science Foundation grant GX-28743 of the International Decade of Ocean Exploration Program, and grants GB-11649 and GB-36593 of the Ecology and Systematics Division; and by the Canadian Wildlife Service. We thank John H. Martin and George Knauer of Hopkins Marine Station, Stanford University, for guidance and assistance with the analyses.

Literature Cited

Anderlini, V. C., P. G. Connors, R. W. Risebrough, and **J. H. Martin.** 1972. Concentrations of heavy metals in some Antarctic and North American sea birds. *In* Proceedings of the Colloquium on Conservation Problems in Antarctica. *Edited by* B. C. Parker. Allen Press, Lawrence, Kansas. pp. 49–61.

Bowes, G. W., B. R. Simoneit, A. L. Burlingame, B. W. de Lappe, and **R. W. Risebrough.** 1973. The search for chlorinated dibenzofurans and chlorinated dibenzodioxins in wildlife populations showing elevated levels of embryonic death. Environmental Health Perspectives 5: 191–198.

Faber, R. A. and **J. J. Hickey.** 1973. Eggshell thinning, chlorinated hydrocarbons and mercury in inland aquatic bird eggs, 1969 and 1970. Pesticides Monitoring Journal 7: 27–36.

Fimreite, N. 1974. Mercury contamination of aquatic birds in northwestern Ontario. Journal of Wildlife Management 38: 120–131.

Gilbertson, M. 1974. Pollutants in breeding Herring Gulls in the Lower Great Lakes. Canadian Field-Naturalist 88: 273–280.

Gilbertson, M. 1975. Seasonal changes in organochlorine compounds and mercury in Common Terns of Hamilton Harbour, Ontario. Bulletin of Environmental Contamination and Toxicology. *In press.*

Gilbertson, M. and **R. Hale.** 1974. Early embryonic mortality in a colony of Herring Gulls in Lake Ontario. Canadian Field-Naturalist 88: 354–356.

Gilbertson, M. and **L. M. Reynolds.** 1972. Hexachlorobenzene (HCB) in the eggs of Common Terns in Hamilton Harbour, Ontario. Bulletin of Environmental Contamination and Toxicology 7: 371–373.

Gilbertson, M. and **L. M. Reynolds.** 1974. A summary of DDE and PCB determinations in Canadian birds, 1969–1972. Canadian Wildlife Service, Occasional Paper Number 19.

Hays, H. and **R. W. Risebrough.** 1972. Pollutant concentrations in abnormal young terns from Long Island Sound. Auk 89: 19–35.

Nisbet, I. C. T. and **W. H. Drury.** 1972. Measuring breeding success in Common and Roseate Terns. Bird-Banding 43: 97–106.

Peakall, D. B., J. L. Lincer, R. W. Risebrough, J. B. Pritchard, and **W. B. Kinter.** 1973. DDE-induced egg-shell thinning: Structural and physiological effects in three species. Comparative and General Pharmacology 4: 305–313.

Risebrough, R. W. and **G. M. Carmignani.** 1972. Chlorinated hydrocarbons in Antarctic birds. *In* Proceedings of the Colloquium on Conservation Problem in Antarctica. *Edited by* B. C. Parker. Allen Press, Lawrence, Kansas. pp. 68–78.

Sokal, R. R. and **F. J. Rohlf.** 1969. Biometry. W. H. Freeman, San Francisco. 776 pp.

Stainton, M. P. 1971. Syringe procedure for transfer of nanogram quantities of mercury vapor for flameless atomic absorption spectrophotometry. Analytical Chemistry 43: 625–627.

Uthe, J. F., F. A. J. Armstrong, and **M. P. Stainton.** 1970. Mercury determination in fish samples by wet digestion and flameless atomic absorption spectrophotometry. Journal of the Fisheries Research Board of Canada 27: 805–811.

Received 22 September 1972
Revised and resubmitted 30 July 1974
Accepted 11 December 1974

A New Hybrid Woodfern, *Dryopteris* × *algonquinensis* D. M. Britton, from Algonquin Park, Ontario

D. M. BRITTON,[1] C.-J. WIDÉN,[2] D. F. BRUNTON,[3] AND P. A. KEDDY[4]

[1] Department of Botany and Genetics, University of Guelph, Guelph, Ontario N1G 2W1
[2] Department of Pharmacognosy, University of Helsinki, Helsinki, Finland
[3] Algonquin Park Museum, Ministry of Natural Resources, Whitney, Ontario K0J 2M0
[4] Department of Biology, Dalhousie University, Halifax, Nova Scotia B3H 4J1

Britton, D. M., C.-J. Widén, D. F. Brunton, and P. A. Keddy. 1975. A new hybrid woodfern, *Dryopteris* × *algonquinensis* D. M. Britton, from Algonquin Park, Ontario. Canadian Field-Naturalist 89: 163–171.

Abstract. A new interspecific hybrid of *Dryopteris fragrans* (L.) Schott × *D. marginalis* (L.) A. Gray, *D.* × *algonquinensis* D. M. Britton is described. The hybrid was found growing near Greenleaf Lake, Algonquin Park, Ontario. The phloroglucinol spectrum and cytology of the hybrid was investigated to support the conclusion that this plant is a hybrid and has the parentage as given.

Introduction

An unusual hybrid woodfern which is considered to have the parentage *Dryopteris fragrans* (L.) Schott × *D. marginalis* (L.) A. Gray was found growing in Algonquin Park, Ontario. *Dryopteris fragrans* (L.) Schott is considered in this paper as being one species without varieties (Kallio *et al.* 1969). This species is near its southern limit in Ontario in Algonquin Park (Britton and Soper 1966) and the ones here would be identified as *D. fragrans* var. *remotiuscula* Komarov by many authorities. A description of the site, description of the type and comparisons with its parents, as well as evidence of ancestry from chromatography and cytology will be considered in turn.

Description of Site

The plant was growing on the southern shore of Greenleaf Lake in Barron Township, Algonquin Provincial Park (45°52′ N, 77°57′ W). Greenleaf Lake had proved to be an interesting region for floristic studies because of the relict northern plant communities found on the north-facing cliffs, including such species as *Saxifraga aizoon, Draba glabella*, and the northern *Alnus crispa*. The hybrid was found on a narrow, horizontal, moss- and forest litter-covered rock ledge at the base of a 35-foot northeast-facing cliff of what appears to be precambrian gneiss. The cliff-face is highly fractured with many ledges and fissures and is part of a larger fault line producing a half-mile series of 30- to 350-foot cliffs. The rock appears to be acidic; however, the presence of calcicolous species such as *Saxifraga aizoon* and *Carex eburnea* less than 50 feet from the hybrid may indicate local calcareous deposits. The cliff at this site has mature red pine (*Pinus resinosa*) with scattered white pine (*Pinus strobus*) at its summit, while on the cliff-face white birch (*Betula papyrifera*), balsam fir (*Abies balsamea*), white cedar (*Thuja occidentalis*), and green alder (*Alnus crispa*) are found together with scattered white spruce (*Picea glauca*). Other vegetation at the site included *Vaccinium angustifolium, Woodsia ilvensis, Saxifraga virginiensis, Fragaria virginiana*, and *Aquilegia canadensis. Dryopteris marginalis* and *D. fragrans* are both abundant at the site. The former is on horizontal ledges and in pockets of soil on the talus whereas the latter is on the more vertical and overhanging surfaces of the cliff itself. There is one plant of *D. marginalis* less than 2 feet from the hybrid and a robust plant of *D. fragrans* less than 6 feet distant.

Description of the Type and Comparisons with Parents

The salient features of the hybrid and its parents are summarized in Table 1. Some of these features are evident in Figures 1 to 6,

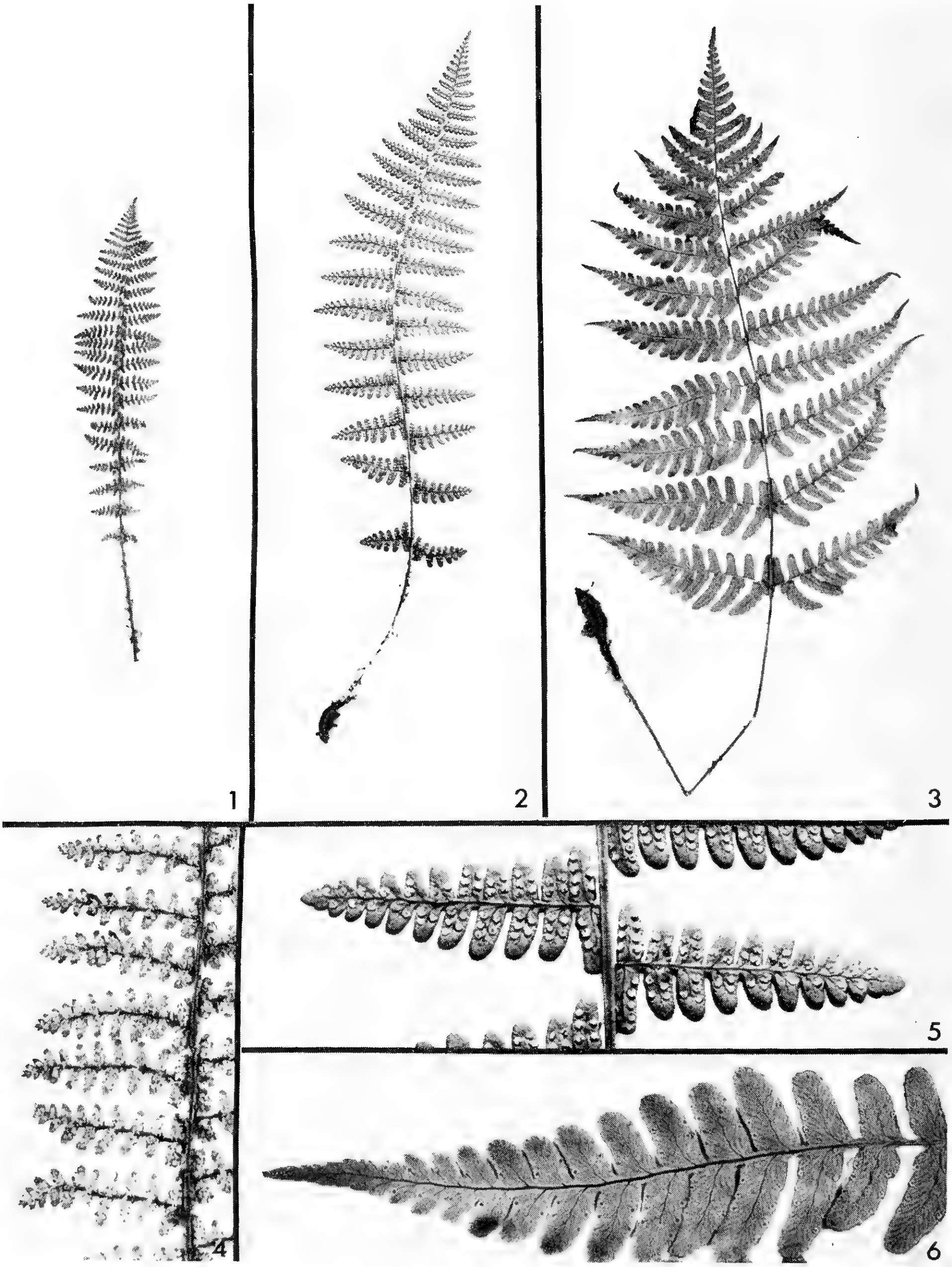


FIGURE 1. Leaf of *Dryopteris fragrans, Britton 3207.*
FIGURE 2. Leaf of hybrid, *Dryopteris* × *algonquinensis* from type *(Keddy and Brunton 533).*
FIGURE 3. Leaf of *Dryopteris marginalis, Britton 3206* from a plant of *D. marginalis* nearest hybrid.
FIGURE 4. Portion of leaf of *Dryopteris fragrans, Britton 3207.* Note how indusia appear to give a fuzzy outline to the leaf.
FIGURE 5. Portion of leaf of hybrid, *Dryopteris* × *algonquinensis* from type.
FIGURE 6. A pinna from *Dryopteris marginalis* to show shape and soral position, *Britton 3206.*

where leaves and portions of leaves are shown at the same magnification. The specimens of D. *fragrans* and *D. marginalis* in the illustrations came from the two plants of these species nearest to the hybrid. In the hybrid, the short blunt pinnae at right angles to the rachis with notably shortened basal pinnae clearly show the influence of *D. fragrans*. The undivided rounded pinnae segments show a relationship to *D. marginalis*. Other striking features of the hybrid are the narrow outline of the leaf blade (see blade ratios) and the pronounced tapering from the middle of the blade to the base and the apex as in *D. filix-mas*. The hybrid is glandular, whereas *D. marginalis* is glabrous, but the glandularity is less pronounced on the stipe, rachis, and indusia than it is in *D. fragrans*. The most pronounced expression of glandularity is on the mid-veins at the base of the pinnae. Brunton observed on the visit of 24 June that the fragrance of *D. fragrans* was very marked whereas that of the hybrid was not noticeable. The hybrid merits a binomial designation. The following is proposed: *DRYOPTERIS* × *ALGONQUINENSIS* Hybr. nov. D. M. Britton, planta hybrida inter *Dryopterem fragrantem* et *D. marginalem*, indusium margine modice glandulosum, lamina ca. 3½ plo longior quam lata. Breves obtusae basilares pinnae directae ad rachin.

TABLE 1 — Morphological features of the leaves

	Dryopteris fragrans	Hybrid	*Dryopteris marginalis*
Color	Dark dull-green	Dark lime–green upper surface, lighter green lower surface	Blue green, lighter on lower surface
Blade ratio (length/width)	4.8	3.6	1.6
Stipe	Well covered by large broad, tan-colored scales, glandular	Scales scattered, pronounced just below basal pinnae and towards base, lightly glandular	Scales scattered, more pronounced toward base, glabrous
Rachis	Well covered by large, broad, tan-colored scales, glandular	Scales few, but somewhat more conspicuous than in *D. marginalis*, lightly glandular	Scales few and narrow, glabrous
Pinna–apex	Oblong lanceolate, obtuse	Intermediate	Long attenuate
Pinna–segments	Markedly lobed or toothed	Shallowly and distantly toothed	Shallowly and distantly toothed
Pinna segment next to rachis	Markedly elongated in comparison to next segment	As in *D. fragrans*	Gradual decrease or sometimes increase from rachis out
Sori	Medial, but indusium extending to edge of leaf or beyond	Intermediate	Submarginal
Indusia	Very large, crowded and overlapping, glandular on edges	Large but neatly arranged, slightly glandular	Discrete and distant, glabrous
Upper leaf surface	Glandular	Very few scattered glands	Glabrous
Spores	Normal	Abortive	Normal
Chromosomes at Metaphase I	41 pairs	*ca.* 82 singles (fewer than 6 pairs)	41 pairs
Habitat	Cliff faces and talus, little soil	Rocky ledge	Talus, rocky slopes and woods in larger pockets of soil

Type Specimen

Ontario: Algonquin Provincial Park (Nipissing District), Barron Twp., south shore Greenleaf Lake, one third length from north end, below low cliffs. Habitat: Wet, shaded seepage area of small cliffs (north-facing) *Keddy and Brunton 533* (DAO); two leaves on one sheet labeled Algonquin Park Herbarium No. 2131 (Figure 7). Other collections: One of the previous year's leaves was collected on 15 June 1974, by *D. F. Brunton et al. 721*, (Algonquin Park Herbarium No. 271). Another leaf is *Britton et al. 3208*, 15 June 1974 (OAC).

Evidence for Ancestry

Chemotaxonomy

One of the petiolar bases was analyzed for phloroglucinols by C.-J. Widén. The results of this chemical analysis are given in Table 2, together with previously published results for *D. fragrans* (Widén and Britton 1971a) and

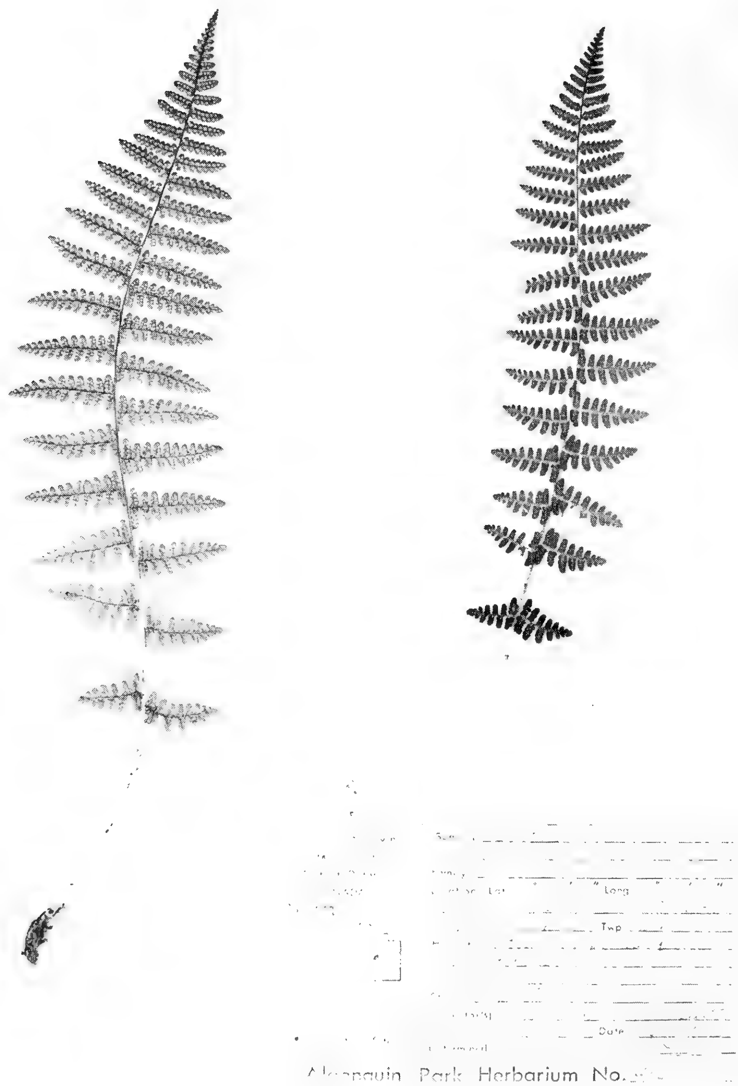


FIGURE 7. Type specimen of *D.* × *algonquinensis* (*Keddy and Brunton 533*).

D. marginalis (Widén and Britton 1971b). For the methods used in this chemical analysis please see the cited papers for the parents. The samples of these two species had also come from Algonquin Park at Lake of Two Rivers. The chemical analysis strongly suggested the hybrid nature of this plant. If one considers the phloroglucinol spectra to be additive as they are in many hybrids of *D. marginalis*, then it can be seen that the presence of aspidin BB (PB) is a constituent from *D. fragrans*, whereas phloraspidinol is contributed only by *D. marginalis*.

It is interesting to note that the *Dryopteris fragrans* from Lake of Two Rivers was unlike the material from elsewhere in having margaspidin and desapidin present (Widén and Britton 1971a). In this respect, Lake of Two Rivers *D. fragrans* is similar to *D. marginalis*. Chemically it was also similar to *D. marginalis* in having small amounts of para-aspidin and flavaspidic acid. The reasons for these chemical similarities for species which now appear so completely morphologically and ecologically isolated are obscure. One possibility is that the basic similarities in chemistry indicate a very ancient common ancestry.

TABLE 2 — Phloroglucinol spectra in parents and their hybrid. (+), compound present in trace amounts (< 5%); +, compound present in small amounts (5–10%); ++, compound present in moderate amounts (10–20%); +++, compound present in large amounts (≧ 25%)

	D. fragrans[a]	*D. marginalis*[b]	Hybrid
"Albaspidin 1"	(+)	−/(+)	+
Aspidin BB(PB)	++	—	++
Aspidin AB	+	—	—[c]
Para-aspidin BB	+	+/++	+
Desaspidin	+	+++	+
Margaspidin	+	+++	+
Flavaspidic acid	+	+	(+)
Methylene bis-aspidinol	—	++	—
Methylene bis des-aspidinol	—	+	—
Trisdesaspidin	—	—	(+)
Phloraspidinol	—	++	+
Phloraspin	—	+	—

[a] Material from Lake of Two Rivers; see Widén and Britton 1971a.
[b] See Widén and Britton 1971b.
[c] Cannot be detected because of overlapping.

Cytological Studies

Spore mounts were made from several sori of the type specimen and no normal-appearing spores were seen. In fact, the degree of abortion seemed even more striking than that seen in *D. X boottii* (Tuckerm.) Underw. or *D. X triploidea* Wherry, in as much as not even shrunken or shrivelled spores could be found.

Material for detailed cytological studies was first collected 15 June 1974. Two pinnae from each of the four leaves were fixed in absolute ethanol: glacial acetic acid (3:1). The sporangia from this material when squashed in iron aceto-carmine proved interesting. Unlike other *Dryopteris* hybrids studied by Britton, the sporangia from different pinnae and from different sori of a single pinna were all at approximately the same stage of maturity. The onset of meiosis seemed normal but only early stages were observed. The latest stages observed were at zygotene-pachytene (Figure 9). At this date, *D. fragrans* was undergoing meiosis (Figure 8) and some of the sporangia had already produced spores whereas *D. marginalis* was judged to be a week or so too young for meiosis. Accordingly, in this characteristic the putative hybrid was intermediate.

Further material was collected on 24 June and this material, although almost too old, proved satisfactory. Many young and completely aborted spores of bizarre and contorted shapes were seen, and they tended to stick together in a heterogeneous mass. Immature spores after cytokinesis (Figure 11) had varying shapes and sizes with poorly organized nuclei. Although interphase nuclei between the first and second divisions of meiosis did not look unusual, an earlier stage at Anaphase I showed many lagging chromosomes and an occasional bivalent still undivided (Figure 10). The characteristic four-nucleate stage at the completion of meiosis proved to be similar to that of other *Dryopteris* hybrids. Micronuclei, fragments, and chromosomes left out of nuclear groupings were observed (Figure 12). This evidence provided an explanation of the early and complete abortion of spores, and further indicates the hybrid nature of this plant.

A concerted effort was made to find younger

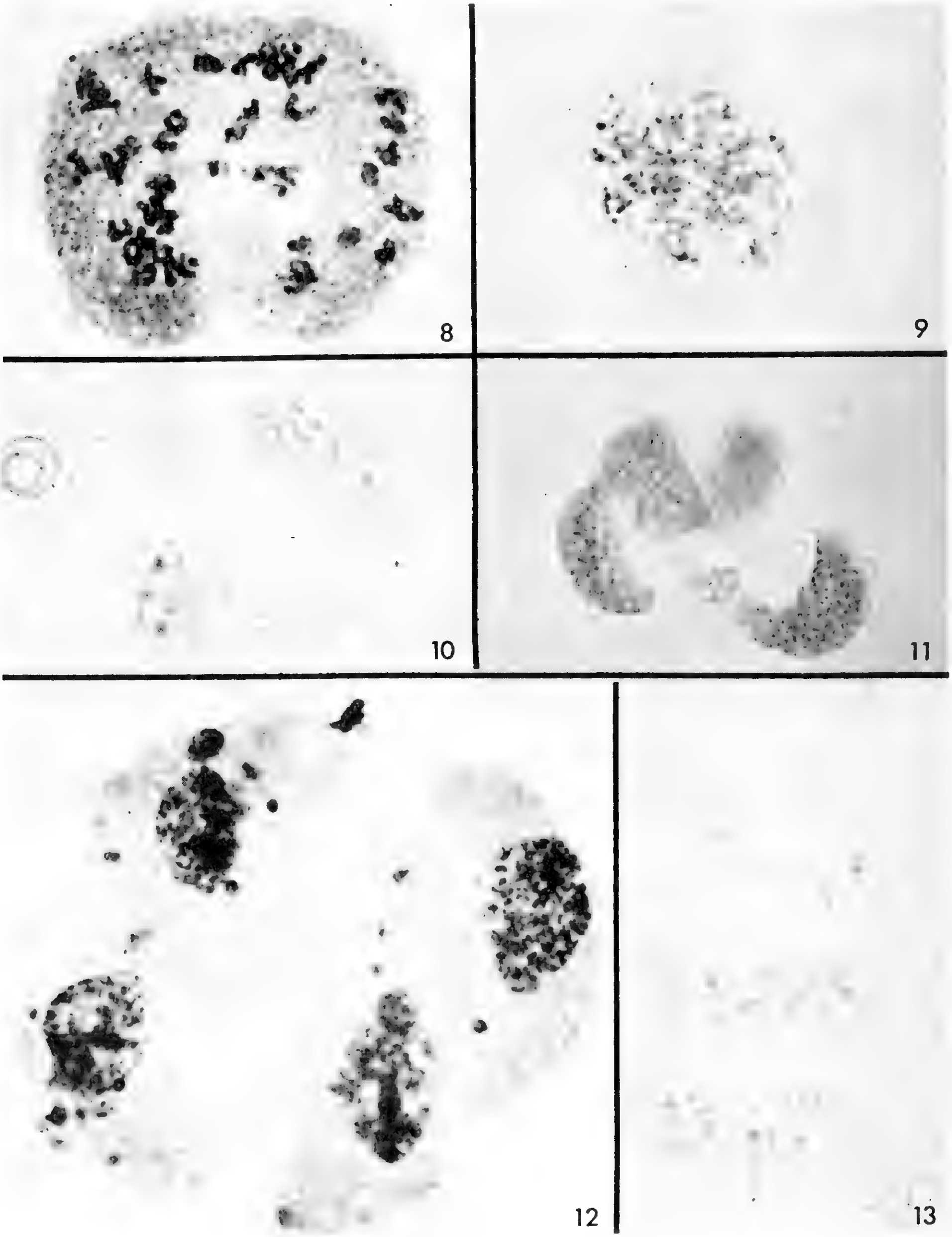


FIGURE 8. Diakinesis in *Dryopteris fragrans*, n = 41, *Britton 3207* from plant of *D. fragrans* nearest hybrid, × 2000.

FIGURE 9. Zygotene-pachytene in hybrid, × 2000.

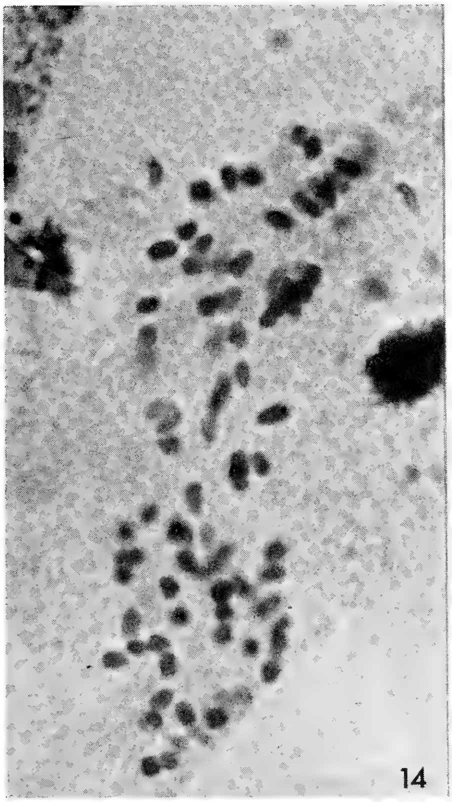
FIGURE 10. Late Anaphase I in hybrid, note lagging univalents, × 1500.

FIGURE 11. *Dryopteris* × *algonquinensis*, five products of meiosis of varying sizes and shapes, × 1000.

FIGURE 12. *Dryopteris* × *algonquinensis*, four-nucleate stage with many chromosomes at different stages of contraction outside nuclear groupings, × 1500.

FIGURE 13. *Dryopteris* × *algonquinensis*, early Anaphase I with univalents at each pole and others clustered at the equator, × 1500.

sporangia so that the homology of the chromosomes from *D. fragrans* and *D. marginalis* could be assessed. It is known that *D. fragrans* is a diploid species ($n = 41$) (Figure 8) (Widén and Britton 1971a), as is *D. marginalis* (Britton and Soper 1966; Widén and Britton 1971b). Using letter designations for genomes, *D. fragrans* would be FF and *D. marginalis* MM. A hybrid would be FM. Without any homology between the 41 chromosomes of the F genome and the 41 chromosomes of the M genome, diakinesis and metaphase I would show 82 univalents. In this material, a frequent stage observed was early anaphase with one group of chromosomes at each pole and a third group clustered at the equator (Figure 13). This type of configuration is difficult to flatten by squashing, but a few cells were flattened sufficiently for analysis and a photograph (Figure 14). The analysis of this plate (Figure 15) suggests that very few pairs of chromosomes or bivalents are formed. The interpretation of this plate was 76 univalents and 2 bivalents with a total of 82 chromosomes. Some univalents, however, which are interpreted as being close together may in reality be bivalents. After many plates had been examined carefully, particularly at the equatorial zones of the cells, it was concluded that there were few bivalents (six or less), and accordingly it is considered that there is little homology between the F and M genomes. In fact, there is no assurance that the few loose bivalents do not represent pairing between chromosomes within a genome. No diplotene or diakinesis stages could be found in this material.



14

15

FIGURE 14. *Dryopteris* × *algonquinensis*, early Anaphase I to show univalents, × 2000.
FIGURE 15. Explanatory diagram for Figure 14 showing 76 univalents in outline and two bivalents solid black.

Discussion

This is the first hybrid proven to involve *D. fragrans*, although another described by Tryon in 1942 (*D. fragrans* × *intermedia*) pre-dated the benefits from cytological and chemical analyses. Also, it was collected on 4 July which meant that the spores were not fully developed and hence the degree of spore abortion was not known. Wagner and Chen (1965), on the basis of measurements of young exospores, concluded that this plant was in reality a narrow form of *Dryopteris intermedia.*

Dryopteris fragrans is a small subarctic cliff fern of distinctive appearance. Although species of *Dryopteris* are well known for their ability to hybridize (Britton 1965; Wagner 1971), it seemed unlikely that *D. fragrans* would give rise to successful hybrid offspring because of the highly specialized ecological niche occupied by this species and its characteristics. Superficially *D. fragrans* appears remote from the large woodferns (eg., *D. goldiana* (Hook.) Gray) and is noted for being well covered with specialized scales and glands. Also, although diploid, it has very large spores. The presence of large numbers of both *D. fragrans* and *D. marginalis* at this location, together with a suitable intermediate habitat, was apparently sufficient to allow hybridization and permit this hybrid to reach its present healthy state (Figure 16).

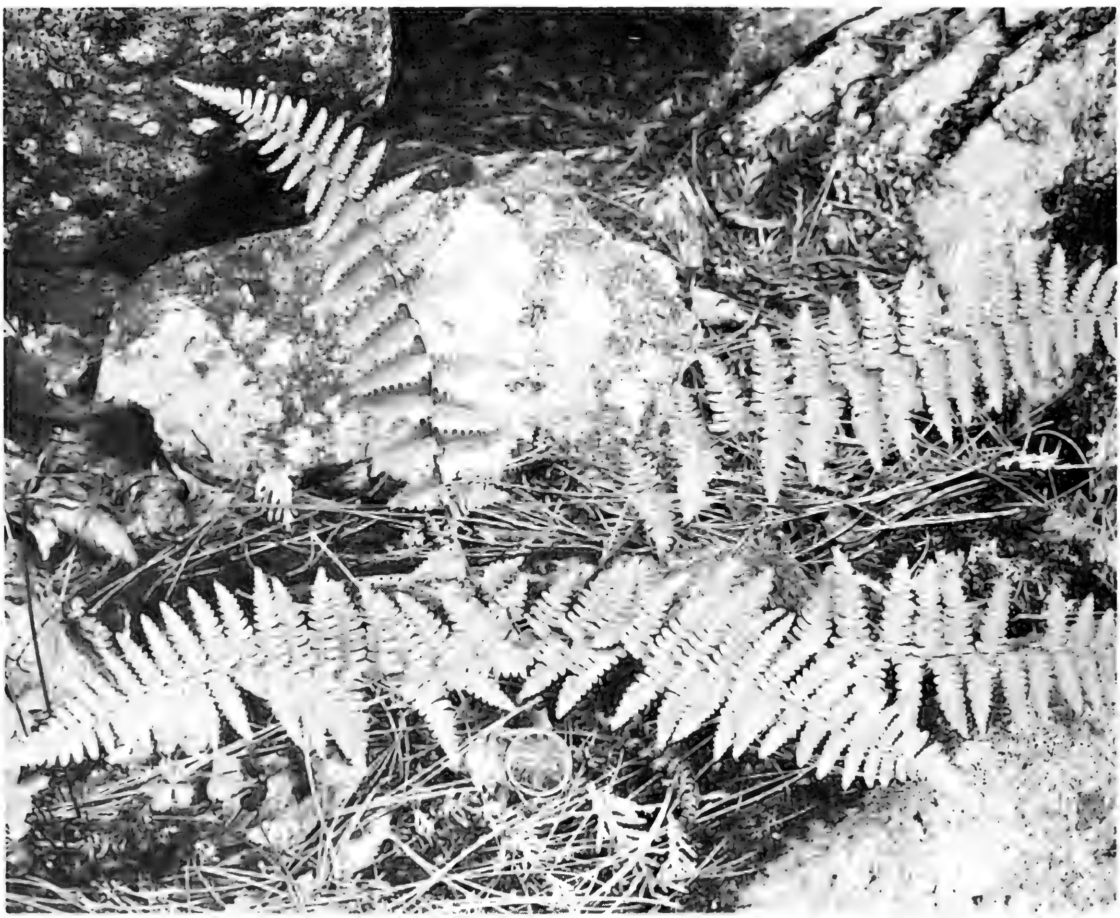


FIGURE 16. *Dryopteris* × *algonquinensis* at Greenleaf Lake, 24 June, 1974.

Acknowledgments

The senior author thanks the National Research Council of Canada for financial support. The photograph for Figure 16 was supplied by G. McPherson, photographer for the Ontario Ministry of National Resources. Keddy and Brunton made the initial collection while employed in ecological inventory with the Ontario Ministry of Natural Resources. We are grateful to them for supplying the authors with transportation to the site. We are also indebted to Professor H. L. Tracy for help with the Latin description.

Literature Cited

Britton, D. M. 1965. Hybrid wood ferns in Ontario. Michigan Botanist 4: 3–9.

Britton, D. M. and **J. H. Soper.** 1966. The cytology and distribution of *Dryopteris* species in Ontario. Canadian Journal of Botany 44: 63–78.

Kallio, P., U. Laine, and **Y. Mäkinen.** 1969. Vascular flora of Inari Lapland. I. Introduction and Lycopodiaceae-Polypodiaceae. Report of the Kevo Sub-Arctic Research Station 5: 1–108.

Tryon, R. M., Jr. 1942. A new *Dryopteris* hybrid. American Fern Journal 32: 81–85.

Wagner, W. H., Jr. 1971. Evolution of *Dryopteris* in relation to the Appalachians. *In* The distributional history of the biota of the southern Appalachians. Part II. Flora. Virginia Polytechnic Institute and State University, Research Division Monograph 2. pp. 147–192.

Wagner, W. H., Jr. and **K. L. Chen.** 1965. Abortion of spores and sporangia as a tool in the detection of *Dryopteris* hybrids. American Fern Journal 55: 9–29.

Widén, C.-J. and **D. M. Britton.** 1971a. Chemotaxonomic investigations on *Dryopteris fragrans*. Canadian Journal of Botany 49: 989–992.

Widén, C.-J. and **D. M. Britton.** 1971b. A chromatographic and cytological study of *Dryopteris filix-mas* and related taxa in North America. Canadian Journal of Botany 49: 1589–1600.

Received 1 October 1974
Accepted 28 November 1974

Notes

A Complex Tracking Board for Small Mammal Studies

Small mammal field studies generally involve trapping, but a less frequently used method utilizes small boards or boxes blackened with smoke or talcum powder-alcohol mixes to record animal tracks. K. E. Justice (1961. A new method for measuring home ranges of small mammals. Journal of Mammalogy 42(4): 462–470) used such boards to examine the movements of house mice (*Mus musculus*), and L. H. Metzgar (1971. Behavioral population regulation in the woodmouse. *Peromyscus leucopus*. American Midland Naturalist 86: 434–448) used similar boards to record the activity of white-footed mice (*Peromyscus leucopus*). By toe-clipping mice, they were able to identify tracks made by individual animals that moved over the area where the boards were placed.

I have developed a complex tracking board (Figure 1) which may provide a more reliable method of differentiating species than the featureless boards used by Justice. It is composed of a plywood board, 30 × 30 cm, with two "walls" 10 × 10 × 0.6 cm. One wall is mounted "on end," providing a vertical height of 20 cm and the other is placed on its side, giving a vertical height of 10 cm. A "ladder" 0.6 cm in diameter, wrapped with thin wire is placed at a 50° angle against the higher wall. Kymograph paper is placed on all horizontal surfaces and smoked with motor oil in the field, just before placement, to provide track records. In their present form the boards are not collapsible.

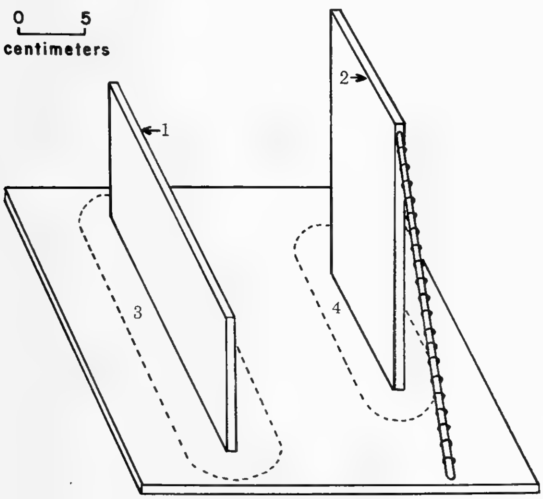


FIGURE 1 — Complex tracking board. Numbers refer to areas differentially marked by various rodent species.

My laboratory research necessitates the live-trapping of particular rodent species at different times, and these boards have provided a quick census method of determining likely habitat for deermice (*Peromyscus maniculatus*), and two vole species (*Microtus montanus* and *M. richardsonii*). My early attempts to locate these species involved conventional tracking boards, but the number of boards necessary to provide such information were prohibitive in terms of the time involved in their preparation and placement. A minimum of 10 boards was necessary in most cases. I next tried boards baited with peanut butter, but the tracks on these boards were apparently rubbed out and difficult to analyze in terms of species differentiation. Perhaps the high number of animals visiting them, or the duration of each visit to these baited boards contributed to the "rub-out" problem.

The advantage of the complex boards appears to be that each of the species referred to above reacts differently to the board's features, and thereby leaves markings discriminable by pattern as well as by their characteristic paw tracks. Table 1 summarizes the areas of the boards marked by deermice, voles, rats (*Rattus norvegicus*), Kangaroo rats (*Dipodomys ordii*), and ground squirrels (*Spermophilus armatus*) in a laboratory study. These animals were placed in pens, 3 × 2 meters, containing the complex boards, for 1 hour each. Each species left easily discriminable markings. *Peromyscus maniculatus* was the only animal that left tracks on the top of both walls. Both *Microtus* species left most of their tracks along the bases of the walls. *Microtus montanus* left tracks on the top of the low wall while none of the *M. richardsonii* did. These differences may reflect the differential climbing abilities of these animals as well as possible species-specific differences in novel-object responses.

For habitat census, I placed three of the boards within a circular area with an approximately 50-meter radius for 3 days. If tracking information was obtained for the target species, 20 Sherman traps baited with beanut butter were placed at

TABLE 1 — Summary of tracking records made on complex boards by six species in a laboratory test. L = light tracking, H = heavy tracking.

Species	Number tested	Areas with tracks after 1 hr exposure 1	2	3	4	5*
Peromyscus maniculatus	15	L	L	L	L	L
Microtus montanus	6	L	—	H	H	L
Microtus richardsonii	6	—	—	H	H	L
*Rattus rattus***	10	H	—	H	H	L
*Dipodomys ordii****	4	H	—	H	L	L
Spermophilus armatus′	4	—	—	L	L	L

* Area 5 encompasses all horizontal areas not included in the other four areas.
** Rat tracks were characterized by many vibrissae marks in areas 3 and 4.
*** Kangaroo rats left triangular marks in area 3, apparently caused by "tail assisted" jumps onto area 1.

random in the area for two dusk-to-dawn periods. I have used these boards on 12 separate occasions to examine natural habitat for the presence of target animals. Five of these investigations resulted in tracking information for the species of interest. My trapping success rate in these areas was somewhat higher than that for uncensused areas. For instance, the capture rate for *P. maniculatus* was 0.07 animals per trap-hour for 160 total trap-hours with the tracking information vs. 0.05 for 3200 total trap-hours without the use of these boards. The rates for *M. montanus* were 0.037 for 320 hours with the tracking boards vs. 0.025 for 800 hours without the preliminary board census. The different success rates, however, may not accurately reflect the advantages of the pre-trapping tracking-board census because many of the non-censused areas were used because of previous success by other researchers or other information indicating a good probability of the presence of target animals. A better test of the utility of the complex tracking board would be to place traps in areas not yielding tracking information as well as areas producing such data and to compare trapping success in the two locations.

Future improvements planned for these boards include the construction of collapsible models to improve portability and the use of talcum powder and alcohol as the tracking medium.

I thank Dr. Carl Cheney of the Psychology Department and Richard Howard of the Wildlife Department, Utah State University, for assistance in both data collection and preparation of the manuscript.

RON L. SNYDER

Institute of Animal Behavior
Department of Psychology
Utah State University
Logan, Utah 84322

Received 16 July 1974
Accepted 26 November 1974

Eastern Yellow-bellied Racer in Central Southern Saskatchewan

The presence of the Eastern Yellow-bellied Racer, *Coluber constrictor flaviventris*, was not verified in Saskatchewan until Maher and Beck (1964) reported two taken at the Walt Larson ranch, 6 miles east of Val Marie, by Mr. N. Lacoursiere and Dr. G. R. Sherven on 4 October 1964. This remained the sole published locality for this subspecies in the prairie provinces until Morrison (1969) mentioned in an incidental list of the fauna that one was killed by T. Marshall on his ranch in the lower Big Muddy Valley in September 1968. Presumably this represents a verbal report only and the specimen was not saved for confirmation of its identification.

On 6 August 1974 the second author collected a road-killed snake south of Big Muddy Lake approximately 8 km west of Highway 6 on the grid road to Big Beaver, Saskatchewan. Although this specimen had dried, it clearly has a dorsal scale formula of 17-17-15 and unkeeled scales. It showed no trace of blotching or other markings, but retained some indication of yellow ventrally. It is clearly a racer and this represents a confirmation of the Morrison report and the first preserved specimen from this area. It has been catalogued in the Herpetology Unit collection of the National Museum of Natural Sciences as Number 16000.

The Big Muddy area is within the arid short-grass prairie of southwestern Saskatchewan and harbors other amphibian and reptile species that are restricted in Canada largely to this region: Plains Spadefoot Toad, *Scaphiopus bombifrons*; Bullsnake, *Pituophis melanoleucus sayi*; and Western Hognose Snake, *Heterodon nasicus*. But, it is east of the range of other prairie species: Great Plains Toad, *Bufo cognatus*; Eastern Short-horned Lizard, *Phrynosoma douglassi brevirostre*; and Prairie Rattlesnake, *Crotalus viridis viridis* (Cook 1966). The latter two species, but not the Great Plains Toad, have been recorded in the Val Marie area and in the vicinity of Killdeer, midway between Val Marie and the Big Muddy Valley (Cook 1966, NMC files). Interestingly, all six of the above prairie species occur in the extensive short-grass prairie continuation in adjacent southeastern Alberta (Lewin 1963) but the racer has not been recorded there. The Saskatchewan records may represent two separate extensions of the racer from the south into Canada via the Frenchman River and Big Muddy Creek Valley.

We thank Eileen Shea for bringing the Morrison record to our attention.

Literature Cited

Cook, F. R. 1966. A guide to the amphibians and reptiles of Saskatchewan. Saskatchewan Museum of Natural Sciences Popular Series 13: 1–40.

Lewin, V. 1963. The herpetofauna of southeastern Alberta. Canadian Field-Naturalist 77(4): 203–214.

Maher, W. J. and **W. H. Beck.** 1964. Two records of the Yellow-bellied Racer in Saskatchewan. Blue Jay 22(4): 174.

Morrison, H. 1969. A preliminary botanical survey of the Big Muddy Valley in southern Saskatchewan, 1968. Blue Jay 27(1): 42–53.

FRANCIS R. COOK[1]
C. G. VAN ZYLL DE JONG[2]

[1] Herpetology Unit
[2] Mammalogy Unit
National Museum of Natural Sciences
Ottawa, Ontario K1A 0M8

Received 1 November 1974
Accepted 11 December 1974

Golden-crowned Sparrow Breeding on Vancouver Island

On 1 June 1973, while assessing gravel quarries on southern Vancouver Island, J. W. McCammon noticed an excited adult Golden-crowned Sparrow (*Zonotrichia coronata*) in a grassy, shrub-dotted field just west of the North Saanich municipal hall. After a short search he discovered a ground nest, at the base of a wild rose bush, containing three large young. He took a photograph, which although slightly under-exposed, shows the near-fledged young filling the nest. The 35-mm slide has since been added to the photographic records file in the British Columbia Provincial Museum (see Campbell and Stirling 1971).

Three days later R.B. Hay and I visited the area and located both adults with one young near the nest site. The other young had probably fledged recently and remained hidden in the bushes nearby. Apparently this habit is not uncommon as Swarth (1924) mentions the "extreme wariness of Golden-crowned Sparrows" and the difficult time he had collecting three juvenile specimens. Neither adults nor young were located on four subsequent visits from 5 to 11 June. No adult Golden-crowned Sparrows were seen the following summer (late May and early June) in the vicinity of the nest site; in fact there are no summer records for this sparrow on southern Vancouver Island for 1974.

This record is of particular interest since Vancouver Island is not included in the breeding range of the Golden-crowned Sparrow (A.O.U. 1957; Godfrey 1966), which extends in western North America from Alaska, Yukon, and western Alberta to Baja, California. The sparrow is considered a common transient in extreme southwestern British Columbia, passing through in spring from late April to late May and in fall from early September to early October (Campbell et al. 1972; Tatum 1969). Small numbers also winter here. In addition there have been several summer reports recently of Golden-crowned Sparrows for the southern tip of Vancouver Island. K. Taylor (personal communication) saw a singing male at Sooke on 10 June 1970. Three years later, on 4 June, J. W. McCammon (personal communication) watched two adults feeding on the hearts of flowers of broom (*Cytisus scoparius*) bushes at Polson's gravel pit next to Bear Hill, Central Saanich, and the following day observed a male singing at the Trio gravel pit on the east side of Elk Lake. The only other summer record is an adult seen by my wife and me in our garden in Saanich on 5 July 1973.

In British Columbia the Golden-crowned Sparrow is known to breed at higher elevations, especially in the Alpland biotic area (Munro and Cowan 1947). Nest cards in the British Columbia Nest Records Scheme in the Provincial Museum show that the altitude at which this sparrow breeds in the province ranges from about 3800 feet (Mile 75, Haines Road) to 5700 feet (Hermin Valley, Wells Gray Provincial Park). There is an isolated record, however, of a nest containing three young found in a cedar hedge in early June in North Vancouver, which is about 500 feet above sea-level. Mrs. J. Hart comments "during several years of observation . . . this is the first Golden-crowned Sparrow nest ever detected in our garden."

The nest located in Saanich, then, is noteworthy since it represents the first breeding record at sea-level in British Columbia. It should be pointed out, however, that F. S. L. Williamson (*in* Bent et al. 1968) mentions that in Alaska Golden-crowned Sparrows "occur locally in several places at sea-level, usually where brush covered slopes extend abruptly down to the shore."

Literature Cited

American Ornithologists' Union. 1957. The A.O.U. checklist of North American birds. 5th edition. Baltimore, Maryland.

Bent, A. C., O. L. Austin, A. A. Saunders, and **W. G. F. Harris.** 1968. Life histories of North American cardinals, grosbeaks, buntings, towhees, finches, sparrows and allies. United States National Museum Bulletin 237. Part 3.

Campbell, R. W. and **D. Stirling.** 1971. A photoduplicate file for British Columbia vertebrate records. Syesis 4: 217–222.

Campbell, R. W., M. G. Shepard, and **R. H. Drent.** 1972. Status of birds in the Vancouver area in 1970. Syesis 5: 137–167.

Godfrey, W. E. 1966. The birds of Canada. National Museum of Canada Bulletin 203. 428 pp.

Munro, J. A. and **I. McT. Cowan.** 1947. A review of the bird fauna of British Columbia. British Columbia Provincial Museum Special Publication Number 2. 285 pp.

Swarth, H. S. 1924. Birds and mammals of the Skeena River Region of northern British Columbia. University of California Publications in Zoology 24: 315–394.

Swarth, H. S. 1926. Report on a collection of birds and mammals from the Atlin Region, Northern British Columbia. University of California Publications in Zoology 30: 51–182.

Tatum, J. B. (*Editor*). 1969. Annual bird report for Southern Vancouver Island – 1969. Victoria Natural History Society. Mimeo. 34 pp.

R. WAYNE CAMPBELL

British Columbia Provincial Museum
Victoria, British Columbia

Received 20 September 1974
Accepted 25 November 1974

A Western Kingbird at Cap Tourmente, Quebec

On 1 September 1969, at Cap Tourmente, some 40 km northeast of Quebec City, I identified a Western Kingbird (*Tyrannus verticalis*) in an isolated tree. The bird was collected and proved to be a molting female (41.1 g). The skull was not fully ossified. The specimen is now in the Redpath Museum collection (No. R 4707). This constitutes the second specimen record for Quebec. The first specimen was obtained on the Moisie River, Duplessis County, on 22 September 1958 (Godfrey 1966, p. 250).

In addition to these records two observation reports have been published for Quebec: a single bird seen on 27 August 1956 at Cap-aux-Meules, Magdalen Islands (Gaboriault 1961, p. 118); a single bird on 19 September 1970 at Valcartier, Quebec (Anonymous 1970).

Literature Cited

Anonymous. 1970. Bulletin ornithologique 15 (5): 95.

Gaboriault, W. 1961. Les oiseaux aux Iles-de-la-Madeleine. Naturaliste Canadien 88: 166–224.

Godfrey, W. E. 1966. The birds of Canada. National Museum of Canada Bulletin 203. 428 pp.

JEAN-LUC DESGRANGES

Department of Biology
McGill University
Montreal, Quebec

Received 11 October 1974
Accepted 11 January 1975

Alpine Woodsia (*Woodsia alpina* (Bolton) S. F. Gray) in Southern Ontario

Abstract. A recently discovered disjunct station of *Woodsia alpina* in Ontario is described in detail. This represents the only station of this species known in southern Ontario. The distribution of *W. alpina* in eastern North America is summarized.

On 13 July 1974, while exploring the shorelines of Jeffrey Lake (45°01′ N, 77°53′ W) in Faraday Township, Hastings County, I discovered several plants of alpine woodsia (*Woodsia alpina* (Bolton) S. F. Gray) growing on exposed rocky ledges of low cliffs (about 5 m high) along the middle south shore of the lake.

In eastern North America *Woodsia alpina* is known from Newfoundland, Labrador, Quebec, and Ontario, reaching its southern limit in the Lake Superior region of Ontario and Michigan, the Adirondack Mountains of New York State, the Green Mountains and at Quechee in Vermont, northern Maine, and New Brunswick (Brown 1964, pp. 45–49; Soper and Maycock 1963, p. 191; CAN; DAO; TRT).

In Ontario alpine woodsia is known from a number of localities on the north shore of Lake Superior in Thunder Bay and Algoma Districts. Here it comprises a part of the relic arctic-alpine flora (Soper and Maycock 1963). It has also been reported from the Kingston region of Ontario (Beschel et al. 1970; Macdonald 1974). The justifying specimens for this latter report, in the Fowler herbarium at Queen's University, are labelled "*Woodsia belli* (Lawson) Porsild." This name has been placed in synonymy with *Woodsia alpina* (Bolton) S. F. Gray (Brown 1964). These specimens (QK 48848, 53213, 54363), however, clearly belong to *Woodsia ilvensis* (L.) R. Br., although some of them are rather atypical and depauperate.

Thus, the newly discovered station of alpine woodsia at Jeffrey Lake, 3 miles southwest of Bancroft, is 200 miles from the nearest known locality, which is in the Adirondacks of New York State. It is 400 miles removed from the nearest Ontario (Lake Superior Provincial Park) and Quebec (Kamouraska County) stations.

The Jeffrey Lake station was revisited in August 1974 to determine the extent of the colony. An intensive search revealed over 200 plants scattered for 30 m, mostly along the higher part of a wooded cliff parallel to the shore. This cliff rises about 12 m above the lake and faces NNW.

Although there are a number of relatively steep and vertical faces, the cliff is very blocky, having numerous ledges and more gradual slopes covered with cedar (*Thuja occidentalis* L.) and white birch (*Betula papyrifera Marsh*). The ferns occurred as solitary plants or as small groups of 2 to 10 in vertical cracks and on ledges (Figure 1). Bryophytes, notably *Tortella tortuosa* (Hedw.) Limpr., *Distichium capillaceum* (Hedw.) BSG., *Bartramia pomiformis* (Hedw.), *Campylium chrysophyllum* (Brid.) J. Lange, *Saelania glaucescens* (Hedw.) Broth., and *Radula complanata* (L.) Dumort were the most frequent associates. A lichen (*Solorina saccata* (L.) Ach.) was also found growing with several vigorous clumps of this fern. Vascular plant associates were few but included *Cryptogramma stelleri* (S. G. Smel.) Prantl., *Carex eburnea* Boott, and another *Carex* species.

The cliff is composed of both fine and coarse ("feather") amphibolite with veins of quartz and marble. The fine amphibolite and marble contain much carbonate as indicated by violent bubbling when 15% HCl was applied to a freshly broken surface. Although the quartz and coarse amphibolite contained no carbonate, the weathered surfaces and cracks gave a moderate reaction. The pH of the rooting medium varied from 6.5 to 7.4, but most readings were 7.2. Soil from a part of the cliff only a few feet from the ferns had a pH of 5.3, further establishing the highly variable nature of the rock.

In sharp contrast with the colony of *W. alpina*, but only a few hundred metres away on the opposite shore of Jeffrey Lake, is an extensive colony of *W. ilvensis* (about 300 plants). Here the amphibolite cliff has a south-facing exposure and is steeply sloping but not precipitous and blocky, and without the seepage fissures and ledges characteristic of the south-shore cliff. The drier and more open nature of this *W. ilvensis* habitat was reflected in the associating plant species, including *Diervella lonicera* Mill., *Danthonia spicata* (L.) Beauv., *Antennaria neglecta* Greene, *Aquilegia canadensis* L., and *Saxifraga virginiensis* Michx. Examination of a few hundred plants of each of *W. alpina*, which is confined to the south shore, and *W. ilvensis*, which is confined to the north shore, indicated that in this location these species are quite distinct.

Specimens of *W. alpina* from this newly discovered station have been placed in the herbariums of the National Museum of Canada (CAN), the Canada Department of Agriculture (DAO), and the University of Toronto (TRT).

FIGURE 1. *Woodsia alpina* photographed at Jeffrey Lake, August 1974.

Acknowledgments

I am grateful to K. L. McIntosh, S. M. McKay, and R. E. Whiting, for sharing in this discovery. W. H. Wagner and D. M. Britton confirmed identifications, and W. J. Cody kindly read the manuscript.

Literature Cited

Beschel, R. E., A. E. Garwood, R. Hainault, I. D. Macdonald, S. P. van der Kloet, and **C. H. Zavitz.** 1970. List of the vascular plants of the Kingston region. Fowler Herbarium, Queen's University, Kingston. 92 pp.

Brown, D. F. M. 1964. A monographic study of the fern genus *Woodsia*. Beihefte zur Nova Hedwigia 16: 1–154.

Macdonald, I. D. 1974. Ferns and fern allies of the Kingston region. Blue Bill (Bulletin of the Kingston Field-Naturalists' Club) 21(2): 21–25.

Porsild, A. E. 1945. The so-called *Woodsia alpina* in North America. Rhodora 47: 145–148.

Soper, J. H. and **P. F. Maycock.** 1963. A community of arctic-alpine plants on the east shore of Lake Superior. Canadian Journal of Botany 41: 183–198.

PAUL M. CATLING

University of Toronto
Department of Botany
Toronto, Ontario M5S 1A1

Received 2 December 1974
Accepted 8 January 1975

Habitat Use and Home Range of White-tailed Deer in Point Pelee National Park, Ontario

A study of white-tailed deer (*Odocoileus virginianus*) ecology was conducted from May 1971 to February 1972 to provide basic information for deer management in Point Pelee National Park, Essex County, Ontario. The objectives were to determine use by the deer of different habitat types and size of seasonal home ranges. Although there is an extensive literature on these aspects of deer ecology, especially for white-tailed deer in the United States, no similar information is available for white-tailed deer in Ontario.

Habitat type boundaries were based on a 1967 aerial photograph, ground observations, and the work of Maycock (1970. Ecological relationships of the forests and other upland vegetation of Point Pelee National Park, Essex County, Ontario. Report to the Director, National and Historic Parks Branch, Department of Indian Affairs and Northern Development, Ottawa. 22 pp.). Observations of deer were made using 7×35 binoculars and a Balscope Zoom 60× telescope from a vehicle and on foot from established routes. Individual deer were identified from natural markings: bucks by their characteristic antler growth and does by tail color and scars. Home ranges of individual deer were calculated by joining the outermost locations and measuring the enclosed area on maps. Movements in and out of the park were monitored at the park boundary by checking sand transects for tracks. Only qualitative estimates of food and cover availability were made. Study periods were as follows: summer, May to August; fall, October and November; and winter, December 1971 to February 1972.

Eight habitat types were recognized in the park: hackberry forest, wet forest, abandoned farmland, cedar savanna, red cedar forest, shrub, herbaceous strand, and the marsh. Hackberry forest occurs on dry sand-dune areas. Common tree species are hackberry (*Celtis occidentalis*) and red cedar (*Juniperus virginiana*) with herb robert (*Geranium robertianum*) and grasses (*Gramineae*) common understory plants. The wet forest is found on sand dunes and along sloughs. Common tree species are white elm (*Ulmus americana*) and silver maple (*Acer saccharinum*) with jewelweed (*Impatiens capensis*) and water horehound (*Lycopus uniflorus*) common understory plants. Abandoned farmland occurs on dry open areas. Grasses are abundant with sumac (*Rhus* spp.) and dogwoods (*Cornus* spp.) occurring frequently. Although having similar vegetation, cedar savanna is a distinct habitat type from red cedar forest because of the isolation of the former on a narrow strip of land between the marsh and Lake Erie. Vegetation common in both habitat types includes red cedar, sumac, dogwoods, wild grape (*Vitis* spp.), and grasses. The shrub habitat type occurs on an area of low sand dunes and along sloughs. Horsetails (*Equisetum* spp.) are abundant with sumac, dogwoods, and grasses occurring frequently. The herbaceous strand occurs on dry open areas. Red cedar, hop tree (*Ptelea trifoliata*), and grasses are typical plants. In the marsh, cattails (*Typha* spp.) are the dominant vegetation.

A summary of the distribution of deer observations, expressed as a percentage for each season, and ratios of the intensity of habitat use are given in Table 1. The preferred seasonal habitats were red cedar forest and shrub, and in summer, abandoned farmland. The remaining habitats were avoided. Preferred seasonal habitats of individual deer are not given because too few observations are available for each animal. Each individual had a home range occupying parts of two or more habitat types.

Seasonal home ranges of five bucks and two does are given in Table 2. The ages of the deer were unknown; therefore, age as a possible factor influencing home range cannot be discussed. The home range data in Table 2 support the findings of other studies on deer movements that bucks have larger home ranges than does in summer and winter. In the fall, however, the reverse was true. This cannot have been as a result of underestimation of home ranges of bucks on the edge of the park, as there was no movement of deer across the park boundary.

A hierarchy was observed among the bucks during the winter. The sequences of the aggressive displays at this time were as described by Thomas, Robinson, and Marburger (1965. Social behavior in a white-tailed deer herd containing hypogonadal males. Journal of Mammalogy 46: 314–327) for bucks in Texas. Buck number 2, the dominant buck, was also the largest buck in the herd. Buck number 1 was dominant to buck number 3 and both these deer were dominant to buck number 4, the smallest of the four bucks seen in win-

TABLE 1 — Observations on distribution of deer and intensity of deer use of habitat types in Point Pelee National Park, summer and fall 1971 and winter 1971/72

Habitat types	Percent of total land area[1]	Summer: Deer observed, %	Summer: Intensity of use[2]	Fall: Deer observed, %	Fall: Intensity of use	Winter: Deer observed, %	Winter: Intensity of use
Hackberry forest	44	9	0.2	29	0.6	30	0.7
Wet forest	18	15	0.8	13	0.7	16	0.9
Abandoned farmland	18	50	2.8	22	1.2	11	0.6
Cedar savanna	6	3	0.5	0	0	0	0
Red cedar forest	6	20	3.3	28	4.5	37	6.2
Shrub	2	3	1.5	8	4.0	6	3.0
Herbaceous strand	4	0	0	0	0	0	0
Marsh[3]	0	0	0	0	0	0	0
Total observations of deer		290		173		326	
Total hours observing		295		154		141	

[1] Car parks occupy 2% of the land of 1000 acres.
[2] Intensity of use equals percentage of deer observations in habitat type/percentage area occupied by habitat type. Values greater than 1.0 indicate preference; values less than 1.0 indicate avoidance.
[3] Area of about 2500 acres.

TABLE 2 — Home ranges of deer in Point Pelee National Park during the summer and fall of 1971 and winter of 1971/72

Deer, sex and number	Number of observations	Time interval	Home range, acres
		Summer	
Buck 1	17	17 May–13 August 1971	142
Buck 2	19	17 May–13 August 1971	182
Buck 3	28	13 June–24 August 1971	141
Buck 5	30	24 June–25 August 1971	50
Doe 1	14	16 June–27 July 1971	17
Doe 2	14	13 June–27 July 1971	31
		Fall	
Buck 3	6	31 October–21 November 1971	25
Buck 5	5	8 October–27 October 1971	69
Doe 1	27	1 October–24 November 1971	98
Doe 2	7	10 October–13 November 1971	66
		Winter	
Buck 1	8	12 December 1971–11 February 1972	405
Buck 2	18	3 December 1971–12 February 1972	440
Buck 3	5	3 December 1971–28 January 1972	296
Buck 4	8	3 December 1971–12 February 1972	183
Doe 1	28	9 December 1971–21 February 1972	109
Doe 2	23	9 December 1971–21 February 1972	89

ter. The size of the winter home ranges paralleled the position of the animal in the dominance hierarchy (Table 2). A hierarchy was not observed among the bucks during the summer. During the fall the bucks were apparently solitary.

The deer were more easily observed in winter than in the fall or summer. Changing cover conditions and increased deer mobility for the purpose of searching for food, especially in winter, may have biased the results shown in Tables 1 and 2.

Availability of food and cover were the primary factors influencing habitat preference. The red cedar forest and shrub habitat types were preferred because they provided dense cover, afforded by the red cedar stands, dogwood, and sumac thickets. An adequate food supply was available in the red cedar and shrub habitat types during the summer and fall but the winter food supply in these areas was overutilized. The abandoned farmland habitat type was preferred in summer because of the availability of cover and herbaceous food. The decline in use of this habitat type by deer in the fall and winter was associated with reduced availability of both these requirements. The low intensity of deer use of the cedar savanna and herbaceous strand habitat types in summer was probably caused in part by park visitors since these habitats were adjacent to the beaches. In the fall and winter the sparse cover on these exposed areas did not provide adequate shelter and so were completely avoided. Deer were not observed in the marsh although tracks were seen there in winter when it was frozen. The marsh was little used because it lacked preferred food plants and had soft wet soil which is usually avoided by deer. The hackberry and wet forest habitat types were also avoided because food plants were scarce and cover inadequate, especially in winter.

In winter, dominant bucks had larger home ranges than subordinates. During the summer, however, the abundance of food and cover may preclude aggressive encounters over range. The influence of the rut in early November on home range size was not obvious. At that time the home range of a buck would be expected to increase from pursuit of does. Possibly, the small home range of buck number 3, a subordinate animal, was caused by the aggressive behavior of the dominant bucks. The home range of buck number 5 was not influenced by rutting behavior as he died before the rut began.

The restricted home range of doe number 1 (Table 2) was attributed to nursing of fawns. Doe number 2 did not have fawns so her movements were less restricted. The larger size of the fall home range of each doe probably resulted from pursuit by bucks during the rut and reduction in the availability of cover and food. The larger home range of doe number 1 than doe number 2 in winter most likely reflects the additional forage needs of her fawns.

Home ranges were larger during the winter because the reduced availability of food in the preferred habitat types with good shelter caused the deer to forage further from these areas. The deer did not yard as snowfall was light and did not restrict their movements. Management of deer within the park would require the protection of habitat types affording both preferred forage and cover and sites with good cover and adjacent forage.

Acknowledgments

This paper is based on part of a thesis submitted to the University of Western Ontario for a Master of Science degree. The study was financed by a contract with the Department of Indian Affairs and Northern Development, National and Historic Parks Branch, Ottawa, and was directed by Dr. W. N. Holsworth, Department of Zoology, University of Western Ontario. I am grateful to Dr. K. R. Ashby and Dr. P. R. Evans, Department of Zoology, University of Durham, for their critical reading of the manuscript.

BYRON A. M. HENRY

Department of Zoology
University of Western Ontario
London, Ontario
Present address: Department of Zoology
University of Durham, Durham DH1 3L3, England

Received 21 December 1973
Accepted 26 November 1974

Amphipod Dispersal in the Fur of Aquatic Mammals

Most studies of the freshwater invertebrate faunas of Canada have been concerned with systematics and present-day distribution. The dynamics of how the fauna reached this distribution following glacial retreat has less often been considered (see Dadswell 1974). Undoubtedly, many species, such as various crustaceans, attained much of their present distribution by active dispersal along waterways. But there are many isolated lakes in Canada in small, closed drainage basins that do not have outflowing waters. The presence of crustaceans in such lakes implies the past existence of connecting waterways through which the fauna actively dispersed, or implies active or passive overland dispersal.

Passive overland dispersal of crustaceans has usually involved such suggested mechanisms as wind-blown eggs, and eggs transported in mud carried by animals (Pennak 1953). Little direct observational or experimental proof for such ideas exists, however, especially on the ability of most crustacean eggs to withstand desiccation. Nevertheless, it has been shown that some crustaceans may be distributed as eggs carried in the digestive tracts of animals. Crayfish are possible overland dispersal agents for eggs of fairy shrimp (Moore and Faust 1972), and water fowl and shorebirds have been shown to carry viable anostracan eggs in their digestive tracts (Proctor 1964; Proctor et al. 1967).

Rosine (1956) reported *Hyallela azteca* amphipods in the feathers of ducks, and Segerstråle (1954) reported on experiments in which adult *Grammarus lacustris* amphipods hid themselves for up to 2 h in duck feathers, thus favoring the possibility that the amphipods could be carried to other bodies of water. I would like to add another observation of this sort, which may have some bearing on aquatic mammals and their potential to disperse adult amphipods.

On 30 June 1972, about midnight, I shot a beaver and a muskrat in a small lake, just north of the eastern end of Nahanni National Park, Northwest Territories (61°34′ N, 124°02′ W). The mammals were shot about 30 to 40 feet from shore in fairly shallow water. They were immediately retrieved and brought to shore by being snagged with a treble hook on a fishing line, and were then immediately placed in individual plastic garbage bags so that they could be examined in daylight for ectoparasites in the fur.

What was found in the fur the next day was not the hoped-for ectoparasites but amphipods. Ten *Hyallela azteca* (Saussure) were recovered from the fur of the muskrat, and six *H. azteca* and 21 *Gammarus lacustris* G. O. Sars were recovered from the fur of the beaver. The amphipods were between the guard hairs and deep in the underfur of both mammals.

It is possible that the amphipods were not associated with the mammals when they were shot, but crawled onto them afterwards when they were dragged through the emergent vegetation at the edge of the lake. In the daytime, amphipods were observed to be very abundant in this emergent vegetation. Since beaver and muskrat frequently come to shore for feeding, however, many opportunities are present for amphipods to associate themselves in the mammals' fur.

These two species of amphipods are widely spread through Canada (Bousfield 1958; Holsinger 1972). I do not know how frequently they occur in isolated bodies of water, but the fact that their behavior may include the habit of hiding in the fur of aquatic mammals suggests that the amphipods could be carried into new bodies of water when the mammals travel overland.

I thank the National and Historic Parks Branch, Department of Indian and Northern Affairs for field support for two weeks in and near Nahanni National Park. My emphipod determinations were checked by E. L. Bousfield and he and H. F. Howden critically read the manuscript.

Literature Cited

Bousfield, E. L. 1958. Fresh water amphipod crustaceans of glaciated North America. Canadian Field-Naturalist 72: 55–113.

Dadswell, M. J. 1974. Distribution, ecology, and postglacial dispersal of certain crustaceans and fishes in eastern North America. National Museum of Natural Sciences, Publications in Zoology, Number 11. 89 pp.

Holsinger, J. R. 1972. The freshwater amphipod crustaceans (Gammaridae) of North America. Biota of freshwater ecosystems. Identification Manual Number 5. U.S. Environmental Protection Agency. 89 pp.

Moore, W. G. and **B. F. Faust.** 1972. Crayfish as possible agents of dissemination of fairy shrimp into temporary ponds. Ecology 53: 314–316.

Pennak, R. W. 1953. Fresh water invertebrates of the United States. Ronald Press, New York. 769 pp.

Proctor, V. W. 1964. Viability of crustacean eggs recovered from ducks. Ecology 45: 656–658.

Proctor, V. W., E. R. Malone, and **V. L. DeVlaming.** 1967. Dispersal of aquatic organisms: Viability of diseminules recovered from the intestinal tract of captive Killdeer. Ecology 48: 672–676.

Rosine, W. 1956. On the transport of the common amphipod, *Hyallela azteca*, in South Dakota by the Mallard duck. Proceedings of the South Dakota Academy of Sciences 35: 203. (Not seen.)

Segerstråle, S. 1954. The freshwater amphipods, *Gammarus pulex* (L.) and *Gammarus lacustris* G. O. Sars, in Denmark and Fennoscandia — A contribution to the late- and post-glacial immigration history of the aquatic fauna of northern Europe. Societas Scientifica Fennica Commentationes Biologicae 15: 1–91.

STEWART B. PECK

Department of Biology
Carleton University
Ottawa, Ontario K1S 5B6

Received 23 December 1974
Accepted 11 January 1975

The Giant Cow Parsnip, *Heracleum mantegazzianum* Umbelliferae, in Canada

The discovery of *Heracleum mantegazzianum* Sommier & Levier along the banks of the Saugeen River in and around the village of Tara, in Bruce County of Ontario, is worthy of note. This species can readily be distinguished from our native *H. maximum* Bartram and our other alien *H. sphondylium* Linnaeus by its enormous size. The plant on occasions reaches 5 m in height and at Tara is usually about 2½ to 3 m, with fruiting umbels up to 50 cm across and hollow stems up to 10 cm thick (See Figures 1 and 2). *Heracleum maximum* is usually about 1.5 m high rarely attaining nearly 3 m, has umbels under 20 cm across, and stems up to 4 cm thick. *Heracleum sphondylium* that I have seen growing in North America is a weed of more open places and rarely reaches 1 m high with umbels under 15 cm and stems up to 2 cm thick. In Europe it sometimes attains a larger size. Apart from its large size, the diagnostic characters which separate *H. mantegazzianum* from the other two species are its large elliptic fruits (ca. 13 mm long) in which the vittae (resin canals) are greatly swollen and over 1 mm broad. In the other two species the fruit only reaches 8 mm in length and the vittae are only slightly swollen to less than half this width. *Heracleum mantegazzianum* is a native of the Caucasus, and has been introduced into cultivation as an ornamental in many parts of Europe and become naturalized, especially along river banks. The only reference that I have encountered to its occurrence in North America is a comment by D. H. French (1971. Ethnobotany of the Umbelliferae. *In* The biology and chemistry of the Umbelliferae. *Edited by* V. H. Heywood. Academic Press) that it is sometimes planted as an ornamental. I have not been able to ascertain why or when it was introduced into the Tara area but presumably this was done, as in other countries, because of the remarkable size of the plant which makes it a garden curiosity. The Saugeen Valley was settled over 100 years ago as an agricultural area, the land being "of the very best quality (Anonymous. 1880. Illustrated atlas of the County of Bruce. H. Belden and Co. Offset edition, Port Elgin, 1970). Thriving farming communities with accompanying craft industries soon developed, and with them came a

FIGURE 1 — Giant cow parsnip plants, Bruce County, Ontario.
FIGURE 2 — Umbels of giant cow parsnip.

TABLE 1 — Measurements of Snow Geese collected at the McConnell River and of Greater Snow Geese

	Parameter		
	Culmen (mm)	Tarsus (mm)	Body weight (gm)
CDA 658	67	95	3130
Range (and mean) of other McConnell River males	54–64 (58) N = 125	76–94 (84) N = 125	2130–2410 (2290) N = 6[a]
Range (and mean) of *A. c. atlantica*[b]	59–73 (67)	86–97 (92)	—

[a] Only males collected at end of wing molt are included. Average culmen and tarsus measurements, 57 mm and 83 mm, indicate that this small sample was representative of McConnell River males.
[b] From Godfrey 1966.

more likely however, that it was an *atlantica* which had mated with a McConnell River *caerulescens*. Mating of Snow Geese occurs on the wintering ground or during spring migration (Prevett 1973). I have no knowledge of *atlantica*'s wintering on the Gulf Coast but the following observations indicate that McConnell River *caerulescens* do occur in at least two areas traditionally frequented by *atlantica*.

In 1971, aluminum neckbands bearing fluorescent orange tape were put on 2500 adult female *caerulescens* at McConnell River. On 4 and 5 November one of these females was seen, accompanied by two other Snow Geese, on Schroon Lake in eastern New York (Eric Fried, *in litt.*). On 11 October and 9 November a Snow Goose with a fluorescent orange neckband was observed on Mattamuskeet National Wildlife Refuge in eastern North Carolina (F. A. Williams, *in litt.*). These observations indicate how a male *atlantica* could have the opportunity to mate with a female *caerulescens*. Cooke et al. (*in press*) present evidence that female Lesser Snow Geese are faithful to their colony of origin, but males apparently follow the female of their choice.

Research was supported by a contract between my supervisor, R. J. Planck and the Canadian Wildlife Service. I thank D. M. Scott for helpful suggestions concerning this note.

Literature Cited

American Ornithologists' Union. 1973. 32nd supplement to the A.O.U. checklist of North American birds. Auk 90: 411–419.

Ankney, C. D. 1974. The importance of nutrient reserves to breeding blue geese, *Anser caerulescens*. Ph.D. thesis, University of Western Ontario, London. 232 pp.

Cooke, F. G., C. D. MacInnes, and **J. P. Prevett.** Gene flow between breeding populations of the Lesser Snow Goose. Auk. *In press.*

Godfrey, W. E. 1966. The birds of Canada. National Museum of Canada Bulletin 203. 428 pp.

Prevett, J. P. 1973. Familial and age-dependent behavior of blue geese, *Anser caerulescens*. Ph.D. thesis, University of Western Ontario, London. 194 pp.

Sokal, R. R. and **F. J. Rohlf.** 1969. Biometry. W. H. Freeman, San Francisco, California. 776 pp.

C. DAVISON ANKNEY

Department of Zoology
University of Western Ontario
London, Ontario N6A 3K7

Received 19 August 1974
Accepted 29 November 1974

Record of the Alga *Hydrurus foetidus* (Vill.) Trèv. from Labrador

Hydrurus Agardh (1824) is the only genus of the family Hydruraceae of the division Chrysophyta (West and Fritsch 1927; Smith 1950; Fritsch 1965). This alga is monospecific with only one species, *H. foetidus* (Vill.) Trèv. Cushman (1904, 1907), Taylor and Fogg (1927), Taylor (1933, 1934), and Woodhead and Tweed (1960) did not report the occurrence of *Hydrurus* from Labrador. This note is to document the presence of *H. foetidus* (Figure 1) from a small slow stream between Duley Lake and Labrador City, 52°57′ N and 65°55′ W, during the month of June 1970. The temperature of the water at the time of collection was 4.5°C. The alga is

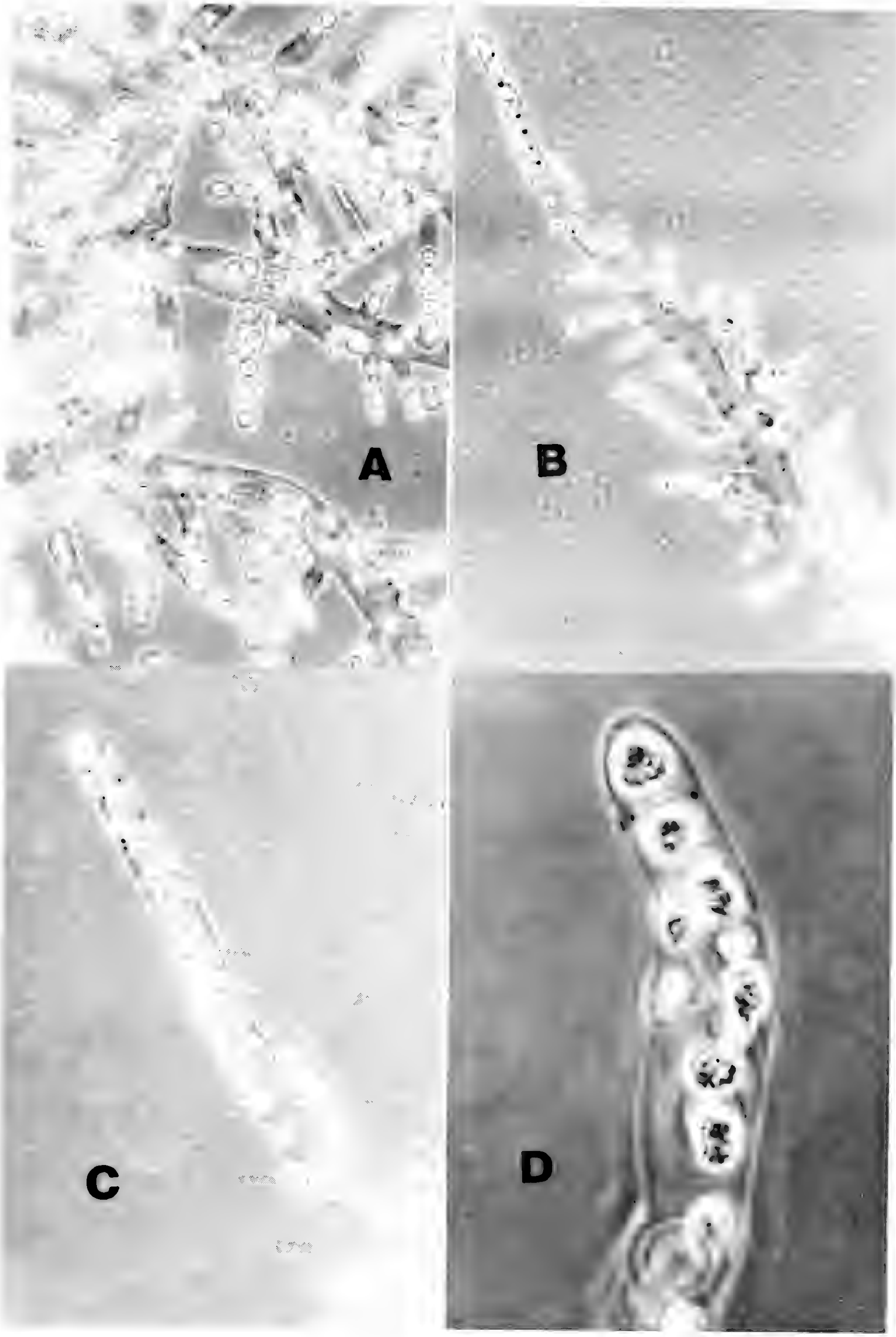


FIGURE 1. *Hydrurus foetidus* (Vill.). A, Part of the colony (× 72.5); B, Branch of a colony (× 72.5); C, Tip of a branch with numerous cells (× 700); D, Cells with a chloroplast and pyrenoid (× 1750).

TABLE 1 — Measurements of Snow Geese collected at the McConnell River and of Greater Snow Geese

	Parameter		
	Culmen (mm)	Tarsus (mm)	Body weight (gm)
CDA 658	67	95	3130
Range (and mean) of other McConnell River males	54–64 (58) N = 125	76–94 (84) N = 125	2130–2410 (2290) N = 6[a]
Range (and mean) of *A. c. atlantica*[b]	59–73 (67)	86–97 (92)	—

[a] Only males collected at end of wing molt are included. Average culmen and tarsus measurements, 57 mm and 83 mm, indicate that this small sample was representative of McConnell River males.
[b] From Godfrey 1966.

more likely however, that it was an *atlantica* which had mated with a McConnell River *caerulescens.* Mating of Snow Geese occurs on the wintering ground or during spring migration (Prevett 1973). I have no knowledge of *atlantica*'s wintering on the Gulf Coast but the following observations indicate that McConnell River *caerulescens* do occur in at least two areas traditionally frequented by *atlantica.*

In 1971, aluminum neckbands bearing fluorescent orange tape were put on 2500 adult female *caerulescens* at McConnell River. On 4 and 5 November one of these females was seen, accompanied by two other Snow Geese, on Schroon Lake in eastern New York (Eric Fried, *in litt.*). On 11 October and 9 November a Snow Goose with a fluorescent orange neckband was observed on Mattamuskeet National Wildlife Refuge in eastern North Carolina (F. A. Williams, *in litt.*). These observations indicate how a male *atlantica* could have the opportunity to mate with a female *caerulescens.* Cooke et al. (*in press*) present evidence that female Lesser Snow Geese are faithful to their colony of origin, but males apparently follow the female of their choice.

Research was supported by a contract between my supervisor, R. J. Planck and the Canadian Wildlife Service. I thank D. M. Scott for helpful suggestions concerning this note.

Literature Cited

American Ornithologists' Union. 1973. 32nd supplement to the A.O.U. checklist of North American birds. Auk 90: 411–419.

Ankney, C. D. 1974. The importance of nutrient reserves to breeding blue geese, *Anser caerulescens.* Ph.D. thesis, University of Western Ontario, London. 232 pp.

Cooke, F. G., C. D. MacInnes, and **J. P. Prevett.** Gene flow between breeding populations of the Lesser Snow Goose. Auk. *In press.*

Godfrey, W. E. 1966. The birds of Canada. National Museum of Canada Bulletin 203. 428 pp.

Prevett, J. P. 1973. Familial and age-dependent behavior of blue geese, *Anser caerulescens.* Ph.D. thesis, University of Western Ontario, London. 194 pp.

Sokal, R. R. and **F. J. Rohlf.** 1969. Biometry. W. H. Freeman, San Francisco, California. 776 pp.

C. DAVISON ANKNEY

Department of Zoology
University of Western Ontario
London, Ontario N6A 3K7

Received 19 August 1974
Accepted 29 November 1974

Record of the Alga *Hydrurus foetidus* (Vill.) Trèv. from Labrador

Hydrurus Agardh (1824) is the only genus of the family Hydruraceae of the division Chrysophyta (West and Fritsch 1927; Smith 1950; Fritsch 1965). This alga is monospecific with only one species, *H. foetidus* (Vill.) Trèv. Cushman (1904, 1907), Taylor and Fogg (1927), Taylor (1933, 1934), and Woodhead and Tweed (1960) did not report the occurrence of *Hydrurus* from Labrador. This note is to document the presence of *H. foetidus* (Figure 1) from a small slow stream between Duley Lake and Labrador City, 52°57′ N and 65°55′ W, during the month of June 1970. The temperature of the water at the time of collection was 4.5°C. The alga is

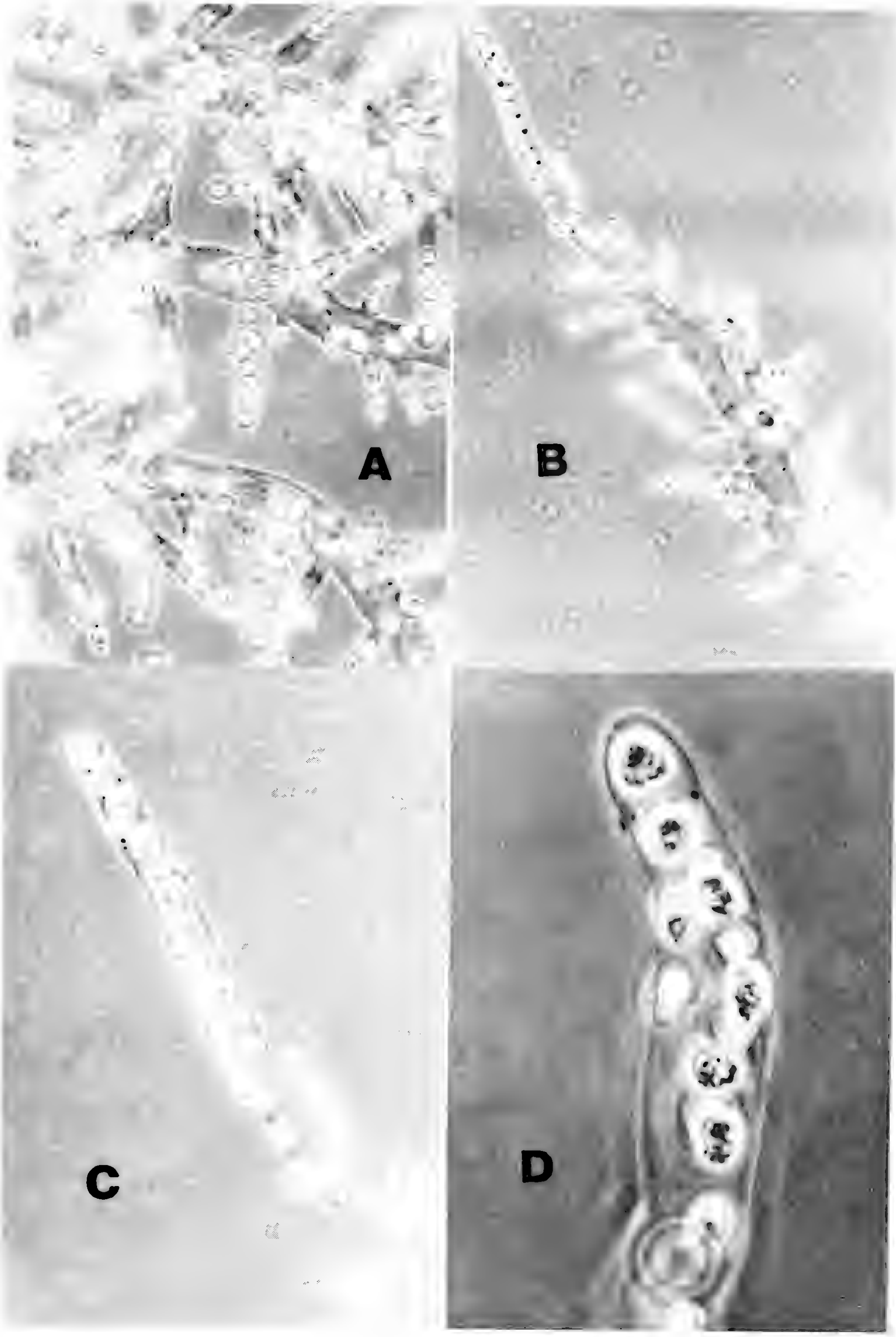


FIGURE 1. *Hydrurus foetidus* (Vill.). A, Part of the colony (× 72.5); B, Branch of a colony (× 72.5); C, Tip of a branch with numerous cells (× 700); D, Cells with a chloroplast and pyrenoid (× 1750).

colonial with olive-green color, is mucilaginous and attached to small stones. The cells are embedded in an irregularly profusely branched, gelatinous thallus with a colony length of 7 to 31 cm, which is different from the reported colony length of 30 cm by Fritsch (1965) and Bourrelly (1968). The cells are numerous, oval, ellipsoid to fusiform, with a golden-brown chloroplast and a visible pyrenoid which is generally oriented on the side of the cell toward the thallus apex. In the apical regions and the branches of the young thallus the cells are uni- or bi-seriately arranged. Several granules of food and one to six vacuoles are found to be present in the colorless portion of the cytoplasm of the cellule.

In conclusion, the authors thank Dr. Stan Frost, Department of Biology, University of Salford, Salford, England, for supplying the material. This work was supported partly by the Memorial University of Newfoundland, St. John's, Newfoundland, and the Research Council of the University of Moncton. We are indebted to Professor Marshall Laird for his continued support and help.

Literature Cited

Bourrelly, P. 1968. Les algues d'eau douce. Tome II – Les algues jaunes et brunes, Chrysophycées, Xanthophycées et Diatomées. Editions N. Boubée & Cie, Paris VI. p. 438.

Fritsch, F. E. 1965. The structure and reproduction of the algae. Volume I. University Press, Cambridge. p. 791.

Cushman, J. A. 1904–1907. Desmids from Newfoundland. Bulletin of the Torrey Botanical Club 31: 580–584; 33: 607–615.

Smith, G. M. 1950. The fresh-water algae of the United States. McGraw-Hill Book Company, New York. pp. 719.

Taylor, W. R. and **J. M. Fogg, Jr.** 1927. Notes on Newfoundland. Papers of the Michigan Academy of Sciences, Arts and Letters 403: 217–278; 482: 185–230.

Taylor, W. R. and **J. M. Fogg Jr.** 1927. Notes on some fresh-water algae from Newfoundland. Rhodora 29: 160–164.

West, G. S. and **F. E. Fritsch.** 1927. A treatise on the British fresh-water algae. Cambridge University Press. p. 534.

Woodhead, N. and **R. D. Tweed.** 1960. Additions to the algal flora of Newfoundland. Hydrobiologia 15: 309–361.

J. S. S. LAKSHMINARAYANA
J. SITA DEVI

Department of Biology
University of Moncton
Moncton, New Brunswick E1A 3E9

Received 7 October 1974
Accepted 21 December 1974

An Unusually Small Hermit Thrush Egg

There are few reports of the occurrence of unusually small eggs in nature. Rothstein (1973) concluded that this phenomenon was rare in three species of songbird he studied. This note reports the finding of a small Hermit Thrush, *Catharus guttatus faxoni* (Bangs and Penard), egg in Antigonish County, Nova Scotia.

On 17 June 1974 a nest was found containing two normal eggs (25.4 × 17.0 mm and 25.0 × 17 mm) and one abnormally small egg (18.5 × 12.5 mm). Bent (1949) reported that the average diameters of 40 eggs was 22.1 × 16.8 mm and the low extreme was 20.8 × 15.8 mm. The small egg contained only albumen and although no measurement was made, the contents appeared to occupy most of the volume of the egg. Nine eggs in three other nests were normal and Tufts (1961) does not report the occurrence of small eggs in 23 nests investigated in Nova Scotia. Neither Tufts nor Bent (1949) report this phenomenon in other thrush species.

Literature Cited

Bent, A. C. 1949. Life histories of North American thrushes, kinglets, and their allies. U.S. National Museum Bulletin 196: vii.

Rothstein, S. I. 1973. The occurrence of unusually small eggs in three species of songbirds. Wilson Bulletin 85(3): 340–342.

Tufts, R. W. 1961. The birds of Nova Scotia. Nova Scotia Museum, Halifax. 481 pp.

NORMAN R. SEYMOUR

Department of Biology
St. Francis Xavier University
Antigonish, Nova Scotia

Received 3 September 1974
Accepted 14 January 1975

More Dwarf Passerine Eggs

In the current number of this journal, Norman R. Seymour records a dwarf egg of the Hermit Thrush, *Catharus guttatus*. He and S. I. Rothstein (1973. The occurrence of unusually small eggs in three species of songbirds. Wilson Bulletin 85(3): 340–342) conclude that dwarf eggs are rare in nature.

A quick and incomplete check of eggs of passerines in the collection of the National Museum of Natural Sciences disclosed six additional instances involving five species as follows:

Eastern Kingbird. *Tyrannus tyrannus*. A set of three eggs (Cat. No. E719) taken at Napanee, Ontario, in June 1897 by T. McCaugherty contains one dwarf egg which measures 12.4 × 10.1 mm. A single egg (E3085) collected at Cote St. Luc, Quebec, on 16 June 1898 by L. M. Terrill is abnormally small (20.0 × 15.4 mm).

Gray Catbird. *Dumetella carolinensis*. A set of four eggs (E731) taken at Gaspereau, Nova Scotia, on 11 June 1902 by Robie W. Tufts contains two small eggs measuring 16.5 × 13.1 and 22.6 × 16.4 mm respectively.

Veery. *Catharus fuscescens*. No. E3820 is a single egg collected on 29 June 1897 (no locality) by L. M. Terrill. This dwarf egg measures 16.5 × 13.3 mm.

Magnolia Warbler. *Dendroica magnolia*. No. E3702, two addled eggs collected from a nest at St. Margaret, Quebec, on 29 June 1913 by L. M. Terrill. Both are dwarf eggs measuring 13.1 × 10.0 and 12.2 × 9.6 mm respectively.

Lincoln's Sparrow. *Melospiza lincolnii*. No. E3821, two eggs taken at Métis, Quebec on 14 June 1922 by L. M. Terrill. One is a dwarf egg (12.4 × 10.0 mm).

W. EARL GODFREY

National Museum of Natural Sciences
Ottawa, Ontario K1A 0M8

Received 22 January 1975
Accepted 22 January 1975

The Auricled Twayblade *(Listera auriculata)* Orchid in Algonquin Park, Ontario

The discovery of a station of the auricled twayblade (*Listera auriculata* Wiegand) in Algonquin Provincial Park in 1974 represents the second record of this orchid in southern Ontario. H. N. MacKenzie and E. W. Greenwood (1969. Range extensions of *Listera auriculata* Wiegand in Ontario and Quebec. Canadian Field-Naturalist 83: 55–56) described the first southern Ontario record, from the vicinity of Barry's Bay, Renfrew County. That station is 68 km southeast of the new one in Algonquin Park. They stated that the plant is known primarily as a western species, being found only sparingly in northern Ontario and Quebec.

Our specimen label for this second record gives the following data:

Ontario: Algonquin Provincial Park (Nipissing District), Bronson Twp; Schooner Rapids, Petawawa River; on shore at SE corner of bridge 45°02.5′ N, 77°47.5′ W.

Habitat: on moist, sandy flood-plain; on open ground beneath shade of alders; with *Habernaria flava, H. psycodes*.

Status: 127 plants, past peak of flower. *D. F. Brunton & W. J. Crins 747 (DAO)*. 16 July 1974, Algonquin Park Herbarium No. 316.

None of the specimens noted had set seed, but as suggested on the label, virtually all were past the peak of flowering, though probably only by a couple of days. All plants were found just above the spring high-water mark which was noticeable by the accumulation of vegetative debris. The habitat of this station conforms remarkably well with that described for the species in F. W. Case's *Orchids of the Western Great Lakes Region* (1964. Cranbrook Institute of Science, Bloomfield Hills, Michigan): "Very distinctive — raw, alluvial sand along rivers. Plants develop at about the high flood water line in sandy wash under alders; often . . . in surprisingly open situations."

It may be that the low diversity of plants in groves of alder (*Alnus rugosa* (Du Roi) Spreng.) in this area has had the effect of discouraging botanists from checking them. For this reason, *L. auriculata* could well be more common in southern Ontario than the very few records would suggest.

We should also mention that the status of the southern Quebec station reported by MacKenzie and Greenwood (1969. *loc. cit.* p. 55) has changed. Subsequent investigations of the stream by which the three plants were found has uncovered several hundred additional specimens; approximately 300 were found on 17 June 1972 by J. D. Lafontaine, P. D. Pratt, R. D. Strickland, and D. F. Brunton.

DANIEL F. BRUNTON[1]
WILLIAM J. CRINS[2]

[1] Algonquin Park Museum
Ontario Ministry of Natural Resources
Box 219
Whitney, Ontario K0J 2M0
[2] 1336 Bunnell Drive
Burlington, Ontario L7P 2E1

Received 21 November, 1974
Accepted 17 December, 1974

Rough-legged Hawks, *Buteo lagopus* (Pontoppidan) as Carrion Feeders in the Arctic

The Rough-legged Hawk is not normally a carrion feeder in the Arctic. Victoria Island birds, referred to the race *Buteo lagopus sanctijohannis,* are known to feed on lemmings (*Dicrostonyx groenlandicus* and *Lemmus trimucronatus*) and small birds (Parmelee, D. F., H. A. Stephens, and R. H. Schmidt. 1967. The birds of southeastern Victoria Island and adjacent small islands. National Museum of Canada Bulletin 222: 1–229).

On several occasions during May and June 1974, I observed members of this species feeding on carcasses of animals left by the Inuit hunters. Three mature birds were seen feeding on the carcasses of two caribou (*Rangifer tarandus*) that had been cached on the sea ice 30 miles southeast of Holman, Victoria Island, Northwest Territories. These birds observed at the site on 17 and 18 May were apparently occupying cliff nesting-sites nearby.

Rough-legged Hawks were also seen feeding on ringed seal carcasses (*Phoca hispida*) that were left on the sea ice by Inuit hunters. Up to three adult hawks occupied one area containing five seal carcasses for approximately 10 days from first observation on 17 May. This site was located near an open lead in the fast ice approximately 6 miles from the nearest land. On one occasion a single adult hawk was seen defending a seal carcass from a number of Glaucous Gulls (*Larus hyperboreus*).

In the preceding three springs spent in the Holman area I did not observe Rough-legged Hawks feeding on carrion. Observations at their nests in the summer show them to feed mainly on lemmings and small birds. It is probable that carrion becomes an important food item only when their normal prey species are scarce. The hawks, one of the earliest spring migrants to these latitudes, usually begin arriving in the Holman area in mid-April. In late seasons such as the spring of 1974, small mammals are probably more difficult to obtain and small birds have not yet arrived. A peak population of arctic fox (*Alopex lagopus*) was present in the spring of 1974, and this might have also reduced the number of lemmings available to the hawks.

The ability of Rough-legged Hawks to feed on carrion is probably an important adaptation to survival in late Arctic springs.

THOMAS G. SMITH

Arctic Biological Station
Fisheries and Marine Service
P.O. Box 400
Ste. Anne de Bellevue, Quebec H9X 3L6

Received 21 October, 1974
Accepted 4 December, 1974

News and Comment

Canadian Presented Seth Gordon Award

Hoyes Lloyd, the first person appointed to administer the Migratory Birds Convention Act after it was passed in 1917, was awarded the 1974 Seth Gordon Award by the International Association of Game, Fish and Conservation Commissioners. The award, the highest honor conferred by the association, is presented each year to a person who has made a unique contribution to fish or wildlife conservation in North America.

Mr. Lloyd is the first Canadian to win both the Seth Gordon Award and the Leopold Award. He was presented the Leopold Award, the highest honor given by The Wildlife Society, in 1956.

Mr. Lloyd's federal involvement with wildlife conservation began in 1918 when he won a competition as head of the Migratory Birds Unit in the Department of the Interior. This unit, the predecessor of the Canadian Wildlife Service, was set up to manage and protect migratory birds in Canada under the Migratory Birds Convention Act. His duties also included administering the Northwest Game Act. In 1919, he was named Supervisor of Wildlife Protection and given charge of wildlife in Dominion parks. He held this post until his retirement in 1943.

During his years as Supervisor of Wildlife Protection, Mr. Lloyd laid much of the groundwork of today's wildlife administration. Working at first with no staff, he set about administering the two acts, both new and different from earlier legislation. He launched a publicity campaign to familiarize hunters and provincial government officials with the new laws. He was secretary to the first federal-provincial wildlife conference in 1922 and played a significant role in succeeding conferences. He sought and secured the co-operation of U.S. federal government officials, necessary for good migratory bird management in North America. He planned and set up over 60 migratory bird sanctuaries across Canada. He worked with various sportsmen and wildlife groups to gain their support for migratory bird and game protection and management programs. He wrote numerous bird and wildlife pamphlets which were distributed in public schools across the country.

Much of his leisure time over the years has also centered around wildlife conservation. While he was Supervisor of Wildlife Protection, he and his wife were active in The Ottawa Field Naturalists' Club; Mr. Lloyd, and his late wife, Wilmot Lloyd were both appointed honorary members of the club some years ago. He also has the distinction of being both an honorary boy scout and girl guide for his work in wildlife among young people.

His first contact with the International Association of Game, Fish and Conservation Commissioners came in 1922 when he attended the association's 16th annual meeting. In 1929, he was president for one year and is now an honorary member.

White Owl Grants

1. *Project Jonah*

Author Farley Mowat, president of Project Jonah Canada, on 21 January 1975 accepted a \$2500 grant from the White Owl Conservation Awards Committee. The money will give Project Jonah's work for 1975 a vital boost.

An international organization, Project Jonah is intent on preventing further slaughter of whales and other cetaceans such as dolphins and porpoises. Representations to the International Whaling Commission, and to the major whaling nations — Japan and Russia — have not succeeded in winning a complete moratorium on commercial whaling.

The Canadian chapter has worked with Environment Canada to stop whaling on the east coast, and successfully opposed "sport fishing" of the beluga in Hudson Bay. There is now no commercial whaling in Canadian waters, or by Canadian-based companies, but just outside Canadian waters, the whaling goes on.

A resource center planned for Toronto, will offer all the information currently available on whales, or next best, will tell where one can find what one is looking for.

To add to the current knowledge, Project Jonah will sponsor a student study this summer of the feeding and travel patterns of the whales found in the St. Lawrence River near the mouth of the Saguenay.

If you wish to contact Project Jonah, write to 629 Lonsdale Road, Apt. 1, Toronto M5P 1R8.

2. *Ancient Quebec mountain range — a potential nature circuit*

The White Owl Conservation Awards Committee granted $2500 for a feasibility study to augment a chain of Quebec parks. Dr. Michel Famelart, Associate Professor of Botany at the University of Montreal, will be in charge of the project.

The Monteregians are a chain of small mountains (average altitude is 1200 feet) of volcanic origin, stretching from Montreal approximately 60 miles east towards Sherbrooke. Of these, Mount Royal and Ste. Helen's Island are Montreal green spaces; part of Mount St. Bruno has recently been declared a park; and a major section of Mount St. Hilaire has been parkland for years.

The rest are unprotected, and two of them, Rougemont and Yamaska, are beginning to show the results of untrammeled development. Dr. Famelart would like to study these two areas, documenting their physical features and the land-use made of them. He hopes to arrive at solid arguments for their conservation.

Then with careful planning, an interesting network of nature trails could be established for hikers, cyclists cross-country skiers, and snowshoers.

Canada Ratifies Agreement on Polar Bear Conservation

Canada has ratified an international agreement for the conservation of polar bears. The agreement provides for better collaboration among the Arctic nations in the research and management of polar bears which, in their movement, cross international boundaries. It also prohibits hunting of bears in international waters, for they sometimes live on pack-ice far out at sea.

In Canada, management of polar bears is the responsibility of the provincial and territorial governments. Parts of Newfoundland, Quebec, Ontario, Manitoba, the Yukon, and the Northwest Territories are natural habitat for polar bears. These governments have concurred with Canada's ratification.

Canadian ratification is accompanied by a declaration which clarifies Canada's position on management, research, and native peoples' hunting rights. As our polar bear population is considered healthy, in the declaration there is an emphasis on sound management principles rather than on a rigid form of protection. Traditional native hunting rights are recognized in the agreement.

Predator Symposium

The American Society of Mammalogists is sponsoring a Predator Symposium in conjunction with their annual meeting being held in 1975 at the University of Montana in Missoula, 16–19 June. The three-hour symposium will be held on the afternoon of June 19. Papers concerning predator biology, behavior, and management will be presented. Potential participants are urged to submit abstracts to the symposium organizers: Dr. Chas. Jonkel, Forestry, University of Montana, or Robert L. Phillips, U.S. Fish and Wildlife Service, Drawer G, Missoula, Montana 59801, by 1 April 1975.

C.C.I.W. Conference Announcement

On 8–11 April 1975 another interesting scientific conference will be organized by the Canada Centre for Inland Waters. Its title is "International Symposium on Environmental Biogeochemistry" and it constitutes an effort to bring together several specialized scientific disciplines in order to discover how they inter-relate with each other and how their separate knowledge of the environment can be shared. Thus, biologists, microbiologists, chemists, geochemists, and soil scientists will be talking to each other in an effort to understand better our environment and man's relationship with it. It is also expected that the meeting should provide a contact point for scientists from different nations who are working on similar environmental problems.

Letters

Salamanders Collected in Ontario

Editor:

The authors of the article "Erythristic red-backed salamanders, *Plethodon cinereus*, from Ontario" which appeared in *The Canadian Field-Naturalist* 88(2): 231–232 exhibit what is an all too common fault of misguided individuals who lead youngsters on field trips. Although it is desirable to expose people to nature in order that they love and respect her, this exposure does not include the wanton and unnecessary destruction of plant and animal life. There appears to be no reason whatsoever for the destruction of 96 red-backed salamanders within two days in the Elora Gorge near Guelph, Ontario. No population study appears to have been involved in the collection of these specimens, only the search for a rare color morph. Young people do not learn principles of conservation by disturbing the habitat, which in this case appears to have been the turning over of every limestone rock that could have harbored one of these salamanders; nor do they learn conservation by collecting everything in sight.

This is not the only time that we have been aware of student field trips causing massive destruction of a habitat in the name of education. For this reason it is important that field trips be guided by responsible, experienced individuals who exercise control over their charges.

EDWARD KOTT[1] and LAIMA KOTT[2]

[1] Department of Biology, Wilfrid Laurier University, Waterloo, Ontario.

[2] Department of Botany and Genetics, University of Guelph, Guelph, Ontario.

Editor:

Unfortunately, it seems that the Kotts are mistaken on several points of fact:

1. The salamanders collected in the Elora Gorge were not "destroyed," they have been deposited in the National Museums of Canada, where I should hope they are not wasted.
2. This population is under study at the moment: I am currently studying the morph ratios of *Plethodon cinereus* in Canada, that an erythristic individual was taken is purely incidental.
3. We caused no significant disruption of habitat while collecting in this area. The students were required to replace all of the rocks they turned. Surely a practical respect for nature can be learned in this manner. Furthermore, the substrate of pine and cedar leaves was not conducive to, and only rarely showed, any differential habitat beneath the rocks.

Only a small fraction of the *Plethodon cinereus* in an area are at the surface at one time, and the removal of 105 salamanders from the Elora Gorge doubtless had no effect on the population there.

Responsible, continued collecting of large series of abundant species in poorly collected areas is imperative if our knowledge of animals is to advance. It is only by the statistical examination of data from large numbers of specimens that geographic variation and life history data can be obtained.

PAUL A. WESTELL

Editor's Note: If collection is done, it should serve a specific need, and where possible, specimens should be deposited in a collection where they are guaranteed perpetual care.

Information Concerning Content of *The Canadian Field-Naturalist*

Articles

The Canadian Field-Naturalist is a medium for publication of research papers in all fields of natural history. If possible, major articles should be illustrated.

Notes

Short notes on natural history and related topics written by naturalists and scientists are welcome. Range extensions, interesting behavior, pollution data, and other kinds of natural history observations may be offered. It is hoped, however, that naturalists will also support local natural history publications.

Letters

Letters commenting on items appearing in this journal or on any developments or current events affecting natural history and environmental values are welcome. These should be brief, clear, pertinent, and of interest to a wide audience.

News and Comment

Informed naturalists, biologists, and others are invited to present documented narratives and commentaries upon current scientific and political events that affect Canadian natural history and the environment. Contributions should be as short as possible and to the point.

Book Reviews

Normally, only solicited reviews are published. Biologists and naturalists, however, are invited to submit lists of titles (complete with pertinent information regarding authors, publisher, date of publication, illustrations, number of pages and price) for listing under "New Titles."

Special Items

As *The Canadian Field-Naturalist* has a flexible publication policy, items not covered in the traditional sections can be given a special place provided they are judged suitable.

Reviewing Policy of *The Canadian Field-Naturalist*

Manuscripts submitted to *The Canadian Field-Naturalist* are normally sent to an Associate Editor and at least one other reviewer. If their comments concerning the scientific merit and suitability of the manuscript for publication are widely divergent or if an original referee's field of competence does not cover the entire contents of the manuscript, one or two additional referees are asked to review it. Referees are requested to complete their reviews within three weeks or to return the manuscript immediately and suggest an alternate reviewer. Reviews offering a general appraisal of the manuscript followed by specific comments and recommendations for revision are most useful to the Editor and author.

Most manuscripts with a content suitable for *The Canadian Field-Naturalist* must undergo revision — sometimes extensive revision. After resubmission, manuscripts that required major revision are usually returned to the original referees for re-evaluation. Some manuscripts must be rejected if they are scientifically unsound, unimportant (i.e. they do not contribute any worthwhile information), or are otherwise unsuitable for publication. The Editor makes the final decision on whether a manuscript is acceptable for publication and in so doing aims to maintain the scientific quality and overall high standards of the journal.

Book Reviews

Zoology

The Ecology of Stray Dogs. A Study of Free-ranging Urban Animals

By Alan Beck. 1973. York Press, Baltimore. 98 pp. $9.50.

A few years ago it would have been difficult to imagine that any biologist would spend years observing what stray dogs are up to in a city. With the current interest in urban animals, however, the subject of city dogs seems both pertinent and intriguing. Thus Alan Beck who studied dogs in Baltimore, a city of 72 squares miles, nearly one million people, and about 43 000 free-ranging dogs, has written a book of general interest.

Beck includes a great deal of information in his book. He found that the number of dogs in Baltimore increased with the density of people. As the human population went up, so did the available garbage, the number of open yards and shelter areas, and the amount of crime, which tended to encourage dog ownership. The mortality of the dogs was also high in slum areas. In one year 8400 dogs were collected that had died of disease or were killed by cars. During this same year the Animal Shelter took in over 18 500 dogs of which 83% were gassed or sent to medical institutions. The total known mortality for the year was one-quarter of the entire dog population of the city, a conservative estimate since many carcasses would not have been collected. Dogs found dead on the street had an average age, judged by their teeth, of 2.3 years and thus were probably much younger than the average household pet. The dead dogs were taken to a rendering plant where they were made into soap and a chicken and hog food-supplement, one of the few examples of recycling of natural components in the urban ecosystem.

The feces and urine of urban dogs are a problem. Beck calculated that over 18 700 gallons of urine were excreted by dogs each day in Baltimore. This urine may kill the bark on trees and pollute storm water. Feces may not only pollute open supplies of water but spread a variety of diseases and parasites to other dogs and to man. Feces also attract hungry brown rats, which may then use dog houses for shelter. Dogs chase the cats that stalk the rats, but ignore the rats themselves.

In Baltimore about 7000 cases of dog bite (mostly by stray dogs) are reported each year. These have not been serious, although children have been killed by dogs in nearby areas. German shepherds attacked people more often than did other breeds, and females bit more people than did males.

The Ecology of Stray Dogs is not a long book, but it contains much of interest to urban dwellers, whether they like or dislike dogs in their city.

Anne Innis Dagg

Otter Press
Box 747
Waterloo, Ontario

Birds of the Oshawa – Lake Scugog Region, Ontario

By Ronald Tozer and James Richard. Private Printing, Box 28, Whitney, Ontario. 384 pp. $7.50.

This is a book to be used. Depending on your need it can be used for reference, for comparison, or to make the novice into an expert. It is not so much a shiny multicolored bird-book that would make a fancy gift, as a book to buy for yourself.

The book's first section is a very understandable account of the region's geology, followed by an interesting outline of the variety of habitats found in the area. The main section deals with the birds in field-guide order. The authors show the abundance and occurrence of each species by selected sightings. Nesting information, including a description of the eggs and nest, are given where applicable. The accounts of rare birds usually include data from outside the Oshawa region so that the local sightings will be more relevant. The book has eight appendices including one on the Little Gull and one on the Oshawa Naturalists Club Bluebird project.

The main drawback of the book is locked into its very purpose. The value of the book decreases markedly with increasing distance from Oshawa. People in the area between say Kingston, Peterborough, and Hamilton will find it directly applicable and most useful. Those living from

Niagara to Windsor and south of the lake will find it an interesting comparison with their own region. Beyond those areas the book will have a more limited appeal. A second more minor criticism should be levelled at the lack of detailed directions to the most productive birding areas. Visitors and beginners would appreciate this information.

These are but minor drawbacks compared to the book's contribution to ornithology. The authors are to be congratulated on turning a dry mountain of statistics into a remarkably readable account. The book achieves its main purpose: it presents an accurate assessment of the background bird populations that is well spiced with those accidental sightings which make birdwatching an engrossing hobby.

Both authors are to be complimented on their sympathetic treatment of hypotheticals. Richards deserves extra credit for his many interesting photographs including Plate 76, the first North American Little Gull chick. The book is also illustrated with some charming drawings by B. K. MacKay.

In my opinion all the hard-core enthusiasts and beginners along Lake Ontario, and all the naturalists from Oshawa, should own a copy of this valuable book.

ROY JOHN

28 Scriven Boulevard
Port Hope, Ontario

Ontario Nest Records Scheme: Tenth Report 1956 – 1973

Edited by George K. Peck. 1973. Royal Museum and Canadian Wildlife Service, Toronto and Ottawa. 27 pp. Free.

The tenth annual report of the Ontario Nest Records Scheme follows closely the reports of previous years in format. The first dozen pages are devoted to a general account of the year's activities. Lists of nests found by the editor and his sons in Algonquin Park and the eastern Georgian Bay region are given. Of particular interest is a summarized list of the highlights of the 1973 scheme, where a number of first breeding records for certain counties are noted. Then follow lists of the numbers of cards on file, the dozen countries with the highest total of cards and with the largest number of species recorded, and the species for which most cards have been submitted. A breakdown of cowbird parasitism as revealed by the scheme contains data on 78 host species, though for only a small proportion are there enough cards for statistically significant data to be extracted.

The remainder of the report is given over to yet more lists, the major one being a list of the card totals submitted for each species. Several pages are devoted to listing the contributors to the scheme, some 515 in number.

Within the limitations imposed by the nature of the report, this is an interesting and reasonably useful document. It is, as its name implies, simply a record of the progress of a tried and worthwhile method of recording information about an important facet of a bird's life cycle. The true measure of the success of the nest records scheme will be found in the use to which ornithologists put the information now gathered in such vast quantities on the cards. A very obvious bias to data occurs owing to the distribution of human population, and there are also some very curious gaps — for example, the song sparrow has yet to be recorded nesting in Wellington County (where it surely must rank within the top 10 commonest species), while the house sparrow has yet to be "carded" from Dufferin (no comment needed). Nonetheless, taking the observer-distribution bias into account, this report taken in conjunction with its predecessors should prove useful to students of bird distribution. It is pleasing to see observers deliberately going to remote or less well-observed parts of the province with the specific intention of filling out obvious blanks. Of the 272 species listed as breeding in Ontario, only 15 have not now been recorded on cards; significantly almost all of these are northern species. It is obviously something of a compliment to the contributors that nearly 95% of Ontario's breeding birds have now been put on cards.

It is pleasant to record that this annual report was produced promptly, while still of current interest. Dr. Peck has not fallen into the trap of so many annual publications by getting so far behind schedule that much of the interest, which derives from currency, is lost.

A. D. BREWER

R. R. 1., Puslinch
Ontario N0B 2J0

Ecology of Pomarine, Parasitic, and Long-tailed Jaegers in Northern Alaska

By William J. Maher. 1974. Cooper Ornithological Society, Pacific Coast Avifauna, Number 37. 148 pp. $3.75.

This is an excellent comprehensive account of the comparative ecology of the three species of jaegers (*Stercorarius*) in northern Alaska. It contains an abundance of detail which is clearly presented with the help of 37 tables and 27 figures. The detail is necessary but can be tedious and the main body of the work will probably be used chiefly for reference either by those engaged in similar studies or those concerned with the general ecology of areas occupied by jaegers. For the more general student there are good but short summaries and discussions at the end of each major section, as well as 20 pages devoted to a final discussion and summary. The main headings are Environmental Description, General Characteristics of Jaegers, Population Biology, Territoriality, Some Aspects of Breeding, Gonad Cycle, Growth Characteristics, Food Habits, and Predation. All sections except the first are broken down by species and all except the second further divided by sub-headings. As there is no index, it would have been helpful if these sub-headings had been listed in the Table of Contents, perhaps in place of the lists of tables and figures which are so often given but so seldom used.

The field work that forms the basis of the study occupied five summers between 1956 and 1960 and was carried out at 13 stations, some situated in the Brooks Range and in the foothills as well as on the coastal plain. In the subsection "Origins" (p. 133) the author appears, perhaps unintentionally, to suggest that the three species of jaegers became differentiated during the Wisconsin glacial age. Surely the species must be older than that, though no doubt their distribution at that time has affected their present habits. Apart from this I find the conclusions well justified. The book (paper cover) is well produced and reasonably priced.

T. H. MANNING

R. R. 4
Merrickville, Ontario K0G 1N0

BOTANY

Wild Flowers of Forest and Woodland in the Pacific Northwest. Field Guide 1
Wild Flowers of Field and Slope in the Pacific Northwest. Field Guide 2

By Lewis J. Clark. 1974. Gray's Publishing Ltd., Sidney, British Columbia. 80 pp. each. $2.95 each.

These two field guides, the first of a series of five, are published posthumously by the estate of the late Professor Clark but the writing and photographs are his. The colored photographs are taken from his much larger work *Wild Flowers of British Columbia* (published in 1973) with additions required by the larger area covered. The flowers included in the series are the more common and showy species that occur from southern Alaska through British Columbia, Washington, and Oregon, to northern California, from the coast to the western timber-line of the Rocky Mountains. In the guide to forest and woodland flowers, 137 species are mentioned of which 101 are illustrated. *Wild Flowers of Field and Slope* makes reference to 157 species, with 108 plates.

The guides open with an introduction discussing some of the general ecological characteristics of the environments dealt with and some of the adaptations found in plants growing there. This is done in terms readily understood by the layman — the author being a scholarly layman himself. In general, technical terms are kept to an absolute minimum with a single-page illustrated glossary at the end of each book. Common names are emphasized with attention drawn to their inadequacies in many cases. Latin names are given in each instance but not to the extent of including the names of the relevant authors. This technical deficiency is not too serious, however, as the taxonomy and nomenclature are based in large measure on the *Vascular Plants of the Pacific Northwest* by Hitchcock et al. The sequence of the families is Englerian with genera arranged alphabetically within the families. Any dislocations from this sequence are dictated by the necessity of printing vertical and horizontal pictures in pairs. Each genus is illustrated by at least one plate and one plate is accompanied by thumbnail descriptions of a single species but more often of several that grow under similar conditions in the Pacific Northwest. Magnifications are included for each plate.

No keys are provided, for as the author says, "we find that very few amateurs use them." It is his hope "that the reader will scan the pictures repeatedly testing his recall of each name. By this means he will become familiar with the general appearance of the plants in each genus, and acquire a set of mental images to which he can relate each plant in the field." Whether this approach will be helpful and practical is doubtful. The plates are excellent in detail although they are darker and the color rendering is not as good as in the *Wild Flowers of British Columbia.* Professor Clark was an expert and artistic photographer. The plates alone would fully justify the adding of these, and subsequent guide books of this series, to the library of anyone, professional or amateur, interested in the flora of the Pacific Northwest.

The departure from the more usual grouping of species by color, in guide books intended primarily for the layman, is very deliberate on the part of the author. He believes that an arrangement of species according to their usual habitats is more practical (and even more useful) than that of grouping plants, from every habitat, by the color of their flowers. He points out that this latter grouping is, in fact, only possible in a single-volume work. Furthermore a number of species have flowers of more than one color. While there is undoubted logic to this plan I am not persuaded of its practicality. Looking at more than 100 plates in search of an unknown may prove to be a frustrating experience, although mitigated by the pleasure of looking at the plates themselves.

The books are well printed with few typographical errors. Being paperbacks of small size (14 × 21 cm) they are admirable for taking into the field. At their price they are good value for the money.

T. M. C. TAYLOR

Millstream Road
R.R. 6, Victoria, British Columbia V8X 3X2

Géographie floristique du Québec/Labrador. Distribution des principales espèces vasculaires

By Camille Rousseau. 1974. Travaux et documents du Centre d'Etudes Nordiques 7. Les Presses de l'Université Laval, Québec. 799 pp., 1021 maps. $30.

This will be an invaluable book for students of the flora of the Quebec/Labrador and adjacent regions, and indeed anyone interested in the flora of the northern half of North America, for many years to come.

For each of 1016 species of the indigenous flora of Quebec/Labrador, the author presents, in a short paragraph, the habitat, distribution, and comments made by various authors on the distribution in Quebec/Labrador and North America in general.

Maps depicting the distribution of these species in Quebec/Labrador are presented in a section at the end of the book. These unfortunately are on three different base maps, depending on the ranges of the various taxa, and are grouped in three sequences, each in taxonomic order. Thus if the reader is interested only in the map for one species, he must search three places or refer to the text to ascertain which sequence to consult. Indeed the reader is forced to consult the text because the maps are identified by number, the initial letter of the genus and the species name. It would have been much better if the generic name had been completely spelled out, only one base map used, and thus only one sequence required. References to other published distribution maps are given in the text.

A chapter is devoted to the comparison of the distributions of the 1016 species. This in part is similar to Marcel Raymond's *Esquisse phytogéographique du Québec*, published in 1950. In another chapter the various hypotheses and theories concerning phytodistribution in Quebec/Labrador are discussed.

The extensive bibliography which is referred to throughout the text contains many titles dealing not only with the flora of Quebec, but Canada as a whole. It is thus a most useful source of information.

The text is offset from typescript and is written in French. Camille Rousseau has done a meticulous job in searching for and gathering together the information presented, and can be justly proud of his accomplishment.

WILLIAM J. CODY

Biosystematics Research Institute
Central Experimental Farm
Ottawa, Canada K1A 0C6

ENVIRONMENT

Battle for the Wilderness

By Michael Frome. 1974. Praeger, New York, published in cooperation with the Wilderness Society. 246 pp. $8.95.

This interesting work is one of a number of recent publications that discusses wilderness values, the history of wilderness areas, and the prospects for conservation of these areas. Frome deals exclusively with the wilderness situation in the USA and uses the 1964 Wilderness Act as a vehicle for much of the presentation.

The book begins with a short Prologue and ends with a somewhat longer Epilogue. Between are two major sections, the first examining the definition, values, and uses of wilderness (seven chapters, 83 pages), the second discussing successes and failures in preserving wilderness (five chapters, 83 pages). The complete text of the Wilderness Act is given in one appendix; a second provides an interpretation of the Act. Four pages of reference notes and a six-page index are provided. There are no illustrations or figures. There are practically no typographical errors.

Frome begins by drawing a parallel between our decreasing reliance on natural aids to navigation with increasing technology, and our increasing separation from the natural environment. The five pages are well-written: "We have been hurtling through space at breakneck speed but without a navigational perspective."

The long section on wilderness values begins with a broad definition of wilderness and goes on to present (in a descriptive, almost flowery, way) wilderness as a panacea for many human problems. Chapter 2 outlines the slow creation of the Wilderness Act. The history of Yellowstone and Yosemite Parks is told briefly. Here there is emphasis on the idea that American wilderness is largely "leftover" land that no group wants, and that the Act has not made too much difference to this attitude. The third chapter discusses the impact of the frontier environment on early writers, artists, and travellers, and the importance of these people in increasing public awareness. This cultural role of wild areas is traced from colonial to recent times, from Muir and Catlin to Leopold and Robinson Jeffers. Chapter 4 examines wild areas as scientific resources — control areas to allow study of the long-term effects of human utilization, sources of plants containing chemicals valuable in medicine or traits that can be utilized in crop breeding, and so on. "Conservation does not only mean 'wise use' but preservation when no immediate uses are apparent."

The next two chapters describe the roles of wild areas as reservoirs for wild life (defined very broadly) and centers for human recreation. Frome makes the point that conservationists generally want to share the areas they are conserving, and goes on to discuss the paradox created by the degrading effect of too much recreational use. Ways of dealing with this increased use are outlined in Chapter 7. From the examples it is clear that some areas are extremely vulnerable, some uses cause much more damage than others, and that some *relatively* harmless uses, especially hiking, have been neglected by government agencies.

The long section on 'Saving Wilderness' first examines the historical record of successes in preservation. The Act came about at a time when the mood in the USA was one of pioneering free-enterprise. The early ideas that culminated in the Act have held up remarkably well in practice considering the many attacks by industry and business. Several examples are related, including the contributions of Robert Marshall, an early forester and conservationist not widely known. There are some polemic statements here (despite the publisher's claim on the dust jacket) and some flat assertions are made without supporting evidence.

Chapter 9 discusses preservation by law. Shortcomings of government agencies administering the laws are considered. Frome focuses on the Forest Service, using examples from the Cascades and other areas. The next chapter emphasizes the need for public enquiry and support for the same government groups, particularly where, as in Canada and the USA, many agencies are involved in wilderness conservation.

The unequal distribution of wilderness areas is examined in Chapter 11. The crowded East has fewer, partly because agencies such as the Forest Service seem loathe to set aside small areas or areas that show signs of human utilization. They fail to recognize that such areas would revert to 'wilderness' if left alone and that the reversion would be of great interest to many.

The last chapter ranges over some wilderness areas and problems not covered by legislation. Frome stresses the importance of private holdings, trusts, and educational reserves. With the fantastic increase in use of wild areas by an increasingly dense population, the need for more impact studies is urgent.

In the Epilogue, Frome attempts to justify concern over wilderness at a time when many concerns seem more pressing. "Park" and "wilderness" groups have much in common with other citizen groups in their opposition to vested interests or misguided political and business forces. There are some strong statements on economic expansion, the nibbling away of all kinds of lands and "doublecrossing of the poor." Several times the suggestion emerges that population limitation is a future requisite for proper wilderness maintenance, just as it is a requirement for the solution of many other environmental problems.

The details of American examples do not always parallel the Canadian situation; however, the book is useful for its discussion of problems that Canadians are facing now and will face in the next decade.

PETER ELLIOTT

Okanagan College
Kelowna, British Columbia

Land Use and Resource Development in the Eastern Slopes: Report and Recommendations

Environment Conservation Authority (Alberta), 2100 College Plaza Tower 3, 8215 — 112 Street, Edmonton, Alberta. 1974. 224 pp.

This report of 200-plus pages is the last in a series presented to the Provincial Department of Environment by the Authority. It summarizes a large quantity of data and opinions on the preservation and management of the eastern foothills of the Rocky Mountains in Alberta. Information from public hearings, other governmental task forces, and questionnaires is synthesized and recommendations on all aspects of land use are given. Six interim reports and 12 volumes of proceedings from hearings are available.

The report stresses the unique nature of the area, the preservation of its integrity, and the growing stresses from recreation, forestry, mining, grazing, and other uses. All contributors seemed to agree that, where major conflicts exist, the water resource should receive priority. Beyond this, three alternatives for major use are suggested: wildland recreation, tourism involving some urbanization, and primary resource development. All these could be accommodated with a master plan and proper zoning.

The hearings apparently produced many useful reports and diverse points of view. Public groups and individuals were generally very critical of industry, of the sale of Crown lands, and of the lack of legislative control over some government agencies. There was a great divergence in views on road access, hunting and fishing rights, dams, grazing rights, ATVs (all-terrain vehicles) and ski-doos, and so on. Results from the hearings and questionnaires are summarized briefly in some 18 pages.

Recommendations are presented in four sections (84 pages). The longest section gives general recommendations under headings such as water, wildlife, forest products, agriculture, recreation and tourism, zoning, liaison with National Parks, "re-urbanization," and a dozen others. Space prevents detailed comment but the suggestions are straightforward and, I think, generally acceptable to the conservation-minded. Shorter sections cover some specific proposals or briefs on natural reserves, wildlife areas, wild rivers, and proposed tourist developments. The report closes with "A Policy for the Eastern Slopes" which discusses the basic principles behind the many recommendations.

The report is quite clearly written for a formal document. There is a fair amount of redundancy, perhaps more than needed to emphasize the main points. A map showing features and areas mentioned in the report would have been useful. Many important topics are covered with just a few pages for each. The report is worth reading, however, as a summary of views on management of this fascinating area.

P. W. ELLIOTT

Biology Department
Okanagan College
1000 KLO Road
Kelowna, British Columbia

Proceedings of the Arctic International Wildlife Range Conference — October 21 and 22, 1970

Edited by Dennis McCrea. June 1971. University of British Columbia Law Review 6 (1), Supplement. 107 pp.

The question of why an arctic wildlife range is needed is answered by George L. Collins in his background paper: "because there is no other region of the North American Arctic that still exhibits, comparatively unchanged, so wide a range of land forms and native life." At the close of the conference there was every reason to be optimistic the Range would soon become a reality. Canada was even then 10 years behind the United States which established the Alaskan section of the Range in 1960.

The Minister of Indian Affairs and Northern Development contributed an assurance to the conference that he would do everything possible to establish the Range. The opening address by James Smith, Commissioner of the Yukon, is a rambling two-and-a-half pages of concern for vanishing wildlife which draws on such widely diverse sources as Genesis and the "Laugh-In" television show. Notably Mr. Smith does not actually state he will do anything to bring about the establishment of the Range.

The six position papers, which form the body of the Proceedings, are excellent. They are written by well-known authorities and range from the history and status of the Range, the legal, social, and economic implications, to the attitudes of the oil industry and the value of the region to ice-age mammal research. Arthur M. Pearson's discussion of the wildlife resources of the area is followed by a selection of photographs which gives a vivid visual impression of the major features of the region.

Very little has been heard of the Range since the conference in 1970 so I wrote Mr. Chrétien to enquire as to its present status. His executive assistant advised me three months later the proposal is still very much alive but he could offer little more than the hope the Range would be established as soon as possible. Obviously someone is dragging his feet on this proposal. I feel that the Range should be established immediately. Northern development is moving at such a rapid rate that irreparable damage may be done to the region if it is left unprotected any longer. In fact there is evidence some damage may have already occurred since the conference.

For a current and critical appraisal of the status of the Range proposal I refer the reader to a paper entitled "The Urgent Need for a Canadian Arctic Wildlife Range" by George W. Calef in *Nature Canada* 3(3): 3–11, 1974.

ALEXANDER W. CARON

Department of Zoology
University of Toronto
Toronto, Ontario

Outdoor Recreation in America: Trends, Problems, and Opportunities

By C. R. Jensen. 1973. Burgess Publishing Co., Minneapolis. 2nd edition. 284 pp. $7.95.

The book's title suggests that here, finally, someone has attempted to document the unique problems and approaches to outdoor recreation. On the first page, Jensen outlines the objectives of his book. "Intellectual treatment must be given to the study of outdoor recreation . . . Such an approach involves at least serious consideration of (a) man's time and the uses he makes of it, (b) socioeconomic forces that influence work, leisure, and recreation, (c) organizations, agencies, and programs concerned with people's outdoor recreation, (d) supply and demand with respect to outdoor recreation resources, (e) economic impact of outdoor recreation pursuits and (f) what we might expect in the future as opposed to the present and the past." Through a framework of 14 chapters, Jensen manages to follow these objectives in a well organized manner.

To Jensen, "outdoor recreation is a commonly used term meaning essentially the same as resource oriented recreation. It is defined as those recreational activities which occur in an outdoor (natural) environment and which relate directly to that environment." His definition clearly points out the importance of the natural environment to outdoor recreation. Recreation, however, is poorly defined: "A total recreation experience includes the following four phases: anticipation, planning, participation, and recollection." A further consideration is that the great bulk of the outdoor-recreation demand must be satisfied in the after-work and weekend hours; therefore, even though Americans are highly mobile they seek most of their recreation close to home.

To the book's discredit is its overemphasis on objective *c*, "organizations, agencies, and programs concerned with people's outdoor recreation." Almost half the book is concerned with this aspect of outdoor recreation and, furthermore, Jensen's consideration is strictly American.

Although the author quite rightly identifies the abuse of our existing natural resources ("Our methods of antipollution have a long way to go before they catch up with our very efficient methods of pollution") and the problems of rapid population increases ("More people means greater consumption and thus more rapid depletion of natural resources"), some of these problems have already been considered by other countries.

Jensen presents several provocative comments but seems to avoid becoming involved in detailed consideration of them. "The basic problem associated with increased leisure time is that it is not inherently good or bad, but has tremendous potential for either." "Wilderness as a recreational resource has always been and probably always will be highly controversial, primarily because of its very low density use." Expansion of either of these comments would greatly enhance the universal applicability of the book.

The book's preparation appears to have been partially sponsored by the National Recreation and Park Association, perhaps explaining the author's apparent preoccupation with the U.S. governmental system. For persons concerned with outdoor recreation in the United States, the book will have some appeal. Canadians will find the book of little value.

PETER CROSKERY

Ministry of Natural Resources
Chapleau, Ontario

Alaska and Its Wildlife

By Bryan L. Sage. 1973. Viking Press, New York. 128 pp. $14.

In this day of raging confrontations between conservationists, oil companies, and oil-starved consumers, a gifted biologist such as Bryan Sage, an Englishman in the employ of the British Petroleum Company along the trans-Alaska pipeline route, should be able to write a provocative tome on conservation and development in Alaska. Certainly he had a unique viewpoint, and as a biologist could encourage constructive dialogue between conservationists and industry.

Such is not the case in this glossy-paged picture book. Those in search of reference material or philosophical viewpoints amongst its 128 pages had best be forewarned by F. Fraser Darling's foreword. The book includes not "the slightest attempt at what can be called fine writing. . . . Here is a naturalist of the old school. . . . He is not writing a professional account of some scientific expedition but communicating his joy in observation. . . ."

But to enjoy vicariously from a book the oft trumpeted excitement and beauty offered by Alaska, one expects to see beautiful photographs amplified by prose that sings of empathy between man and the land. If words stir one's soul, as they do in Leopold's *Sand County Almanac*, then even color photos aren't necessary. Sadly enough, Sage's words, at first promising, become oppressive all too soon, and the beautiful photographs are not enough to rescue the reader.

The book seems to consist of textbook geology followed by an interminable species checklist of flora and fauna, the whole burdened by parenthetical Latin names strung together by purple superlatives. Sage's vocabulary of adjectives just isn't sufficient to hold reader interest, and he acknowledges this fact with a string of "verys" ("very considerable distance") that stretches from cover to cover. Improper punctuation, questionable sentence structure, out-dated scientific names, and doubtful, yet undocumented statements on the biology of mammals make reading a chore.

Sage promises a view of the general philosophy of development in relation to conservation, but what he offers has already been said in less forgettable prose. He grandly suggests achievement of "a satisfactory balance between opposing views," and calls for "the greatest and most imaginative land-use plan ever conceived anywhere in the world." But this late in the game such charges become wearisome clichés of little value unless amplified by workable and specific proposals.

A biologist cannot help but wonder about Sage's credentials as an "ecologist." According to the dust cover flyleaf, Sage is a biologist of note, having published " a number of books and several hundred scientific papers and popular articles." Yet he writes as if he were a pioneer naturalist, making statements and offering opinions on animal behavior and distribution as if there were no previously published work to review. How can the uninitiated wade through statements about the white coats of animals allowing solar radiation to penetrate and warm their bodies, the relation of the presence of grizzly bears to the absence of moose in an area, the killing of moose and caribou by grizzlies, Dall's sheep lambs grazing a few days after birth, and Bald Eagles gathering to feed on Sitka deer, without hungering for documentation or amplification? These comments surely do not result from his own cursory surveys, and they are hardly commonly accepted facts among biologists. If his purpose is partly to educate the reader, then the reader should be led, where possible, from Sage's statements to the sources of the author's conclusions.

Sage has the raw material and an empathy with Alaska, particularly with the Brooks Range and the north coast, that could be turned into captivating reading. But instead of confining himself to the bounty of a portion of that vast state, combining an overview with a strong case for a specific multiple land-use scheme, he includes the entire complex state in a broad, patchy sweep of his brush, with vague generalities about conservation and development, and thereby produces only one more of many $14 coffee-table books, to be idly scanned for pictures and then set aside to gather dust.

NORMAN M. SIMMONS

Canadian Wildlife Service
Box 508, Fort Smith
Northwest Territories

OTHER BOOKS

The Discovery of the Northwest Passage by H.M.S. "Investigator," Captain R. M'Clure 1850, 1851, 1852, 1853, 1854

Edited by Commander Sherard Osborn. 1969. M. G. Hurtig Ltd., Edmonton. 405 pp., 1 fold-out map. $5.95.

Life with the Esquimaux, a narrative of arctic experience in search of survivors of Sir John Franklin's expedition

By Captain Charles Francis Hall. 1970. M. G. Hurtig Ltd., Edmonton. 547 pp., illus., 1 fold-out map. $8.95.

M. G. Hurtig has undertaken the reprinting of a series of books dealing with the early exploration of Canada. The two here reviewed were reports of journeys undertaken in search of Sir John Franklin whose ships and men were lost while he was exploring for a northern sea-route from the Atlantic to the Pacific Oceans.

M'Clure's expedition left England in the sailing ship "Investigator" in January of 1850 and proceeded via Cape Horn and Behring Strait to the western Arctic. Here he explored the coasts of Banks Island and the west coast of what is now known as Victoria Island. They did indeed discover the Northwest Passage! These hardy men spent three winters frozen in their ship, and finally abandoned the ship in Mercy Bay at the north end of Banks Island where it had lain imprisoned in the ice for two years. The crew members were rescued by the "Resolute" which they reached by proceeding eastwards across the ice. They were the first white men to pass across the north from one ocean to the other. They finally returned to England in September 1854.

Captain Charles Francis Hall was an American who became keenly interested in the fate of the Franklin expedition. It was his belief that much could be learned from the Eskimo inhabitants of the country, but in order to do this he decided that he first had to learn their language himself.

Hall left New London, Connecticut at the end of May 1860 on the whaling ship "George Henry" and after spending two winters in the Frobisher Bay area of Baffin Island, finally returned to the United States in September 1862. It had been Hall's intention to sail westward in a small boat with Eskimo companions to the vicinity of King William Land. This, however, was thwarted by the loss of his boat in a storm. Hall's full time in the north was thus spent exploring and charting the shores of Frobisher Bay and living with the Eskimos, learning their language and customs. His theory that much could be learned of earlier white travellers in the north from the Eskimo was proven when these people were able to tell him about white men's (from Frobisher's voyages) having built a boat there 300 years before, and they could show him evidence of their presence there at that time.

Hall's book in particular contains a wealth of information on the life and customs of the Inuit people. Both books are full of observations about the country and various natural history features. The style of writing is rather archaic as can be expected; the first was originally published in 1856 and the second in 1864. Introductions to the new editions have been prepared by William C. Wonders and George Swinton respectively.

Volumes such as these have long been out of print. It is fortunate for us that M. G. Hurtig has had the foresight to reprint them in order to let us read about these early explorations of our country, at a time when so much interest is being focused on the changes which are taking place.

WILLIAM J. CODY

Biosystematics Research Institute
Central Experimental Farm
Ottawa, Canada K1A 0C6

Narrative of the Arctic Land Expedition - - - to the mouth of the Great Fish River and along the shores of the Arctic Ocean in the years 1833, 1834 and 1835

By Captain George Back. 1970. M. G. Hurtig Ltd., Edmonton. 663 pp. $8.95.

"Early in the year 1832 the protracted absence of Captain (now Sir John) Ross, who had sailed in 1829 to the Polar regions, and had not afterwards been heard of, became the subject of general and anxious conversation." In response to public sympathy an expedition was funded either to rescue or discover the fate of the Ross party. Captain George Back, both a friend and an admirer of Captain Ross, as well as an experienced Polar traveller, was designated to lead the expedition. The *Narrative of the Arctic Land Expedition* is an account of his journey presented largely in diary form. Although Back's Arctic land expedition represents a significant contribution to Canadian exploration, it is not the 'exciting' history characteristic of that taught in Canadian schools.

"On Sunday, the 17th of February 1833, . . . I embarked in the packet ship Hibernia . . . and after a somewhat boisterous passage of thirty-five days, during part of which the ship was entangled amongst ice on St. George's Bank, arrived at New York." From New York, Back travelled to Montreal. "From Montreal it was proposed that the ordinary route of the fur traders would be followed by the Ottawa, French Rivers, and the Great Lakes, Lake Winnipeg, and etc. to Great Slave Lake; from whence Indians were to be employed as guides and hunters to accompany the party to the banks of the Thlew-ee-choh-desseth, or Great Fish River."

From the beginning of the Back expedition, it is quite clear that the principal objective is the rescue of the Ross party. But ". . . if no such happy fortune should attend our researches, the geographical knowledge that must be obtained and the scientific information resulting from a course leading nearly over one of the Magnetic Poles, would, it was hoped, tend to console them." Back's orders are clearly spelled out. "But you are not for such objects to deviate from your principal pursuit, until you shall have either succeeded in its accomplishment, or satisfactorily ascertained that its success is impossible."

The *Narrative of the Arctic Land Expedition* may be subdivided into three sections; travel to Great Slave Lake, the winter of 1833–34, and travel to the Polar sea (summer 1834). Since both Sections one and three are basically concerned with canoeing exploits, the excitement of the historical trip up the Great Fish River is lessened by repetition.

Section two is long and drawn out. The winter story was one of survival during severe conditions. "The uncertainty of the means of subsistence, and the almost daily distresses and disappointments by which we were harassed, had interfered with many and altogether marred some of my plans." The detailed listing of incidents that occurred during the winter have little bearing upon the land expedition other than offering several inconveniences.

During the course of the winter, Back learns of the safe return of the Ross party. Now freed to follow the secondary objective of exploration, Back attempts to convey his excitement at the beginning of this trip to the Polar sea. "Before me were novelty and enterprise; hope, curiosity, and the love of adventure were my companions; and even the prospect of difficulties and dangers to be encountered, . . . instead of damping rather heightened the enjoyment of the moment."

Generally speaking the text relates more the personal sacrifice and hardships of Arctic exploration than the glory of discovery. Although presented in diary form, the reader gains a poor image of Back, the person. Back does appear, however, as a man dedicated to a life of adventure and a man experienced in command.

The text itself is long and rather dry reading. In the Appendix are the details of discovery. Exact site locations (latitude and longitude) referred to within the text are listed, plus botanical, zoological, geological, and meteorological observations made during the course of the expedition. This book will probably not receive wide attention from the general public, but should appeal to persons interested in Canadian history and/or life in Canada's north.

PETER CROSKERY

Ministry of Natural Resources
Chapleau, Ontario

The Mighty Mackenzie, Highway to the Arctic Ocean

By Lyn Hancock. 1974. Hancock House, Saanichton, B.C. 95 pp. $3.95.

This excellent travelogue describes the immense Mackenzie River as it flows from Wrigley Harbour on Great Slave Lake to Tuktoyaktuk on the Arctic Ocean, 1089 miles downstream. We float with the author past log cabins, Indian villages, spectacular cliffs, and vast waterfowl nesting grounds, all of which she depicts skillfully in words or in the more than 200 black-and-white photographs and pen sketches. She adds geographical and historical details when these are pertinent.

Lyn Hancock deals particularly well with environmental and social problems. At Norman Wells, where oil comes from the ground with such natural force that no pumping is necessary, she discusses with an oil man the filter ponds where oil and water leaking from the system are trapped. The oil stays on the top to be recycled back to the refinery. The oil man explains his company's policy of allowing their Indian and Eskimo employees frequent time off for hunting. Further north at Mountain River she visits a research station of various gas and oil companies. Here studies are being conducted to determine how a pipeline will affect plants and animals of the Arctic. For example a biologist is pleased to report to her that caribou have been scratching their antlers against noisy compressor pumps.

I was amazed to read of the great activity on the river itself. It is a remarkable contrast with what one finds in other parts of northern Canada. On a recent canoe trip which I took in northern Quebec, we encountered fewer than a boat a week on the Broadback and Rupert Rivers. The Mackenzie conversely is a highway for an assortment of dredges, barges, steamboats, rafts, canoes, and kayaks. Local people are worried about the naïvety of southern adventurers who head into this wild country without adequate supplies and without a sturdy craft to carry them.

The author gives us an interesting glimpse of the birds and mammals she sees during her trip, and vivid descriptions of the native people she encounters. At the Northern Games in Inuvik she describes the bannock-making competition, the wild dances, and the muskrat-skinning contest — 35 seconds for the winners. I wish she had also described her own party, as Pierre Berton did effectively in his *Drifting Home*. One is curious to know who accompanied her on the trip, how they got along together, how many miles they motored each day in their craft, and what their menus were.

This book includes a useful appendix which lists how one can ship oneself and one's boat to the Mackenzie, where there are hotels and what they charge, and when special celebrations are held. At $3.95 this volume is a wonderful introduction to northwest Canada.

ANNE INNIS DAGG

Otter Press
Box 747
Waterloo, Ontario

Fragile Ecosystems. Evaluation of Research and Applications in the Neotropics. A report of the Institute of Ecology (TIE)

Edited by Edward G. Farnworth and Frank B. Golley. 1974. Springer Verlag, New York. 258 pp. $7.80.

This book is not, as the title may suggest, a series of papers on ecosystems, but an evaluation of research done, and more importantly the need for research, in the neotropics. It is the report of a Tropical Ecology Workshop, which was divided into six teams, each reporting on certain aspects of the neotropics.

The six sections dealing with problems of neotropical ecology are these: Tropical Population Ecology; Tropical Ecosystem, Structure and Function; Recovery of Tropical Ecosystems; Interaction of Man and Tropical Environment; Impacts of Regional Changes on Climate and Aquatic Systems; Mechanisms to Support and Encourage Research and Education in Tropical Ecology. In addition to the 72 team members, seven observers and three staff members are mentioned. The conclusions arrived at by the teams are summarized in 58 recommendations. The team reports, given under the headings above, provide the background for these recommendations, and elaborate upon them.

First and foremost is the need for ecological researchers in the widest sense: theoretical, basic and applied research all fall far short of what is needed. Hence, education facilities must be created, preferably unified internationally, and must include courses in biology, agronomy, forestry, veterinary science, meteorology, and hydrology, besides advanced ecology courses. Ideally, an international coordinating body will be created, and eventually lead to in-depth research of tropical ecosystems across international boundaries: forest, savannah, riverine, lake, and estuary systems, as well as modifications caused by man through agricultural development, deforestation, mining, damming, industrialization, and other activities, such as road-building and recreation.

Some of the recommendations seem oddly at variance with basic ecological concepts. For example, ". . . specific recommendations are directed toward a sustained yield of products useful to man without degradation of productivity, *richness or long term stability*" (p. ix, italics mine). This is patently impossible: natural ecosystems cannot be exploited without loss of species, and stability of the disturbed systems will last only as long as the disturbance is continued at a constant level. Another example: "predation . . . by animals on plants may occur without immediately obvious demographic consequences" (p. 17). Did the team overlook the consequence of this predation on seed production, and hence, propagation and renewal? Under natural conditions predation aids in maintaining populations at a stable level, but exploitation can result in extinction of species.

In general, the recommendations are sound enough, if not always practical in view of the manpower and, often very expensive, equipment needed. One can only hope that the pessimists are wrong, and enough time will be available to carry out the much-needed research, and bring it into practice.

My main criticism is not with the evaluation and recommendations, but with some of the terms used, which express a trend towards "bandwagonism," and are objectionable, at least to me. This is the ascribing of human, or even superhuman, abilities to organisms. Despite his superior brain, man cannot "adapt himself" but only modify his environment. To speak of "strategies" — flowering, germination, parasite strategies, etc., etc. — of plants and animals is therefore going a bit far. Plants and animals are adapted to a given environment or not; hence, they can survive in that environment, or must perish. It is impossible to "post-adapt," no matter what "strategy" is "employed."

A second criticism is with the inordinately large number of errors, the use of awkward expressions, and the general execution of the book. Undoubtedly, much could have been improved by better editing. A few examples: Latin names of two species on p. 16 do not check with those in the references; p. 71, it is stated that things are "greater and/or more" . . . than what? ". . . a rise in water table, resulting in the production of swamp conditions" (p. 152); the "vast majority of oil released . . ." (p. 198). No attempt has been made to set a uniform line-length. All this detracts from what otherwise is a needed and worthwhile work.

J. LOOMAN

Canadian Department of Agriculture Research Station
Swift Current, Saskatchewan

Contemporary Biology: Concepts and Implications

By Mary E. Clark. 1973. W. B. Saunders Company. 632 pp. $11.85.

Contemporary Biology is intended to be an introductory biology text for non-science majors. Traditional topics such as plant and animal morphology, which usually occupy a considerable portion in introductory texts, are given a minimum coverage. Those biological topics, however, that appear to have a more immediate importance in the modern world are presented in a concise, lucid manner.

The young student is (or should be) concerned with birth control, environmental pollution, radiation damage, and the human population explosion. The book not only discusses these important topics but also attempts to present some of the biological background necessary for some understanding. The reviewer, a professor of biology, may not be qualified to judge the clarity of presentation of many of the topics since he has been wrestling with them for years. As far as he can put himself in the position of a reader being exposed to them for the first time he believes that they are clearly explained.

The text is well illustrated with numerous good photographs, graphs, and line drawings which enhance the verbal description. Appendices, references, and glossaries supply succinctly some of the necessary background information.

While intended as a university text for non-science majors it can be certainly read with profit even by graduates who have now settled themselves in a specialized area of biology and who now need a refresher course in general biology. It also serves as an up-to-date summary of the current relevant topics in the field.

R. W. MCCAULEY

Department of Biology
Wilfrid Laurier University
Waterloo, Ontario

Churchill: Canada's Northern Gateway

By Nan Shipley. 1974. Burns and MacEachern, Toronto. 124 pp. $3.75.

This anecdotal account of the history of Churchill, Manitoba introduces us to many of the individuals and events that have shaped the community from the time of Jens Munck (whose descendents returned to Churchill in 1967 for a Centennial ceremony) up to early 1974.

Nan Shipley has culled information from libraries, archives, newspapers, private letters and papers and put it together in the breezy style of a news reporter. She touches on the early history of the area, the role of the Hudson's Bay Company, and tells some fascinating stories about beluga whales, polar bears, early fliers, and the building of the railway and port facilities. She includes a brief chapter on the military base with emphasis on the war years and Expedition Muskox. She ends the book with several chapters devoted to an account of the community's campaigns (most of them ending in disappointment) to interest various levels of government in the development of the town as a major shipping center. But most delightful of all was the chapter titled "Churchill's Naturalist," in which Mrs. Shipley relates some of the story of Eva Beckett, who for 25 years studied the birds and vegetation of the region. I was one of probably hundreds who, while working in the region, visited Mrs. Beckett and benefited from the experience. It was a pleasure to hear more news of this outstanding naturalist and to see her given a special place in this account of the history of the town.

Mrs. Shipley has managed to include many items of interest in this small book, but she has not been well served by her editor. In many places it reads as though it is still in draft form. Nonetheless the book is a pleasure to read and will be of interest to those who have known and visited the town in the past as well as to those who will be learning about it for the first time.

D. B. BECKEL

1410 – 20th Avenue South
Lethbridge, Alberta T1K 1E9

The Countryman Bird Book

Edited by Bruce and Margaret Campbell. 1974. David and Charles, South Devon House, Newton Abbot, Devon. 194 pp. $10.50.

Anyone with a liking for the British countryside will probably have encountered *The Countryman*, a "miscellany of rural life and work for the English-speaking world." It is in its 79th year, and its sheer existence seems like a miracle in a day of multi-media gimmickry. But it has a devoted following on both sides of the Atlantic, a quarterly speck of sanity in a frenetic world. It really *is* a miscellany, with short anecdotes, letters, poems, and humor interspersed with longer articles on every facet of rural life. Its pace is leisurely, its tone both thoughtful and conversational, and while it certainly does not ignore the events of the day it does provide a calmer perspective — a little like going on a two-week holiday without any news and returning to find not very much has happened!

The pages of *The Countryman* are always full of items on nature, and now some of these have been gathered into anthologies, with the present volume the latest. They present the same remarkable diversity and high quality as the pages of the journal itself. Interspersed through the text are abundant and sensitive line drawings by Robert Gillmor and others, some fine photography, and scraperboard drawings by Kenneth Underwood, whose Tawny Owl on page 93 is an exquisite little study.

The text offers well-known names such as W.H. Thorpe, Len Howard, and Campbell himself, through local experts such as William Condry, poets such as Alasdair Maclean, to a host of contributors and readers from points as dispersed as South Africa, the Middle East, and the Falkland Islands.

Subject matter is equally diverse. Although the book is arranged alphabetically by species, poultry and turkeys have their place ("the chief characteristic of the young turkey is its determination to die"), and the articles range from poems or delightful anecdotes to intriguing insights into some common birds. Because of its emphasis on the interesting and intriguing qualities of ordinary and commonplace things, *The Countryman* has often been the source of information on changes in bird behavior — and so, Robins fishing for tadpoles, Bullfinches visiting feeders, the expansion of the Collared Doves and, more recently, the appearance of Rose-ringed Parakeets. So often it is the commoner species that yields noteworthy behavioral observations. For one thing, they are common and readily available — and British birds are among the most-watched birds anywhere — but this often also reflects some adaptability and versatility.

In 1972, Viscount Grey of Falloden started his book *The Charm of Birds* with the words "This book will have no scientific value," and went on to write one of the best-loved bird books in the English language. *The Countryman Bird Book* will have no scientific value either, and it can be easily read in an evening. But it is in the same tradition, and it deals with the same things — the charm, delight, and constant fascination of quite ordinary birds. It's worth reading.

CLIVE E. GOODWIN

11 Westbank Crescent
Weston, Ontario M9P 1S4

Natural History in the National Capital Region: A Bibliography

By A. F. Muhammad and E. Jorgensen. 1974. Information Report FMR-X-65. Forest Management Institute, Canadian Forestry Service, Department of the Environment. 97 pp. Available upon request to Publications, Forest Management Institute, 396 Cooper St., Ottawa, Ontario K1A 0H3

This bibliography contains all the references the authors were able to locate in a first search for published literature dealing specifically with the natural history of the National Capital Region. Publications that refer to the natural history of this region only as part of a broader topic have not been included. A total of 799 titles is listed, with publication dates from 1847 to July 1974.

The listing is arranged alphabetically by author, with the publications for each author arranged chronologically. A brief supplementary subject index renders the bibliography more useful than the author-title arrangement alone would be. In the subject index, each of the 799 numbered articles is listed (by number only) under one of six main categories — botany, zoology, environmental biology, climatology, geology, and nature study and appreciation.

In compiling the subject index, the authors necessarily relied on the title of the article as an indication of content. The result is that some articles with vague or misleading titles have been placed in inappropriate categories. Browsing of the articles to ascertain their content and usefulness is left to the user of the bibliography. One is pleased to see an occasional annotation such as in Number 734 (Taylor and Latchford. 1890. Report of the conchological branch. Ottawa Naturalist 4(3): 51–58) . . . "contains the last complete list of Mollusca of the Ottawa region, with a bibliography of previously published papers." A liberal use of this kind of factual annotation would be a valuable addition to any future printing the Forestry Institute might contemplate.

The project was originally conceived as a reference source for use within the Forestry Service, but subsequently the guidelines for its preparation were expanded with the recognition that others outside Forestry would find it useful. No effort has been made, therefore, to sift out the more scholarly works from articles with a less pedantic approach to natural history. The bibliography is all-inclusive and contains an interesting mix of titles, from formal reports of scientific studies to entertaining accounts of the experiences of amateur naturalists over the century. The publication will be of value to a very broad sector of the public, biologists, educators, naturalists, land use planners, historians, youth leaders, and others.

The Forest Management Institute has performed a most useful service in making the bibliography available outside the Institute. It is to be hoped that, in return, its users will draw omissions to the attention of the authors so that a second printing will be even more complete than this initial attempt appears to be.

SHEILA C. THOMSON

2066 Rideau River Drive
Ottawa, Ontario K1S 1V3

Sellout. The Giveaway of Canada's Energy Resources

By Philip Sykes. 1973. Hurtig Publishers, Edmonton. 235 pp.

This book was prompted by a brief entitled "Economic development with environmental security" submitted by four scholars at Dalhousie University to the Canadian Council of Resource and Development Ministers in Halifax. It is an account of what these scholars, and the author, regard as irresponsible exploitation of Canadian energy resources, largely although not exclusively by or on behalf of American interests, or large cartels dominated by Americans.

The topics discussed include the development of the Columbia River, and the subsequent development of the Peace River, which the author regards as a consequence of this, with its disastrous effects on the Peace-Athabasca Delta; the proposed North American Water and Power Alliance; the exploitation of western Canadian gas and oil; the Churchill-Nelson Project; the James Bay Project. Several provincial governments, as well as the federal government, are severely criticized.

As well as I can judge, the facts are accurately related; indeed the book is a valuable source of information that might otherwise be difficult for different interpretation could be put on the facts the average person to obtain. As the author states, by someone starting from a different position. It is also possible that the situation may have improved a little since the book was written. At least the federal government and the governments of Saskatchewan and Alberta have recently agreed to construct a weir to restore the Peace-Athabasca Delta to something like its original state.

Nevertheless the book is disturbing.

I have little sympathy with nationalism in general. I always fear that a legitimate concern for the rights of a group to which an individual feels he owes loyalty may degenerate into an irrational xenophobia. Moreover I believe that the riches of the earth should be used for the benefit of everyone, and I should be happy to see some of my country's resources used to help the poorer nations of the world to bring themselves nearer to the standard of living which we enjoy.

But I am not happy to see Canadian resources being used to enrich further those who are already rich, to the disadvantage of Canadians, and poor Canadians at that. I am not happy if Canadian rivers are to be destroyed to generate "it is not a neutral effort" and doubtless a electricity which will be consumed for no useful purpose. The author believes that "strong provincial leadership as well as a determined assertion of . . . 'economic federalism' . . . [is] the only combination capable of containing the acquisitive thrust of the energy corporations, managing Canadian resources, and preserving a decent environment for the remnant of the fossil fuel age." Perhaps he is right. Perhaps if enough people read his book, and others dealing with similar problems, governments will be led to put an end to the kind of abuses he has described.

I am not convinced of this. Darwin, in a well-known passage discussing spontaneous generation, wrote this: "It is often said that all the conditions for the first production of a living organism are now present, which could ever have been present. But if . . . we could conceive . . . that a protein molecule was formed, ready to undergo still more complex changes, at the present day such matter would be instantly devoured or absorbed . . ."

It almost seems that a similar principle applies in economics. There is surely a tendency for the economies of smaller countries to be "devoured or absorbed" by those of the few great powers. If this is true, as it seems to be, for a country like Canada, the prospects for the less developed countries' ever achieving economic independence seem small indeed. Perhaps only a radical reorganization of the world economic system could solve problems such as Mr. Sykes has described.

There is a curious misprint in the sixth entry in the bibliography.

R. M. BAXTER

715 Dynes Road
Burlington, Ontario L7N 2V7

Annotated Bibliography of Permafrost – Vegetation – Wildlife – Landform Relationships

By Patricia Roberts-Pichette. 1972. Department of the Environment, Forest Management Institute, Ottawa, Information Report FMR-X-43. 350 pp. Free.

The publication of an annotated bibliography of interest to terrestrial ecologists is a rare event — too rare. Anyone studying northern environments will find this a valuable book to have, and a quick and easy introduction to the literature.

Dr. Roberts-Pichette has compiled and annotated 487 titles, from the period 1926 to 1972, that pertain to the sensitivity of arctic and subarctic habitats. The Russian, European, and North American literature have all been well searched to provide a bibliography on the ecological problems created by man's activity in the north, and on the ways of reducing and repairing any environmental damage. The references are arranged alphabetically by author, with a good, cross-referenced subject index. The annotations are unusually well done, uncritical summaries of the pertinent information in each reference.

Of particular value is the inclusion of abstracts from many of the hard-to-get graduate theses and reports from government and industry. These include detailed summaries of several reports from the ALUR (Arctic Land Use Research) program for 1971 and 1972, and from the Environmental Protection Board for 1971. Unfortunately, many of these publications are still not readily available, so that a list of library locations for this material would be a handy addition to the bibliography.

In the introduction to this report, the compiler has summarized her 'general impressions from the literature' with reference to eight specific topics covered by the bibliography. These summaries outline the present state of knowledge, and give some insights for further research, on the relationships between permafrost and vegetation, on the recovery of tundra from disturbance, and on the protection of arctic topography, flora, and wildlife from destruction by man. These are a valuable addition to the book and should really be a part of any bibliography. I was surprised to find that no references were given for any of the information presented in this introduction!

Certainly many such bibliographies are produced by government and industry that never see publication. If this one receives the distribution that it deserves we can hope that the publication of others will be encouraged. The scope of this present work is current and important enough that it should be updated in five years to keep pace with the expansion of research in the north.

ROBERT MONTGOMERIE

Department of Biology
McGill University
Montreal, Quebec

New Titles

Zoology

Animal partners and parasites. 1975. By P. Street. David and Charles, Newton Abbot, England. £4.50.

Australian marsupials and other native mammals. 1974. By M. Morcombe. Scribner, New York. 100 pp. $7.95.

***Biology of the Kaminuriak population of barren-ground caribou.** Part 2. 1974. By F. L. Miller. Canadian Wildlife Service Report Series No. 31, Ottawa. 88 pp. $3.

The bird life of Texas. 1974. By H. C. Oberholser. University of Texas Press, Austin. 2 vols. 1070 pp. $60 boxed.

Birds of Australia. 1974. By M. Morcombe. Scribner, New York. 80 pp. $7.95.

The bird watcher's book. 1974. Edited by J. Gooders. David and Charles, Newton Abbot, England. £2.95.

***Canadian endangered species.** 1974. By D. Stewart. Gage, Toronto. 172 pp.

***Dolphins and porpoises.** A comprehensive annotated bibliography of the smaller Cetacea. 1974. Compiled by D. Truitt. Gale Research Co., Book Tower, Detroit. 582 pp. $45.

Fauna of the U.S.S.R. Polychaetes. Vol. 1. 1974. By P. V. Ushakov. U.S. Distributor, International Scholarly Book Services, Portland, Oregon. 260 pp. $26.

***A field guide to Mexican birds and adjacent Central America.** 1973. By R. T. Peterson and E. L. Chalif. Houghton-Mifflin, Boston. 298 pp. $10.75.

The insect societies. 1974. By E. O. Wilson, Belknap (Harvard University Press), Cambridge, Mass. 548 pp. $7.95. Reprint of the 1971 edition.

Introduction to arachnology. 1974. By T. Savory. Crane, Russak, New York. 112 pp. $1.50.

The life of birds. 1974. By J. Dorst. 2 vols. Columbia University Press, New York. 700 pp. $35.

***The mammals of Canada.** 1974. By A. W. F. Banfield. University of Toronto Press for National Museums of Canada. 438 pp. $19.95.

The naturalist in Scotland. 1974. By D. Knowlton. David and Charles, Newton Abbot, England. £4.50.

***Les oiseaux des collines montérégiennes et de la région de Montréal, Québec, Canada.** 1974. Museum National du Canada, Ottawa. Zoological Publication 5. 167 pp.

Poissons d'eau douce du Canada. 1974. By W. B. Scott and E. J. Crossman. Office des recherches sur les pêcheries du Canada, Bulletin 184. 1026 pp. $9.75 in Canada from Information Canada; $11.70 for other countries.

The roadside wildlife book. 1974. By R. Mabey. David and Charles, Newton Abbot, England. £3.50.

Rodents, their lives and habits. 1974. By P. Hanney. David and Charles, Newton Abbot, England. £4.50.

Swans of the world. 1974. By S. B. Wilmore. David and Charles, Newton Abbot, England. £4.50.

The wild canids. 1974. Edited by M. Fox. Van Nostrand Reinhold, New York. 256 pp. $17.25.

***Wildlife in an urbanizing environment.** A symposium held November 1973 at Springfield, Mass. 1974. Edited by J. H. Noyes and D. R. Progulske. Cooperative Extension Service, University of Massachusetts, U.S. Department of Agriculture and County Extension Services Cooperative. 182 pp. $3.

Wild life today. The world conservation handbook. 1974. Edited by N. Sitwell. David and Charles, Newton Abbot, England. £2.95.

Botany

The flora and vegetation of Japan. 1974. Edited by M. Namata. Kodansha, Tokyo and Elsevier, New York. 294 pp. $30.80.

Flora Boreali-Americana. 1803. (Reprint 1974). by A. Michaux. Hafner Press, New York. 2 vols. 736 pp. $42.50.

A flora of southern California. 1974. By P. A. Munz. University of California Press, Berkeley, Los Angeles, London. 1086 pp.

Flora of the U.S.S.R. Vol. 15, Malvales, Parietales, Myrtiflorae. 1974. Edited by B. K. Shiskin and E. G. Bobrov. Available from International Scholarly Book Services, Portland, Oregon. 556 pp. $55.

Flowers and plants. An international lexicon with biographical notes. 1974. By R. Shosteck. Quadrangle (New York Times), New York. 330 pp. $9.95.

Forest history books — 1975 catalogue. A list of books on the history of conservation, forestry, and logging. 1975. Forest History Society, P. O. Box 1581, Santa Cruz, California 95060. 76 pp. $1.

The indigenous trees of the Hawaiian Islands. 1974. By J. F. Rock. Pacific Tropical Botanical Garden and Charles Tuttle Company, Rutland, Vermont and Tokyo, Japan. 548 pp. $22.50.

Index herbariorum. Part 1. 1974. By P. K. Holmgren and W. Keuken. *In* Regnum Vegetabile: a series of publications for plant taxonomists. 6th edition. Oosthoek, Scheltema and Holkema, Utrecht. ca. 400 pp. Cloth F165.00.

The lichens. 1973. Edited by V. Ahmadjian and M. E. Hale. Academic Press, New York and London. 697 pp.

The thistles of Canada. 1974. By R. J. Moore and C. Frankton. Research Branch, Canada Department of Agriculture Monograph 10. 112 pp. Free.

Unasylva. An international journal of forestry and forest industries. Published by FAO, quarterly. First issue July 1974. $8. per year.

Environment

***Canadian public land use in perspective.** Proceedings of a symposium 25–27 October 1973, sponsored by the Social Science Research Council of Canada. 1974. Edited by J. G. Nelson, R. C. Scace, and R. Kouri. Obtain from 151 Slater Street, Ottawa, K1P 5H3. 579 pp.

Climate Canada. 1974. By F. K. Hare and M. K. Thomas. Wiley, New York. 256 pp. $9.95.

***Environmental cause/effect phenomena relating to technological development in the Canadian Arctic.** 1974. By W. Eedy. National Research Council of Canada, Ottawa. 126 pp. $2.

Great Lakes focus on water quality. International Joint Commission, Windsor, Ontario. Quarterly newsletter. First issue in Fall 1974. For copies write IJC Regional Office, 100 Ouelette Ave., Windsor, Ontario.

The national atlas of Canada. 1974. Macmillan, Toronto and Department of Energy, Mines and Resources, and Information Canada.

The naturalist in London. 1974. By J. Burton. David and Charles, Newton Abbot, England. £3.50.

Policies, programs and proposals relating to the environment from speeches of Hon. W. J. Yurko, Minister of Environment, Alberta, 1971–74. Environment Conservation Authority, Edmonton. 227 pp.

***The restoration of water levels in the Peace-Athabasca Delta.** Report and recommendations. 1974. Environment Conservation Authority, Edmonton. 136 pp. Available in Cree.

Miscellaneous

God or beast. Evolution and human nature. 1974. By R. Claiborne. Norton, New York. 260 pp. $7.95.

Canada energy crisis. 1974. By J. Laxer. James Lorimer and Co., Toronto. 160 pp. Cloth $10; paper $3.95.

***Outdoor recreation in America.** Trends, problems, and opportunities. 1973. Burgess, Minneapolis. 2nd edition. 284 pp. $7.95.

*Assigned for review.

The Ottawa Field-Naturalists' Club

Annual Reports of Committees of the Council, 1974

Publications Committee

Eight hundred and forty-eight replies were received from the questionnaire sent out with the 1974 dues notices. A complete copy of the results is with the Club minutes, but several points are worthy of mention here. Replies indicate that subscriptions to *The Canadian Field-Naturalist* should be available to individuals, fee schedules for the Club should be based on publications received, and *Trail & Landscape* should not be available to individuals on a subscription basis. Members' interests in the Club are, in descending order of importance, *The Canadian Field-Naturalist, Trail & Landscape*, and the excursion and lecture program. As a result of these answers, individuals will be able to obtain subscriptions to *The Canadian Field-Naturalist* in 1976, but at the same rate as members.

The Canadian Field-Naturalist

The finances of *The Canadian Field-Naturalist* have been separated from the Club, and *The Canadian Field-Naturalist* now has its funds in its own accounts.

Problems in production of *The Canadian Field-Naturalist* led the Committee to call for tenders for producing Volume 89 of the journal. Several Ottawa printers submitted bids, and from these, the Committee selected Mutual Press Ltd. to print *The Canadian Field-Naturalist* for 1975.

In the fall, the services of a production manager for *The Canadian Field-Naturalist* were obtained, and a clerk-typist was hired for the Editor of *The Canadian Field-Naturalist*. It is anticipated that these persons will substantially reduce the work load of the Editor.

Since the last Annual Meeting *The Canadian Field-Naturalist* has published four numbers. These include Volume 87, Number 4 (October–December 1973, containing 162 pages); and Volume 88, Numbers 1, 2, and 3, containing 127, 144, and 125 pages respectively. Fifty-six papers were published in the field of ornithology, 21 in mammalogy, 16 in botany, and the remaining 14 were in such areas as ichthyology, herpetology, and entomology. The number of manuscripts submitted to *The Canadian Field-Naturalist* reflects the continued interest of the community of natural historians in the journal.

	Manuscripts Received	Manuscripts Accepted
1972	119	95
1973	153	117
1974	152	—

The Grants and Scholarships Committee of the National Research Council awarded *The Canadian Field-Naturalist* a grant of $4500 and the Conservation Committee of The Canadian National Sportsmen's Show generously supported the journal through a grant of $750. These grants have offset the increasing costs of publication and enabled the journal to continue support to authors who do not have other sources of funds for publication costs.

Trail & Landscape

Five issues of *Trail & Landscape* were published in 1974. As in previous years' volumes, the 140 published pages included a variety of articles ranging from local natural-history notes to notices for Club members. The editorial staff still find that there is a lack of club-member contribution and they feel very strongly that *Trail & Landscape* would benefit from an infusion of new blood. This publication should be "for the members by the members," but it continues to be (primarily) "for the members, by the dedicated few." Contributions of all types, notes, drawings, photos, articles, and letters are needed to make *Trail & Landscape* more representative of the members and reduce the workload of the staff.

C. G. Gruchy (Chairman)

Excursions and Lectures Committee

During 1974, the Committee provided 41 excursions, 12 evening programs and the annual dinner. The excursions consisted of 24 relating to ornithology, 5 to botany, 2 to entomology, and 10 of general interest. The evening programs dealt with a wide variety of topics, including the birds of Ramsayville marsh, the botany of the Mackenzie Mountains, the natural history of Chile, spring wildflowers, the mammals of the Ottawa area, wetlands ecology, the life history of frogs, and the muskoxen of Bathurst Island.

In response to several requests, the committee instituted regular monthly meetings, to be held on the second Tuesday of each month, excluding July and August. The first of these meetings was held on 14 May. Inevitably a particular day of the week cannot be suitable for all members, but to date the response (both verbal and by increased attendance) is favorable and it is anticipated that this policy will be continued through 1975.

The annual dinner was held on 12 March at the Holiday Inn. The after-dinner talk, entitled "The Living Arctic," was given by Stewart MacDonald of the National Museum of Natural Sciences. Over 190 people attended, which indicates the popularity of the speaker and the topic.

The Committee thanks sincerely all the speakers, leaders, and members that helped with refreshments.

ROGER A. FOXALL (Chairman)

Finance Committee

Early in the year a budget for 1974 was prepared and accepted by the Council.

A notice was received from the executors of the estate of Mr. Rowley Frith that a sum of $500.00 would be given to the Club.

In accordance with previous recommendations, all stocks of Bell Telephone Company of Canada and of Microsystems International Limited, held for the Reserve Fund, were sold.

It was decided to separate the funds of The Ottawa Field-Naturalists' Club from those of *The Canadian Field-Naturalist* (journal), for ease of operation of both. This was requested by the Publications Committee, advised by the Auditors, and agreed to by the Council. This resulted in formation of a Current Account and a Reserve Fund for each organization.

History of the Reserve Funds of the Club and The Canadian Field-Naturalist

In the course of separating the finances of *The Canadian Field-Naturalist* from those of The Ottawa Field-Naturalists' Club, it was found necessary to delve into the background of the Reserve Fund as it stood at the end of 1973. The money in this fund resulted from the amalgamation in 1969 of the former Reserve Fund and what was then called the Publication Fund.

The practice of publishing financial statements of The Ottawa Field-Naturalists' Club in *The Canadian Field-Naturalist* began in Volume 39 (1925), when the statement for the Club year ending 27 November 1924 appeared. At that time there was a Trust Fund which then amounted to just over $600.00. This fund appears to have been derived largely from the estate of R. B. Whyte, which continued to contribute $100.00 a year until Mrs. Whyte died in 1928. The name "Reserve Fund" was first used for this trust fund money in the Statement of Financial Standings of the year 1925–26 (C.F.-N. 41: 17, 1927). This fund continued to grow, primarily through interest and small transfers from the current account, through to 1968, when $5000.00 was transferred there from the current account, although this was actually supposed to be considered as Current Account money (C.F.-N. 83: 87, 1969).

The first mention of a Publication Fund appears in C.F.-N. 38: 181, 1924, when "the hat was passed" as a means of obtaining additional funds for publishing *The Canadian Field-Naturalist*, following the termination of a Province of Ontario grant that had been received for a number of years. For a few years, this money, however, was apparently not kept separate from current revenue, but when the Statement of Financial Standing for 1931–32 was published (C.F.-N. 47: 16–17, 1933), the Publication Fund was included and already had a Government Bond of $500.00 plus cash amounting to $41.25. This fund increased in size from interest and from the deposit of money from Life Memberships.

When the accounts were separated in 1974, all funds were allocated as appropriate; however, where the origin of certain monies was uncertain and where fixed assets belonging to both the Club and *The Canadian Field-Naturalist* were concerned, it was agreed that the value be split as for the Current Account, i.e. 60% to the Ottawa Field-Naturalists' Club Reserve Fund and 40% to *The Canadian Field-Naturalist* Reserve Fund.

EWEN TODD (Chairman)

Membership Committee

There has been a slight increase in the total membership this year. A breakdown of the membership, with comparable figures from the 1973 report, is given in the Table. Because this is a slightly more detailed breakdown than that given in past years, a complete comparison is not available.

We regretfully announce the loss of four of our Honorary Members: Mr. R. Frith, Dr. H. F. Lewis, Mrs. Wilmot Lloyd, and Dr. M. Y. Williams.

PATRICIA J. NARRAWAY (Chairman)

Conservation Committee

The Conservation Committee, which has replaced the Research and Briefs Committee and the Natural Areas Committee, devoted much of its effort to aspects of the Ottawa-Carleton Region Official Plan. A brief was submitted to the Region containing various criticisms of the Plan and suggesting severad additional conservation areas as well as some changes to the boundaries of some proposed conservation areas. The final version of the Plan approved by the Ottawa-Carleton Council incorporated most of our suggestions. The most notable exception was the retention of the Britan-

Memberships	Local*		Canada (non-local)		USA		Other countries				Total
	1973	1974	1973	1974	1973	1974	1973	1974	1973	1974	Change
Individual	329	416†	481	503	130	106	6	12	946	1037†	+91
Family	217	200	10	16	1	2		2	228	220	−8
Life	5	5	1	1	1	1	2	2	9	9	0
Honorary	8	5	5	4					13	9	−4
Total	559	626	497	524	132	109	8	16	1196	1275	+79
Change	+67		+27		−23		+8		+79		

* Local members are arbitrarily designated as those within "comfortable" driving distance of Ottawa.
† Includes six Sustaining Members.

nia arterial in the Plan. In this case we had written to the members of the Ottawa-Carleton Council before their vote, but still we were unsuccessful. In spite of this one item, we feel that we have good contact with the Ottawa-Carleton Region and that they consider our input carefully.

The Carp Hills have been designated as a Conservation and Recreation Area in the Ottawa-Carleton Plan. More detailed knowledge of this area is required in view of the multiple uses permitted there. A field study was undertaken of the more accessible parts of the Hills. Useful information was obtained and a report is in preparation. It is unlikely, however, that we can find enough people with sufficient competence and spare time to do a satisfactory study of such a large area in a reasonable time.

A number of other issues concerned us and were studied in some detail. The National Capital Commission (NCC) snowmobile trail along the edge of the Mer Bleue in the winter of 1973–74 prompted us to write letters of opposition to the NCC Chairman, to the local Member of Parliament (Turner), and to the Minister answering for the NCC (Basford). We have also written to the NCC to point out several interesting but easily overlooked orchid fields in the neighborhood of the Mer Bleue, which could be damaged if the NCC were not aware of them. The traffic problem raised by the lack of adequate parking at the Ramsayville Marsh was pointed out to Ottawa-Carleton Roads Department. In returning a questionnaire on Highway 416, we opposed the use of the Pinhey Forest for road construction.

In addition, we provided information on natural areas requested by the Ontario Ministry of Natural Resources, by three ecological consulting firms doing studies, and by a group of SWEEP (Students Working on an Environmental Enhancement Project) students at University of Ottawa who were gathering available information on the Mer Bleue. We also attended a symposium on the Mer Bleue sponsored by the NCC.

A request to the Club members in *Trail & Landscape* to provide information for a natural areas inventory brought 15 replies dealing with nine areas, four of which were in urban or suburban areas, and all of which were in Ontario. We are very grateful to these 15 people for their trouble and information. On the other hand, since the Club has about 600 local members, one must conclude that most of these members know little about the Ottawa region or do not care enough about conservation to help the Club to respond quickly and knowledgeably when the need arises. We know that some agencies, particularly the Regional Municipality of Ottawa-Carleton, will listen carefully to us when we have something significant to say. We also know that our knowledge of the Ottawa area is very incomplete. Members who are in favor of conservation must realize that we cannot try to conserve areas about which we do not know.

A. H. REDDOCH (Chairman)

Macoun Field Club Committee

At the closing meeting of the 1973–1974 session last June, Dr. Irwin Brodo relinquished his position as advisor to the Seniors thereby ending an eight-year association with the Club. Dr. Brodo served as chairman for five years beginning in the fall of 1966 and then continued on as advisor to the Seniors. As a token of appreciation, the Seniors presented Dr. Brodo with a photo album containing many reminiscences of pleasant times spent together over the past number of years.

A new presentation was initiated as a means of recognizing the merits of outstanding graduating members of the Senior Group, The

Macoun Field Club Special Awards. This award (or awards) represents the Club's way of recognizing the dedication and zeal of those members who have shown the same traits which characterize recipients of the F.O.N. Baldwin Scholarships but who have not had similar official recognition. The 1974 winners were H. Loney Dickson and Robert Lee, both very outstanding naturalists.

The recipient of the W.K.W. Baldwin F.O.N. Scholarship was a very deserving Claude Jutras. Claude's enthusiastic participation in all of the activities was very much appreciated and helped spark the kind of Club spirit which is necessary to ensure the success of its programs.

Dr. David Gray, a staff member of the museum in the Vertebrate Ethology Section, has joined the Club as advisor to the Seniors.

The program at the Club as in past years provided its members with a diversity of subject matters ranging from talks on insect mimicry, ice age mammals, and northern pipelines in the Senior program, and talks on muskoxen and big game animals of east Africa, among others, highlighted the Junior and Intermediate programs. The Seniors were also engaged in a number of identification workshops on such subject matters as molluscs, rocks and minerals, and freshwater algae.

Field outings as ever before are a large part of the activities of the Seniors and, to a lesser extent, the Juniors and Intermediates. As a special outdoor experience, another extended canoe outing was organized by the Seniors for La Verendrye Park, Quebec. This trip was supervized by Mr. Alex Fournier.

ERICH HABER (Chairman)

Bird Records Committee

During 1974, the Committee considered 52 submitted reports of unusual birds in the Ottawa area, of which 42 were accepted. These included the first documented records of Hooded Warbler, Blue-winged Warbler, and Forster's Tern. Accepted as second records were Yellow-throated Warbler, Piping Plover, Sabine's Gull, and Red-bellied Woodpecker. Other noteworthy records were of two Boreal Owls and a Marbled Godwit.

The Committee also organized the spring, fall, and Christmas counts. The spring count was held on 19 May. Thirty-six observers operating as 13 parties recorded 188 species. The most exciting finds were a Marbled Godwit, and two LeConte's Sparrows (apparently on territory) near Metcalfe. Other species of note were Blue-gray Gnatcatcher, Tree Sparrow, Snow Goose, Oldsquaw, Surf Scoter, and Peregrine Falcon.

The fall count was held on 1 September. Only 12 observers participated, operating as three parties. The 162 species found included Red-bellied Woodpecker, Golden-winged Warbler, eight Black-crowned Night Herons, Double-crested Cormorant, and a remarkable 21 species of shorebirds.

The 1974 Christmas count was held on 15 December. Sixty-four observers observed 62 species. The highlight of the count was the phenomenal number of three-toed woodpeckers, 25 Northern and 19 Black-backed. Other exciting birds were two Winter Wrens, four Mockingbirds, two Kingfishers, a White-winged Scoter, and an Oldsquaw.

The Committee thanks P. J. Narraway for acting as secretary for most of the year.

ROGER A. FOXALL (Chairman)

Publicity Committee

During 1974, the Publicity Committee was active in a number of areas. The O.F.-N.C. displays were organized for the Federation of Ontario Naturalists' conference in Kingston in June and the Canadian Nature Federation conference in London in August. Our special thanks go to Erich Haber and the Macoun Field Club for preparing the Macoun Club displays.

Persons were found for radio interviews on the CBC Saturday morning program "In Town and Out." Most of the interviewers dealt with Ottawa natural history (birds, trees, amphibians). One interview dealt specifically with the Club and its activities.

One press release, on the Club's contribution to the Niven's Woods Conservancy fund, was prepared (published in *Ottawa Citizen*, 31 December 1974).

ARNET SHEPPARD (Chairman)

Education Committee

The Education Committee passed through a somewhat dismal year. Many of the objectives set in the early part of the year were not achieved owing to a loss of committee members and the involvement of the remaining members in other activities. The Committee did find judges for the conservation awards of the 1974 Ottawa Regional Science Fair, and provided speakers and trip leaders for a number of outside groups during the years.

A meeting was held in November to assess the Committee's performance. The members felt that this Committee should be amalgamated with the Publicity Committee because of a similarity in the general aims of both committees.

ARNET SHEPPARD (Chairman)

Federation of Ontario Naturalists Affairs Committee

As a result of restructuring of the Federation of Ontario Naturalists and their appointment of a new Executive Director, the F.O.N. did not make as much contact with its affiliated clubs as in past years. But this situation is now improving. Four O.F.-N.C. Council members attended the annual meeting of the F.O.N. held 7–9 June 1974, at Kingston, Ontario. A brief resumé of the resolutions passed at the F.O.N. Annual Meeting on 8 June appeared in *Trail & Landscape*, Volume 8, Number 5, and an article "Notes from the [F.O.N.] Newsletter" was forwarded to the Editor of *Trail & Landscape.*

V. M. HUMPHREYS (Chairman)

Bird Feeders Committee

The two bird-feeding stations operated by the Club were again ably managed, by Hazel and Hugh Munro at the west end station on Moodie Drive, and George McGee and Bill Holland at the east end feeder at the Pine Grove picnic site. Special thanks are extended to these four dedicated Club members who continue to give of their time and energy in manning the feeding areas through all types of weather. As in the past, donations of money, seed and other food, from members and interested outsiders, some known and some anonymous, are acknowledged with thanks.

V. M. HUMPHREYS (Chairman)

Minutes of the Ninety-fifth Annual Business Meeting of The Ottawa Field-Naturalists' Club

The 95th Annual Business Meeting of The Ottawa Field-Naturalists' Club was held in the auditorium of the National Research Council on Sussex Drive, Monday, 21 January 1974. The President, Dr. I. M. Brodo, called the meeting to order at 8:03 p.m., with forty-three people present (several more arrived later).

The minutes of the 94th Annual Meeting, compiled by A. W. Rathwell (then Secretary), were read by the Recording Secretary and adopted on motion (by M. Dickman, 2nd J. Gates).

The Treasurer's Report was available. Mr. C. G. Gruchy pointed out that the Club showed a surplus this year, but that a large deficit would have occurred in the absence of the grants received in aid of *The Canadian Field-Naturalist.* He noted that money for subscription to *Trail & Landscape* had been merged in general Membership income. A small decrease in overall membership had resulted from the increased membership fees. H. A. Thompson queried the application of the entire grant from The Canadian National Sportsmen's Show to *The Canadian Field-Naturalist*, rather than partly to *Trail & Landscape*; W. J. Cody replied that the application had requested support for both publications, but that the reply had awarded it to *The Canadian Field-Naturalist* only. (This was later confirmed.) The report was adopted on motion (by Gruchy, 2nd F. Brodo).

The President reviewed the Annual Report of Council, copies of which were available to those present. He mentioned that more briefs and submissions had been produced than ever before. Housekeeping matters, including the question of the Treasurer's Assistant, the relationships between the Club and *The Canadian Field-Naturalist*, and revision of the Constitution and By-Laws, had also occupied considerable time.

Highlights of the committee reports included continued growth in the numbers of papers submitted for publication in *The Canadian Field-Naturalist* and the need for grants in aid of Club publications; the successful general meeting on conservation activities; investigation of tax-free status for the Club; slight decrease in local membership, and death of Honorary Member Prof. A. F. Coventry; briefs submitted on the chlorination of Mooney's Bay, preservation of the Ottawa beach area, and the Carp Hills area, and on the Ottawa/Carleton Draft Regional Plan; the 25th anniversary of the founding of the Macoun Field Club; award of prizes for natural history exhibits in the Regional Science Fair; successful bird counts in the Christmas, late spring, and early fall periods; consideration for erection of more bird feeders for public viewing; need for terms of reference for Publicity committee; regular reports of F.O.N. affairs in *Trail & Landscape*, which needs more material of all sorts.

G. Neville queried the Club's continuing to hold stocks of Bell Canada, and moved (2nd L. C. Smith) that a committee be appointed to bring a decision on this to Council in February; this was carried.

In the absence of its chairman, the President asked A. Hanes to report for the Nominations Committee. Names of the slate of officers were read, and approved on motion (by A. Hanes, 2nd M. Stuart). Names of additional Council members were then read, and approved on motion (by A. Hanes, 2nd H. Thompson).

M. Brigham and H. Williamson were then approved as Auditors, on motion (by C. Gruchy, 2nd J. Reddoch).

The President read a letter from the retiring Governor-General Mr. Roland Michener, who has served as Patron of the Club during his term of office.

Under new business, D. A. Smith then introduced eight amendments to the Constitution. He reviewed parts of the revised Constitution adopted last year, without opportunity for amendments at the time, and pointed out the problems involved in proposing amendments under existing procedures; under these, he proposed eight separate amendments, to be voted on next year, as follows:

(1) delete Article 24 on Amendments, and replace it which a clear sequence of events to be carried out (2nd by S. Thomson). After considerable discussion, the meeting agreed that such proposed amendments needed only two supporters (mover and seconder) since Council could consider them subsequently;
(2) delete Article 5 on Affiliated Societies completely (2nd by R. Foxall). In discussion, W. J. Cody indicated that affiliation had originally been specifically to aid publication of *The Canadian Field-Naturalist*; now the Club actually shows an appreciable deficit through affiliation. It was agreed that adequate time was available to find out if the affiliated clubs wished to terminate their association, transfer it to the Canadian Nature Federation or raise it to a level of support for *The Canadian Field-Naturalist*;
(3) delete first paragraph of Article 10 on make-up of Council and replace it with omission of Presidents of Affiliated Societies and of Editor of *The Canadian Field-Naturalist* and Business Manager of *The Canadian Field-Naturalist* (2nd by G. Neville). It was suggested that the Business Manager of *The Canadian Field-Naturalist* should be on Council, since 40% of Club funds are assigned to *The Canadian Field-Naturalist*;
(4) amend Article 18 to state that the Vice-President be a member of the Finance Committee (2nd C. Gruchy);
(5) amend Article 19 to require the Recording Secretary to deal with amendments to the Constitution under Article 24 (2nd R. Foxall);
(6) amend Article 21 to state that the Treasurer be a member of the Finance Committee (2nd Ian Sutherland);
(7) delete second paragraph of Article 14 on appointments by Council, and replace it with omission of Associate Editors (2nd S. Thomson);
(8) amend Article 15 on Terms of Office so that Council, Auditors, Committees, Editors, etc. serve until their successors are duly elected or appointed, and that Editors be appointed for renewable terms not exceeding 3 years (2nd G. Neville).

Further to submissions on the Ottawa-Carleton Draft Regional Plan, Mr. Champ suggested that the Club should formally deplore the rumored statement (in the media) that not all briefs would be fully considered owing to insufficient time; A. Reddoch noted that many of the Club's suggestions have already been discussed with the O/C Planning Board. Champ moved (2nd G. Neville) that the Club request that its submission be given full and adequate consideration, and that copies also be sent to the Ontario Municipal Board (as the final authority in this matter); this passed, with three opposed.

The President then made the following announcements:

(a) the National Capital Commission has issued maps showing the new ski and snowshoe trails in the region; he noted that the Jack Pine Trail is open to all, not reserved for skiers and snowshoers (as some have believed);
(b) the National and Provincial Parks Association of Canada, Ottawa-Hull Chapter, will hold a meeting on 30 January, with Mr. E. Gallant, Chairman of the NCC, as speaker;
(c) the Colour Photographic Association has a display of nature slides at the National Archives, in connection with its meeting on 18 February, with Dr. Mosquin, Executive Director of the Canadian Nature Federation, as speaker;
(d) the Canadian Nature Federation will hold its 1974 annual meeting 21–27 August in London, Ontario, with the assistance of the McIlwraith Field Naturalists' Club;
(e) Dr. Harrison F. Lewis, Honorary Member of the Club, died on 16 January 1974.

After the business meeting, two films were shown. Ken Buck introduced his film on the natural beauties of Meach Brook, and David Nettleship showed the film "Puffins, Predators, and Pirates," which had been prepared for the television series *The Nature of Things* with his technical advice. Refreshments were served, and the meeting adjourned on motion (by R. Foxall) about 11:35 p.m.

A. J. ERSKINE (Recording Secretary)

Proposed Amendment to the Constitution of The Ottawa Field-Naturalists' Club

Add to Article 1

All assets and other accretions of the Club shall be used in promoting the Objectives of the Club and in no way shall be used for the purpose of financial gain for its members. In the event of dissolution of the Club, all remaining assets, after payment of liabilities, shall be distributed to one or more recognized charitable organizations in Canada.

Moved by C. G. Gruchy
Seconded by L. C. Smith

The Ottawa Field-Naturalists' Club Balance Sheet

as at December 31st, 1974

Assets

Current		
Cash in Bank – Current Accounts	$24,789.27	
Cash in Bank – Savings Accounts	1,675.17	
Bills Receivable	2,044.18	
Accrued Interest Receivable	5,227.64	$33,736.26
Fixed (at cost)		
Furniture, fixtures and equipment	529.50	
Less Accumulated Depreciation	312.62	216.88
Investments and Securities		
Canada Savings Bonds		10,700.00
		44,653.14

Lialibities and Equity of Surplus

Current Liabilities		
Income Received in Advance	6,574.00	
Accounts Payable	14,312.54	20,886.54
Equity of Surplus		
Balance January 1st, 1974	19,859.96	
Add Net Income for the Period	3,906.64	23,766.60
		$44,653.14

(Signed) F. M. Brigham, Auditor
H. Williamson, Auditor
C. G. Gruchy, Treasurer

The Ottawa Field-Naturalists' Club Statement of Profit and Loss
for the year ending December 31, 1974

Net Income from ***The Canadian Field-Naturalist***		$ 842.33
Other Revenue		
Membership Income	$ 5,998.80	
Donations	120.44	
Sale Income	22.37	
Subscription *Trail & Landscape*	308.50	
Back Numbers *Trail & Landscape*	46.55	
Interest Income & Dividends	1,433.46	7,930.12
		8,772.45
Less Cost of Publication		
Trail & Landscape Volume 8	1,802.79	
Circulation	173.71	
Office	63.92	
Honoraria	250.00	2,290.42
Gross Profit on Operations		6,482.03
Less Operating Expenses		
Special Activities	—	
Capital Expenditure	414.91	
Council Expenses	517.86	
Printing & Stationary	20.34	
Membership Committee	372.86	
Excursions & Lectures	135.00	
Bird Feeder	211.58	
Research & Briefs	—	
Macoun Club	181.10	
Delegation Expenses	—	
Orchid Survey	—	
F.O.N. Scholarship	130.00	
Bank Charges & Interest	38.34	
Depreciation Expense	54.22	
Accounting Services	200.00	
Advertising & Promotion	159.39	
Conservation Committee	99.79	
Education Committee	40.00	2,575.39
Net Income		3,906.64

The Ottawa Field-Naturalists' Club Statement of Profit and Loss — The Canadian Field-Naturalist

for the year ending December 31, 1974

Revenue			
Membership Income		$ 3,999.20	
Subscription Income		6,873.21	
Grants — National Research Council of Canada	$4,500.00		
Canadian National Sportsmen's Show	750.00	5,250.00	
Reprints		3,282.80	
Plates & Tab Settings		1,290.29	
Extra Pages		2,946.01	
Back Numbers		871.10	
Special Publications		265.00	$24,777.61
Less Cost of Publications			
Volume 88 (No.'s 1, 2, 3, 4)		13,966.00	
Plates & Tab Settings		71.00	
Reprints		2,972.83	17,009.83
Gross Profit on Operations			7,767.78
Less Operating Expenses			
Bank Charges & Interest		68.75	
Circulation		1,636.94	
Office Assistant		1,293.28	
Postage		625.66	
Printing & Stationary		1,051.36	
Maintenance & Repairs		—	
Editing Contracts		500.00	
Editing General Expenses		839.46	
Capital Expenditure		210.00	
Business Managers' Expenses		250.00	
Honoraria		450.00	6,925.45
Net Income			842.33

Instructions to Contributors

Manuscripts

Authors should submit three complete manuscripts with two copies of figures (in addition to the originals) for use by referees. Manuscripts are accepted in either English or French. They should be typewritten on paper measuring $8\frac{1}{2} \times 11$ inches, and if possible, the paper should have numbered lines. Margins should be 1 to $1\frac{1}{2}$ inches wide to allow for copy marking. All text matter, including quotations, footnotes, tables, literature citations and captions for figures should be double-spaced. Only words meant to appear in italics should be underlined. Every sheet of the manuscript should be numbered. In no case should words be abbreviated; this includes references to tables and figures as well as literature citations. Authors are requested, however, to use SI symbols for units of measure.

It is strongly recommended that, before submitting a paper, authors ask qualified persons to appraise it.

An abstract is required for all Articles but is optional for Notes. Authors are requested to use at least one given name. Literature cited should be listed alphabetically according to author and should be placed immediately after the main body of the text, except in Letters to the Editor. If only one or two references are cited, they should be inserted in the text. The tables should be titled and numbered consecutively in arabic numerals, and each should be placed on a separate page after the Literature Cited. Captions for figures should be typed together on one page. The places in the text for tables and figures should be marked in the margin.

Extensive tabular or other supplementary material not essential to the text should be submitted on letter size paper ($8\frac{1}{2}'' \times 11''$) for the Editor to place in the Depository of Unpublished Data, National Science Library, National Research Council of Canada, Ottawa, Canada K1A 0S2. A notation in the published text should state that the material is available, at a nominal charge, from the Depository. Two copies are required for the Depository.

The **CBE Style Manual**, third edition (1972), published for the Council of Biology Editors, Committee on Form and Style, by the American Institute of Biological Sciences, is recommended as a guide to contributors.

Webster's New International Dictionary is the authority for spelling. In a case, however, of difference in the spelling of a common name, and in the use of a variant name, a decision of a learned society is preferred.

The order in which papers are published will be determined by the Editor.

Illustrations

All illustrations should be numbered consecutively in arabic numerals. The author's name, title of the paper, and figure number should be written in the lower left corner of the sheet on which each illustration appears. The caption should **not** appear on the illustration.

Line drawings should be made with India ink on white, good quality drawing paper, blue tracing linen, or good quality blue-lined co-ordinate paper. Co-ordinate lines that are to appear on the reproduction should be ruled in black ink. Descriptive matter should be lettered, not typewritten, and all parts of the drawing should permit easy legibility even if a reduction is made. Photographic reproductions of line drawings are acceptable in lieu of large originals.

Photographs should have a glossy finish and show sharp contrasts. For reproduction as a complete plate they should be mounted with minimal space between prints.

For large drawings and mounted photographs the ratio of height to width should conform to that of the printed journal page (ratio of 45 up to 35 across) or roughly $7\frac{1}{2} \times 5\frac{3}{4}$ inches, but the height should be adjusted to allow for the caption if the caption is to go on the same page.

Special Charges

Authors must share in the cost of publication by paying $40.00 for each page in excess of six journal pages. When grant or institutional funds are available, we ask authors to help defray a higher proportion of the cost of publishing their manuscripts. At the time the galley proofs are sent to authors, the journal will solicit on a voluntary basis a commitment to pay $40.00 per page for all published pages. Authors will also be charged for excessive changes in proofs.

Illustrations cost $5.00 each for any size (up to a full page). Tables cost up to $40.00 per page, depending upon size. The special charges for illustrations and tables are *in addition* to all charges that are levied for pages in excess of six. Reproduction of color photos is extremely expensive and the full cost must be borne by authors. Price quotations may be obtained from the Business Manager.

Limited journal funds are available to help offset publication charges to authors with minimal financial resources. Requests for financial assistance should be made to the Editor when the manuscript is submitted.

Reprints

An order form for the purchase of reprints will accompany the galley proofs sent to authors.

TABLE OF CONTENTS (*concluded*)

Mailing date of previous issue 18 April 1975

Errata

1974. Canadian Field-Naturalist 88(4): 477. *A physical and biological survey of La Grande River estuary, James Bay, Quebec* by Michael J. Dadswell. The footnote that reads "where the ratio of chlorinity to total dissolved solids drops below 18:1 (i.e., 0.1 parts per 1000 salinity)" should read "where the ratio of total dissolved solids to chlorinity changes from 1.8:1 to 10:1 or higher (i.e., 0.1 parts per 1000 salinity)."

1974. Canadian Field-Naturalist 88(2): 235. *Brown Thrasher on the coast of British Columbia* by R. Wayne Campbell. In the second paragraph the date "1973" should read "1972."

1974. Canadian Field-Naturalist 88(4): 437–448. *The distribution of aquatic plants in selected lakes of Gatineau Park, Quebec* by Susan Aiken and J. M. Gillett. The reference to Rubec (1973) is in error. The correct reference is Rubec, P. J. 1975. Fish distribution in Gatineau Park, Quebec, in relation to postglacial dispersal, man's influence, and eutrophication. Canadian Field-Naturalist 89. *In press.*

1974. Canadian Field-Naturalist 88(4): 558, 560 and 564. *Index to Volume 88.* The plant genus that appears as *"Listeria"* should read *"Listera."*

Indexer Needed. If you are someone who is careful about details and are willing to provide this valuable service to *The Canadian Field-Naturalist*, please contact Dr. C. G. van Zyll de Jong, Chairman of the Publications Committee, at Box 3264, Postal Station C, Ottawa, Ontario K1Y 4J5.

TABLE OF CONTENTS

concluded on inside back cover

THE CANADIAN FIELD-NATURALIST published by **The Ottawa Field-Naturalists' Club**
Box 3264, Postal Station C, Ottawa, Canada K1Y 4J5
Second Class Mail Registration No. 0527 — Return postage guaranteed
ISSN 0008–3550

The CANADIAN FIELD-NATURALIST

Published by THE OTTAWA FIELD-NATURALISTS' CLUB, Ottawa, Canada

Volume 89, Number 3

July-September 1975

The objectives of this Club shall be to promote the appreciation, preservation, and conservation of Canada's natural heritage; to encourage investigation and publish the results of research in all fields of natural history and to diffuse information on these fields as widely as possible; to support and co-operate with organizations engaged in preserving, maintaining, or restoring environments of high quality for living things.

Correspondence: Address to The Ottawa Field-Naturalists' Club, Box 3264, Postal Station C, Ottawa, Canada K1Y 4J5

The Canadian Field-Naturalist

The Canadian Field-Naturalist is published quarterly by The Ottawa Field-Naturalists' Club with the assistance of contributions from the National Research Council of Canada and The Canadian National Sportsmen's Show. Opinions and ideas expressed in this journal are private and do not necessarily reflect those of The Ottawa Field-Naturalists' Club or any other agency.

Subscriptions and Membership

Subscription rates for individuals are $7.00 per calendar year. Libraries and other institutions may subscribe at the rate of $12.00 per year (volume). The annual membership fee of $7.00 includes club publications. Subscriptions, applications for membership, notices of changes of address, and undeliverable copies should be mailed to: The Ottawa Field-Naturalists' Club, Box 3264, Postal Station C, Ottawa, Canada K1Y 4J5.

Back Numbers

Most back numbers of this journal and its predecessors, *Transactions of The Ottawa Field-Naturalists' Club*, 1879-1886, and *The Ottawa Naturalist*, 1887-1919, may be purchased from the Business Manager.

All material intended for publication should be addressed to the Editor:

Dr. Lorraine C. Smith, Department of Biology, Carleton University, Ottawa, Ontario K1S 5B6

Cover photograph: Woodland caribou rutting band, a bull and cows, grazing in autumn in Newfoundland. Canadian Wildlife Service photo by G. L. M. Tuck. Similar animals were reintroduced to Nova Scotia. See article on page 299.

The Canadian Field-Naturalist

VOLUME 89, NUMBER 3 JULY-SEPTEMBER 1975

High Arctic Lemmings (*Dicrostonyx groenlandicus*) I. Natural History Observations[1]

W. A. FULLER,[2] A. M. MARTELL,[2] R. F. C. SMITH,[3] and S. W. SPELLER[4]

[2] Department of Zoology, University of Alberta, Edmonton, Alberta, T6G 2E1
[3] Department of Zoology, University of Brandon, Brandon, Manitoba, R7A 6A9
[4] Department of Indian and Northern Affairs, Ottawa, Ontario

Fuller, W. A., A. M. Martell, R. F. C. Smith, and S.W. Speller. 1975. High arctic lemmings (*Dicrostonyx groenlandicus*): I. Natural history observations. Canadian Field-Naturalist 89: 223–233.

Abstract. Greatest density (533.3 per hectare) of burrows of collared lemmings (*Dicrostonyx groenlandicus*) in a high arctic setting occurred in peat polygons which occupied well under 1% of Truelove Lowland, Devon Island. Raised beaches occupied more than one-quarter of the lowland and had a burrow density of 115.4 per hectare largely associated with frost cracks. Meadows were much less densely settled. Winter nests were found in areas of deepest snow accumulation and were subject to 11.6% predation by *Mustela erminea*. Subnivean temperature in a meadow site fell gradually to about −25°C, where it remained for at least 11 weeks during the winter of 1972–73, when the population was in increase phase. Four species of plants, *Dryas integrifolia, Saxifraga oppositifolia, Salix arctica,* and *Pedicularis* sp. predominated in the autumn diet. Presence and calorific values are given for plants in winter habitats.

Lemmings (*Lemmus* and *Dicrostonyx*) have fascinated natural historians literally for centuries. Legends and anecdotal accounts of their biology have received some attention from scholars (Elton 1942; Marsden 1964), but it is only since the middle of this century that systematic attempts have been made to study their biology in depth. Batzli (*in press*) has reviewed the role of small mammals in tundra ecosystems.

Both genera have been studied on the mainland tundras of North America west of Hudson Bay. Pitelka (1973), in Alaska, and Krebs (1964), in Keewatin, found *Lemmus* more abundant than *Dicrostonyx,* but Shelford (1941) found the reverse at Churchill on the southern fringe of the tundra. Both genera occur on many islands in the low Arctic and studies have been reported from Southampton (Sutton and Hamilton 1932; Parker 1974) and Baffin (Watson 1956). Only *Dicrostonyx* occurs in Ungava and on islands of the high Arctic. Previous studies in the high Arctic of the New World have been anecdotal and of short duration (Jensen 1905; Manniche 1910; Savile and Oliver 1964). In contrast, there have been major studies of *Dicrostonyx* in the Soviet Arctic; see, for example, the detailed account of *D. torquatus* on Yamal Peninsula (Dunaeva 1948).

In this paper we report on some natural history observations. Our material on demographic changes (Fuller et al. 1975) and on energy flow through lemmings will be published elsewhere.

Study Area

The study area was Truelove Lowland (75°33′ N, 84°40′ W), on Devon Island, (Figure 1) a detailed description of which is being published (Bliss 1975). In general, the lowland consists of a system of raised beaches with a thin vegetation cover and de-

[1] Contribution Number 23 Devon Island Project IBP

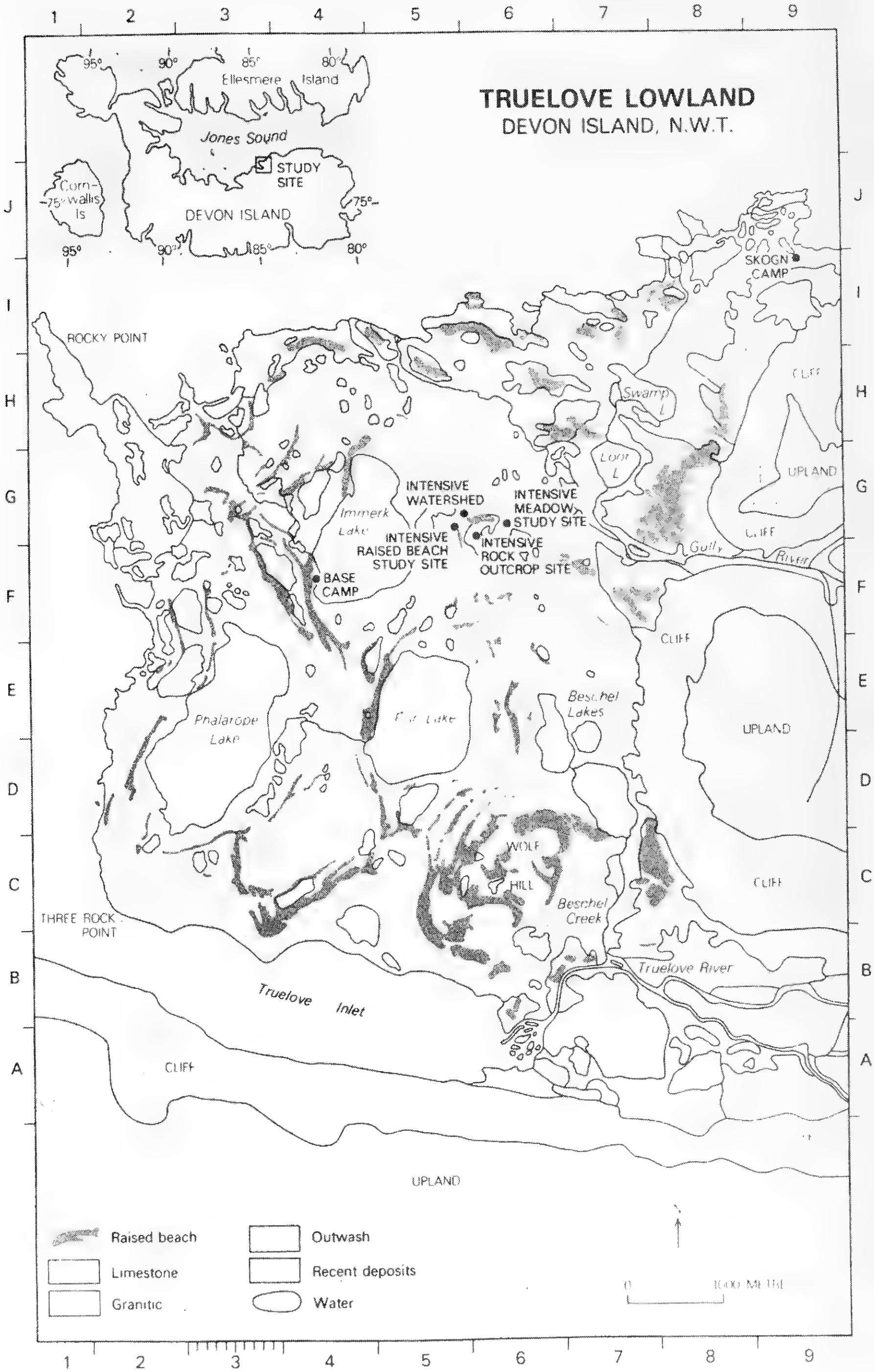


FIGURE 1. Map of Truelove Lowland.

pressions containing mesic to wet meadows with much richer and more productive plant communities. There are also several lakes and many ponds. The area is underlain by permafrost, and periglacial features, such as frost mounds and ice-wedge polygons, occur.

Base camp for the study was the Arctic Institute of North America's Devon Island Research Station. Previous studies on the lowland dealt with vegetation (Barrett and Teeri 1973) and birds (Hussell 1972). Hussell and Holroyd (1974) undertook limited studies of lemmings in connection with the avian program.

Because a system of raised beaches is a dominant feature of Truelove Lowland, there is good interspersion of lemming habitat. The ancient beaches are slightly elevated and, therefore, dry during summer and to a large extent exposed, or covered only by a thin veneer of wind-blown snow in winter. Their crests support a sparse cover (10–25%) of vascular plants dominated by *Dryas integrifolia, Carex nardina, Saxifraga oppositifolia,* and *Salix arctica*; their slopes have a somewhat denser cover (25-50%) with *D. integrifolia* assuming even greater importance, *Carex rupestris* ranking third and *S. arctica* being much reduced (Svoboda 1973). Their seaward-facing foreslopes grade into meadows through a transition zone that has a cover value greater than 50% and is dominated by a further increase in *D. integrifolia* and *C. rupestris,* with the addition of *Cassiope tetragona.* The most common meadows are mesic (hummocky sedge-moss) meadows dominated by *C. stans* and *Eriophorum angustifolium* (Muc 1973). Frost-boil sedge-moss meadows dominated by *E. triste* and *C. membranacea* are nearly as common (Bliss 1975). Backslopes of raised beaches are frequently rocky and grade into meadow or, occasionally, go abruptly to meadow. Outcrops of granitic rock, changing abruptly to meadow, constitute another type of lemming habitat. A small part of the lowland (approximately 10 ha) is occupied by ice-wedge polygons which are heavily utilized by lemmings.

Methods

As an aid to working out habitat preferences and to providing additional data on population density, counts were made of burrows, both active and inactive, in a variety of habitat types. Active burrows were usually easy to recognize by the presence of recently excavated soil at their entrances.

Counts of winter nests were made each spring from 1970–1973 just at snow-melt. Each spring all nests discovered were destroyed on discovery to prevent double counts and to remove the possibility of counting nests that had survived from an earlier winter. Thus, only in 1970 was a judgment required concerning the age of most nests found. At the same time a record was kept of nests probably invaded by predators, predominantly ermines (*Mustela erminea*). Nests that had been invaded could usually be recognized by modification of the nest to serve as shelter for the predator after the prey had been eaten or evicted, as noted by Maher (1967); and by the presence nearby of lemming remains such as stomachs, feet, and skulls, or an abundance of ermine scats.

Finally, an examination of winter habitat was undertaken in 1970. In each of five sites having heavy concentrations of winter nests, six randomly chosen plots, 40 $\times$ 40 cm, were established. All vegetation on each plot was carefully removed, individual plants were counted, and mean weights of live and dead tissues determined. Later, caloric content of the most important species was determined by bomb calorimetry.

The following periods were spent on the area: 29 May – 2 September 1970 (A. M. Martell); 14 June – 1 October 1971 (S. W. Speller); 18 May – 8 September 1972 (R. F C. Smith). In addition a party of botanists returned to the lowlands in 1973 and undertook nest counts and limited sampling of lemmings.

Observations

Habitats

Our approach to summer habitat preference was to record burrow density in different habitats (Table 1). Ice-wedge polygons were obviously preferred summer habitat with raised beaches receiving moderate use and mesic to wet meadows much less. Granitic outcrops are rather densely inhabited, but accurate burrow counts were impossible because many burrow entrances were hidden under rocks or in crevices.

TABLE 1—Estimates of lemming burrow densities in three habitats on Truelove Lowland; data are averages of three summers

	Area sampled (ha)	Density (burrows/ha)
Raised beaches	16.67	115.4
Polygons	1.44	533.3
Mesic meadows	26.63	26.7

A finer subdivision of the location of burrows was attempted in 1970 and 1971. In July 1970 a small (approximately 30 × 50 m), isolated portion of raised beach and the earth mound areas immediately adjacent to it were mapped for lemming burrows (Figure 2). The area examined was bounded by a lake and mesic *C. stans* meadow, and had a total area of 2300 m^2.

Clustered burrows individually within about a metre of another burrow were counted as a group; the numbers on Figure 2 indicate the number of burrows within a group. The largest concentrations of burrows were in earth mound areas where, for example, a group of 60 burrows lay in an area of about 18 m^2. Some earth mound areas, however, contained no burrows. Burrows on raised beach proper were strongly associated with frost cracks that served as runways and provided some concealment from avian predators.

A second beach ridge approximately 625 m long was divided into 25-m^2 blocks and burrow counts were made in each block (Figure 3). Association of burrows with frost cracks and foreslope transition zone is readily apparent. As elsewhere in the Arctic, microtopography appears to play an important role in the life of lemmings.

In 1971 the proportion of burrows in a number of microhabitats was tallied (Table 2). Frost cracks were clearly heavily used on ridge tops (cf., Figures 2 and 3); there was a strong association with rocks on backslopes and mesic meadows; and southern exposures were preferred on polygons.

Some indication of seasonal shifts in habitat was also obtained in 1971 (Figure 4). Catches declined strongly on raised beaches and polygons, declined, then levelled out in rocky areas, and increased temporarily in mesic meadows during July and August, before declining in September.

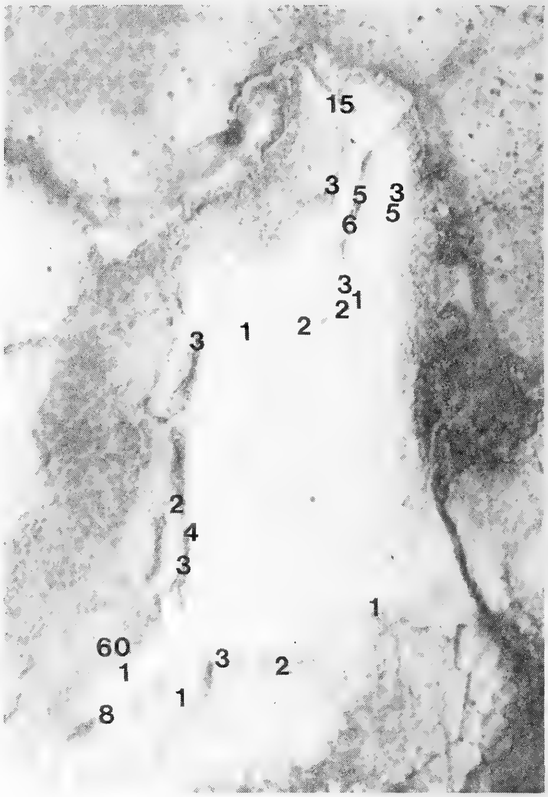


FIGURE 2. A small, isolated beach ridge and surrounding habitat having an area of 2300 m^2 showing locations of lemming burrows. Numbers refer to single burrow entrances or to groups of entrances probably belonging to a single burrow system. Note the concentration of burrows in an earth mound area in the lower left of the photograph and the association of burrows with frost cracks on the beach ridge proper.

Winter habitat preferences were determined from the location of winter nests, which were overwhelmingly located in two areas, transition zones of raised beach foreslopes and those backslopes that terminated abruptly in meadow. These are the places that have the deepest and most persistent winter snow cover.

Results of the study of winter habitat are shown in Tables 3 and 4. It is clear that relatively few species dominate in terms of both

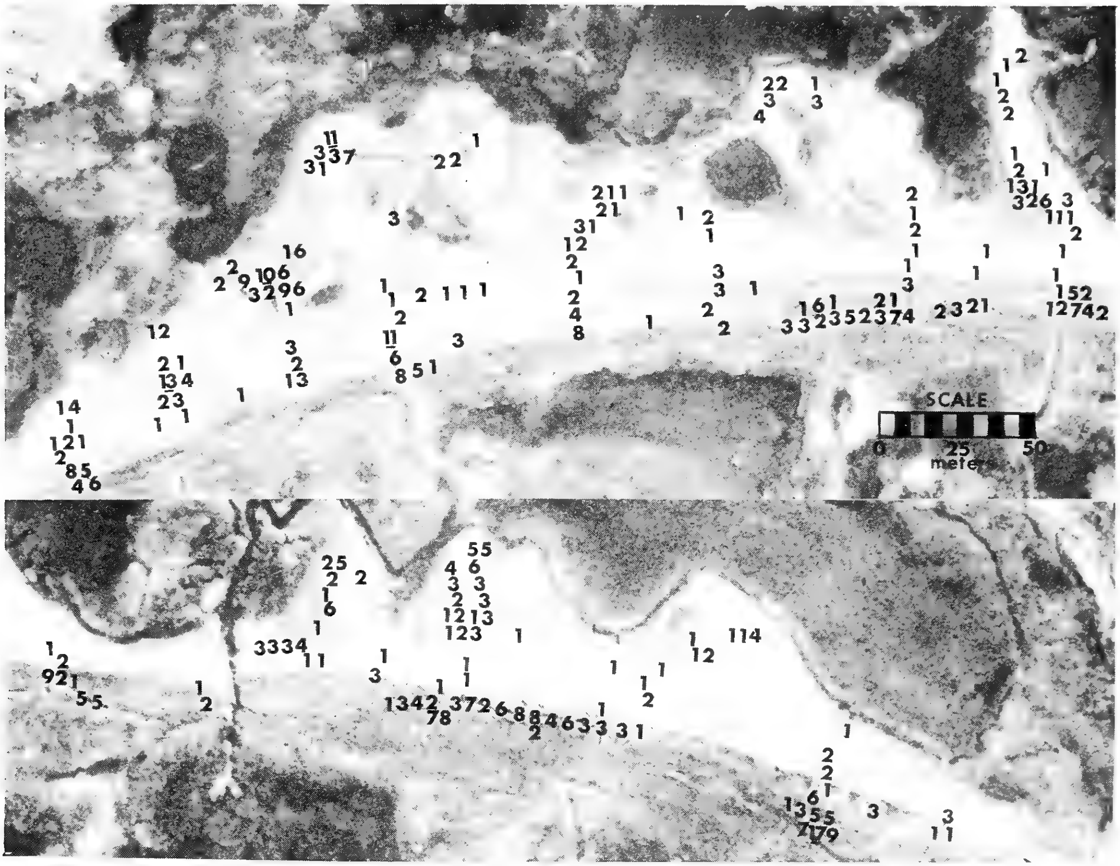


FIGURE 3. Location of lemming burrows on a beach ridge about 625 m long. Numbers indicate the number of burrows in each square 5 × 5 m. Note the concentration of burrows along frost cracks and in the foreslope transition zone.

TABLE 2—Percentages of lemming burrows located in different microhabitats in 1971

	Burrows (%)		
Microhabitats	Under rocks	In ice wedges	Other sites
Raised beaches			
Ridge tops	18	54	29
Foreslope	56		44
Backslope	96		4
Mesic Meadows	67		33
Polygons			
Exposure: North			14
South			36
East			12
West			13
Top			25

presence values and either numbers or biomass. Caloric values for vascular plants were mostly in the range 4.5 to 5.0 Kcal/g, but values for lichens were considerably lower.

Food Habits

In June identifiable remains of *Carex misandra* were found at entrances to ventilation shafts. This is the only direct evidence we have concerning probable winter foods. Availability of *C. misandra* in relation to other flowering plants stands out clearly (Table 3), but its caloric value is only moderately high (Table 4).

Opportunity to study autumn food selection was provided by a light fall of snow (4 cm)

TABLE 3—Number, biomass, and presence value for major species of plants growing in lemming winter habitats

Species	Dry weight (g/m^2) Live ($\bar{x} \pm SE$)	Dry weight (g/m^2) Dead ($\bar{x} \pm SE$)	No. individuals per m^2 ($\bar{x} \pm SE$)	Presence (%)
Monocots				
Carex misandra	4.12 ± 0.619	10.88 ± 1.588	226.4 ± 26.9	100
Juncus biglumis	0.38 ± 0.063	0.50 ± 0.063	182.7 ± 27.1	97
Luzula nivalis	0.81 ± 0.150	2.00 ± 0.431	84.2 ± 13.2	93
Arctagrostis latifolia	0.50 ± 0.188	0.69 ± 0.356	78.8 ± 34.9	43
Carex stans	0.31 ± 0.188	0.19 ± 0.106	7.5 ± 4.9	10
Dicots				
Salix arctica	17.13 ± 2.275	0.06 ± 0.000	59.2 ± 4.8	100
Saxifraga oppositifolia	4.50 ± 0.938	17.81 ± 3.294	30.0 ± 2.7	97
Stellaria + *Cerastium*	0.13 ± 0.000	0.50 ± 0.106	37.1 ± 6.9	87
Papaver radicatum	0.25 ± 0.000	0.62 ± 0.188	15.4 ± 3.5	70
Dryas integrifolia	1.31 ± 0.694	5.13 ± 3.081	8.9 ± 1.9	70
Saxifraga caespitosa	0.56 ± 0.175	1.13 ± 0.256	43.8 ± 11.9	67
Polygonum viviparum	0.13 ± 0.000	0.06 ± 0.000	11.9 ± 3.5	57
Pedicularis hirsuta	0.19 ± 0.106	0	12.5 ± 4.4	40
Pedicularis lanata	0	0	3.8 ± 1.8	27
Saxifraga cernua	0	0	4.6 ± 2.3	23
Oxyria digyna	0	0	2.5 ± 1.5	20
Saxifraga nivalis	0	0	0.6 ± 0.4	10
Lichens				
Thamnolia vermicularis	4.80 ± 0.613			100
Cetraria nivalis	1.94 ± 0.331			93
Stereocaulon glarescum	0			93
Lecanaria carpestris	0			83
Cetraria islandica	2.44 ± 0.525			83
Cladonia puccilum	0.25 ± 0.150			73
Dactylina ramulosa	0.25 ± 0.125			33
Parmelia sp.	0			27
Bryophytes				
Total mosses	53.75 ± 12.863			100

on 19 September 1971. During the next two days lemming trails were frequently encountered and followed. The animals dug feeding craters to reach favored food plants. Of 701 craters examined, 95.8% terminated at one of only four species of dicot. The remaining 4.2% terminated at eight additional species. The species most often utilized were *Dryas integrifolia* (42.9%), *Saxifraga oppositifolia* (36.9%), *Salix arctica* (12.3%), and *Pedicularis* sp. (3.7%). Note that August caloric values are high for *D. integrifolia* and *S. arctica* and moderately high for *S. oppositifolia* (Table 4), while all three have high presence values (Table 3).

Microclimate

Meteorological observations were related mainly to sites studied intensively for primary production (e.g., Intensive Meadow and Intensive Beach Ridge, Figure 1). Winter records were only attempted in 1972–73 when a small party overwintered on the lowland. Weekly mean temperatures in the air (T_a), at the soil–snow interface (T_s), and in the snow, 5 cm above the soil (T_5) at the Intensive Meadow Site (Courtin 1974) were plotted to obtain the temperature curves in Figure 5. A partial record of T_s in the transition zone during May and June 1973 has been added to Figure 5. Data points for 1973 are weekly

TABLE 4—Calorie value (Kcal/g ash-free dry matter) of potential lemming food plants sampled in August 1970

Species	Caloric value (mean ± SE)	Number of runs
Monocots		
Carex misandra	4.477 ± 0.021	5
Juncus biglumis	4.525 ± 0.006	3
Luzula nivalis	4.518 ± 0.039	4
Arctagrostis latifolia	4.493 ± 0.006	2
Carex stans	4.521 ± 0.015	2
Dicots		
Salix arctica – entire	4.812 ± 0.000	2
– stems	5.018 ± 0.031	3
– leaves	4.653 ± 0.036	5
Saxifraga oppositifolia	4.508 ± 0.057	5
Papaver radicatum	4.531 ± 0.054	3
Dryas integrifolia	4.802 ± 0.092	3
Saxifraga caespitosa	4.626 ± 0.148	5
Pedicularis hirsuta	4.263 ± 0.026	2
Lichens		
Thamnolia vermicularis	3.880 ± 0.079	4
Cetraria nivalis	3.539 ± 0.247	5
Cetraria islandica	4.088 ± 0.056	5
Cladonia puccilum	3.630 ± 0.011	2
Dactylina ramulosa	4.254 ± 0.000	2

means of T_s recorded daily at 1200 hours (J. Sharp, personal communication). Thickness of snow cover (api) was measured monthly in a meadow adjacent to the Intensive Study Site. It increased linearly by 5 cm per month from 10 cm in October 1972 to 30 cm in February 1973, then stabilized at 30 cm through May 1973. Meadows were 50% snow-free on 18 June 1973, the earliest of four years studied. In sharp contrast, 46 cm snow was recorded in the meadow in May and June 1972, and meadows were 50% snow-free only on 6 July—the latest of the years studied.

Although no claim can be made that 1972–73 was a "typical" winter, and although the record pertains to a meadow site rather than the transition zone, where most lemming winter nests occur, some observations that have relevance to lemming biology seem warranted.

By mid-May 1972 T_a already exceeded T_s by about 12°C, and T_s stood at —20°. T_s rose slowly through most of June while the meadow remained snow-covered, then rose more rapidly in late June and early July as snow ablated. During the "spring" period, T_5 averaged about 5°C higher than T_s and reached 0°C about one week ahead of T_s. In the early spring of 1973, T_s began to increase earlier, and reached 0°C about three weeks sooner than in the previous spring. In both years, however, lemmings were breeding in May.

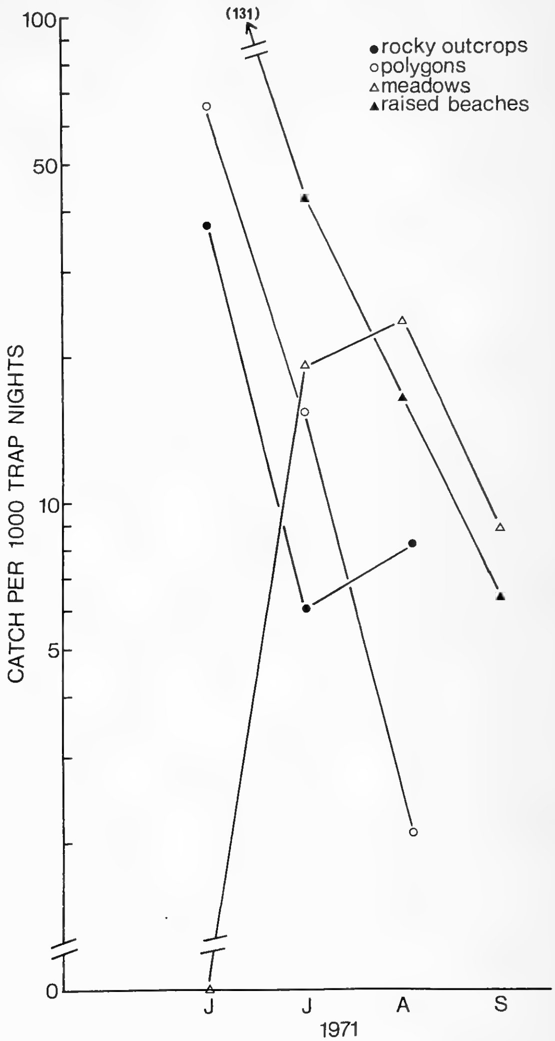


FIGURE 4. Changes in snap-trap capture index during summer 1971, in four habitats. Note exponential declines on raised beaches and in polygons, with temporary invasion of meadows in July and August.

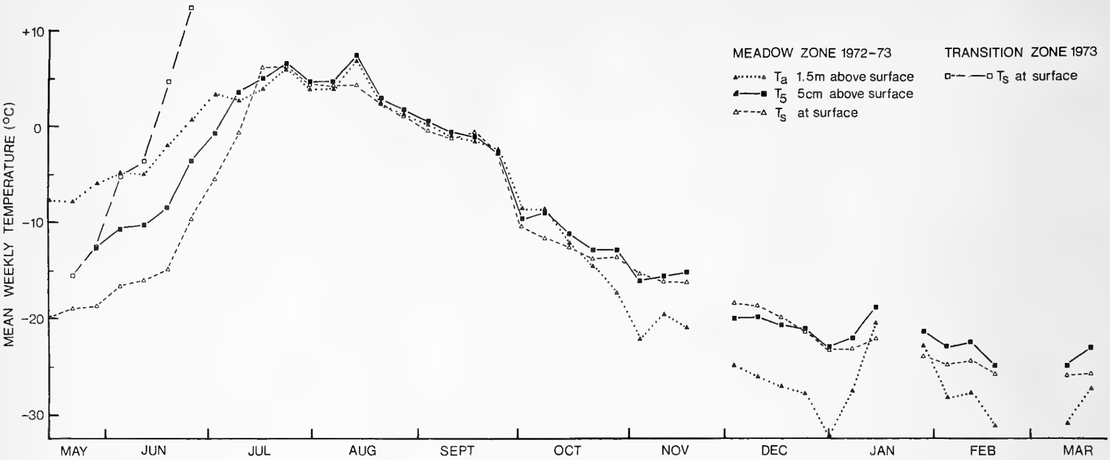


FIGURE 5. Weekly mean temperatures in a meadow site on Truelove Lowland from May 1972 to March 1973 and in a transition zone site during May and June 1973.

This sequence of thermal events differs markedly in at least one respect from the sequence in taiga. Pruitt (1957) showed that spring thermal overturn in taiga occurs at about the same time as T_a and T_s reach 0°C. On Devon Island these events were separated by at least six weeks and probably more (Figure 5).

Summer was short and cold in 1972. Mean weekly T_a exceeded 0°C for only about nine weeks, and T_s for only about eight weeks. There was little temperature stratification from soil surface to 1.5 m, and no weekly mean exceeded 7°C.

Fall thermal overturn (Pruitt 1957) was also delayed well beyond the time when T_a and T_s fell to 0°C (week ending 10 September). Except for the week of 17 September, T_s was below T_a until mid-October. This long delay is again quite different from the course of events in the taiga (Pruitt 1957), and may be related to the scanty snow fall in September and October 1972.

During winter, T_s tracked T_a but fluctuations were dampened under the snow. To mid-March, the temperature advantage in the subnivean environment never exceeded a weekly mean of 10°C. Commencing about mid-January a separation reappeared between T_s and T_a which gave an added advantage of 2–3°C to the region just above the soil surface until the record ended in mid-March. The occurrence of this warmer zone, for which we have no physical explanation, is undoubtedly a partial explanation for an observation first made decades ago (e.g., Sutton and Hamilton 1932), that *Dicrostonyx* winter nests are not built on the soil surface, but actually in the snow cover some distance above the surface.

A striking feature of the curve is the near linearity of the temperature decline from the summer peak, in the week ending 23 July, to full winter conditions. From 23 July to 31 December (23 weeks) T_s fell about 30°C (weekly average decline of about 1.3°C) and in only one week (ending 1 October) did it fall by more than 2°C. Thereafter it fell only 3°C in 11 weeks and was essentially stable near —25°C, while snow thickness stabilized at 30 cm. Such a gradual decline may be important in allowing physiological acclimatization of lemmings to keep pace with the increasing thermal stress.

Lemming numbers reached a low in July–August 1972 and attained a peak by early spring 1973 (Fuller et al. 1975), so that breeding must have proceeded vigorously during the winter of 1972–73, which must, therefore, be considered a favorable winter in spite of its severity. Unless conditions were markedly more favorable in the transition zone than in the meadow, these data seem to conflict with Quay's (1960) observation that captive female *Dicrostonyx* failed to ovulate when maintained at a temperature below about —8°C.

Predation

No direct observations of either avian or mammalian predation on lemmings were made; however, some idea of the intensity of winter predation by ermines (*Mustela erminea*) was obtained from examination of lemming winter nests in spring (Table 5). Observed rates of ermine predation were not significantly different from year to year although lemming numbers were low and declining in 1970, moderately high in 1971, low in 1972, and high in 1973 (Fuller et al. 1975).

TABLE 5—Predation by ermines (*Mustela erminae*) on winter nests of lemmings over four winters

Winter	Nests examined	Attacked by ermines number	%
1969–70	198	23	11.6
1970–71	80	9	11.3
1971–72	58	9	15.5
1972–73	35	2	5.7
Total	371	43	11.6

Discussion

Maher (1967) suggested that ermine predation might so depress an already declining lemming population that it would take two or three years to recover. He observed 30 winter nests attacked by ermines in a sample of 153 and thought that this intensity of predation (about 20%) contributed to the near-extinction of lemmings on Banks Island the following summer. MacLean et al. (1974) observed 34.7% predation by *M. nivalis* on *Lemmus* nests and 65% on a small sample of 17 *Dicrostonyx* nests. They also concluded that "predation on a declining lemming population is important in sustaining the amplitude of the cycle."

Although our data do not necessarily conflict with the above suggestions, neither do they offer much support. The fact that we found no significant differences in intensity of nest predation over four springs in which trapping indices varied as much as 200-fold (Fuller et al. 1975) suggests that predation had little effect on lemming numbers, but it may simply mean that a scanty ermine population was unable to keep pace with rapid changes in lemming numbers. Second, the average intensity of nest predation on Devon was significantly lower than that reported by Maher (1967) on Banks ($\chi^2 = 5.80$ $0.05 > P > 0.01$) and MacLean et al. (1974) in Alaska ($\chi^2 = 67.43$, $0.001 > P$). Averages can be deceptive, however, and a more sensitive test is to compare Maher's figures with ours in comparable years, that is, winters during which lemming numbers declined. Such winters in our study were 1969–70 and 1971–72. We had significantly less nest predation on Devon in 1969–70 than Maher recorded on Banks ($\chi^2 = 4.30$, $0.05 > P > 0.025$), and our population recovered to moderately high density in one year. This leads us to doubt that nest predation had a strong depressive effect. On the other hand, nest predation on Devon in 1971–72 was as severe as that reported for Banks ($\chi^2 = 0.467$, $P \simeq 0.5$). It may, therefore, have reached a level that intensified the lemming low of 1972, but it did not prevent the lemmings from attaining peak numbers the following year.

It has long been known that *Dicrostonyx* selects areas of thick snow for winter nests, but we found no previous record of the thermal advantage provided by a high arctic snow cover. Even for the low Arctic, records are rare. MacLean et al. (1974) have now shown that subnivean temperatures at Barrow, Alaska, can fall to —20°C in January, —26°C in March, and may vary as much as 7°C in different microhabitats on a given day. They concluded that subnivean temperature "may have a large influence on winter reproduction" and hence on the period of the cycle, a conclusion with which we are in full accord.

Dunaeva (1948) observed that *D. torquatus* was more "accurate" than *L. sibiricus* in constructing winter nests, even though she believed them less well adapted to arctic conditions. MacLean et al. (1974) observed two kinds of winter nests built by *Lemmus* and suggested that small flimsy nests were occupied by males whereas thick-walled ones were used by females and litters. They also noted that "*Dicrostonyx* nests consist more clearly of a shredded inner layer and a coarse outer layer," a description which also fits the nests we found on Devon. Since it seems unlikely that homeotherms as small as *Dicrostonyx* can survive chronic exposure to —25°C, temperature recordings inside winter nests would be of considerable interest.

Dunaeva (1948) commented on the spacing of winter nests. She found them to be 100–150 m apart in a winter of high numbers, but she spoke of "family" nests being closer together (2–5 m). She also recorded multiple occupancy of nests by subadults. MacLean et al. (1974) observed significant clumping of *Lemmus* nests in a year of abundance, but not in a year of low numbers. All of this suggests that winter social structure of lemming populations may be complex and worthy of study.

Lowlands such as Truelove Lowland are relatively minor features of the Arctic Archipelago and they contain some of the most productive plant communities. For this reason it is clear that our data do not represent the outer limits of conditions that lemmings can tolerate. Nevertheless, quantitative estimates of plant cover and related determinations of energy content of the commonest species all too rarely accompany studies of small mammals even at lower latitudes. Data recorded here should prove to be of considerable value to future students for comparative purposes. The same may be said concerning our quantitative data on habitat utilization.

Dicrostonyx groenlandicus is the smallest homeotherm permanently resident in the high Arctic. In order to occupy this place of distinction, collared lemmings may have competitive or adaptive advantages over brown lemmings of the genus *Lemmus*. This study has shed little light on what those advantages may be, but hopefully it has brought into sharper focus our knowledge of the high Arctic as a habitat for small homeotherms.

We conclude by re-echoing the plea of Fuller (1967) and MacLean et al. (1974) that there is still a great "need for data on events occurring under the snow cover of the arctic winter."

Acknowledgments

From 1970 to 1973 Canada mounted a study of a high arctic ecosystem under the auspices of the International Biological Program. We thank the project director, L. C. Bliss, for the opportunity provided to study intensively a high arctic population of *Dicrostonyx groenlandicus*. Financial support came from the Canadian Committee for the International Biological Program. Logistic support was provided by the Polar Continental Shelf Project and the petroleum industry. The Arctic Institute of North America operated the base camp. F. A. Pitelka and an anonymous reviewer made valuable suggestions for improvement of an earlier draft of the manuscript.

Literature Cited

Barrett, P. E. and **J. A. Teeri.** 1973. Vascular plants of the Truelove Inlet region, Devon Island. Arctic 26: 58–68.

Batzli, G. O. 1974. The role of small mammals in arctic ecosystems. J. J. Moore (editor). Tundra Biome Synthesis, Cambridge University Press. (*In press.*)

Bliss, L. C. 1975. High arctic ecosystems, Devon Island, Canada. "Abisko Proceedings," Tundra Biome Steering Committee, Stockholm. (*In press.*)

Courtin, G. 1974. Preliminary report on Devon Island microclimate. Devon Island IBP Project Report for 1973. 11 pp. (mimeo.)

Dunaeva, T. N. 1948. Comparative survey of the ecology of the tundra voles of the Yamal Peninsula. Trudy Instituta Geografii Akademii Nauk SSSR 41: 78–143. (English translation in Boreal Institute, University of Alberta.)

Elton, C. 1942. Voles, mice and lemmings. Oxford Press, London. 469 pp.

Fuller, W. A. 1967. Ecologie hivernale des lemmings et fluctuations de leurs populations. La Terre et la Vie 21: 97–115.

Fuller, W. A. 1967. Ecologie hivernale des lem- **S. W. Speller.** 1975. High arctic lemmings, *Dicrostonyx groenlandicus*: II. Demography. Canadian Journal of Zoology. (*In press.*)

Hussell, D. J. T. 1972. Factors affecting clutch size in Arctic passerines. Ecological Monographs 42: 317–364.

Hussell, D. J. T. and **G. L. Holroyd.** 1974. Birds of the Truelove Lowland and adjacent areas of northeastern Devon Island, N.W.T. Canadian Field-Naturalist 88: 197–212.

Jensen, S. 1905. Mammals observed on Amdrup's journeys to East Greenland 1890–1900. Meddelelser om Gronland 29(I): 1–62.

Krebs, C. J. 1964. The lemming cycle at Baker Lake, Northwest Territories, during 1959–62. Arctic Institute of North America Technical Paper 15. 104 pp.

MacLean, S. F., B. M. Fitzgerald, and **F. A. Pitelka.** 1974. Population cycles in arctic lemmings: winter reproduction and predation by weasels. Arctic and Alpine Research 6: 1–12.

Maher, W. J. 1967. Predation by weasels on a winter population of lemmings, Banks Island, Northwest Territories. Canadian Field-Naturalist 81: 248–250.

Manniche, A. L. 1910. The terrestrial mammals and birds of northeast Greenland. Meddelelser om Grønland 45(1): 1–200.

Marsden, W. 1964. The lemming year. Chatto and Windus, London. 252 pp.

Muc, M. 1973. Primary production of plant communities of the Truelove Lowland, Devon Island, Canada—sedge meadows. *In* Primary production and production processes, Tundra Biome. *Edited by* L. C. Bliss and F. E. Wielgolaski. Tundra Biome Steering Committee, Edmonton, Canada. pp. 3–14.

Parker, G. R. 1974. A population peak and crash of lemmings and Snowy Owls on Southampton Island, Northwest Territories. Canadian Field-Naturalist 88: 151–156.

Pitelka, F. A. 1973. Cycle pattern in lemming populations near Barrow, Alaska. Arctic Institute of North America Technical Paper 25: 199–215.

Pruitt, W. O., Jr. 1957. Observations on the bioclimate of some taiga mammals. Arctic 10: 131–138.

Quay, W. B. 1960. The reproductive organs of the collared lemming under diverse temperature and light conditions. Journal of Mammalogy 41: 74–89.

Savile, D. B. O. and **D. R. Oliver.** 1964. Bird and mammal observations at Hazen Camp, northern Ellesmere Island, in 1962. Canadian Field-Naturalist 78: 1–7.

Shelford, V. 1941. The abundance of the collared lemming (*Dicrostonyx groenlandicus* (Tr.) var. *richardsoni* Mer.) in the Churchill area, 1929–1940. Ecology 24: 472–484.

Sutton, G. M. and **W. J. Hamilton, Jr.** 1932. The mammals of Southampton Island. Memoirs of the Carnegie Museum 12 (part II, section 1). 111 pp.

Svoboda, J. 1973. Primary production of plant communities of the Truelove Lowland, Devon Island, Canada—beach ridges. *In* Primary production and production processes, Tundra Biome. *Edited by* L. C. Bliss and F. E. Wielgolaski. Tundra Biome Steering Committee, Edmonton, Canada. pp. 15–26.

Watson, A. 1956. Ecological notes on the lemmings *Lemmus trimucronatus* and *Dicrostonyx groenlandicus* in Baffin Island. Journal of Animal Ecology 25: 289–302.

Received 4 November 1974
Accepted 8 February 1975

Leech (Hirudinea) Infestations among Waterfowl near Yellowknife, Northwest Territories

JAMES C. BARTONEK and DAVID L. TRAUGER

Northern Prairie Wildlife Research Center, U.S. Fish and Wildlife Service, Jamestown, North Dakota 58401

Bartonek, J. C. and D. L. Trauger. 1975. Leech (Hirudinea) infestations among waterfowl near Yellowknife, Northwest Territories. Canadian Field-Naturalist 89: 234-243.

Abstract. Fourteen species of aquatic birds, including 11 species of ducks, were infested with leeches, *Theromyzon rude* and *Placobdella ornata,* near Yellowknife, Northwest Territories. Leeches infested 88% of 41 American Wigeon (*Anas americana*) and 31% of 86 Lesser Scaup (*Aythya affinis*) examined after death. Lesser Scaup captured by drive-trapping contained significantly more leeches than undisturbed ducks. Leeches were attached to the host within the mucosa of the nasal chamber, to the conjunctiva of the eye, and on the skin of the body. Although only two deaths of ducklings were directly attributed to leech infestations, other birds probably died as a result of parasitism by leeches.

Although leech parasitism of waterfowl is apparently widespread in North America (Trauger and Bartonek, *in press*), the incidence and significance of these infestations is poorly understood. Greatest contributions towards knowledge of leech–waterfowl relationships have accrued from studies conducted in Canada. Early work by Moore and Meyer (1951) and Meyer and Moore (1954) clarified the taxonomic relationships of leeches parasitizing waterfowl and identified the principal host species. This information was significantly extended by Moore (1964, 1966). Ecological relationships of leeches and aquatic birds were investigated in studies of the helminth fauna of grebes (Gallimore 1964), coots (Colbo 1965), and ducks (Graham 1966). Recently, Davies (1973) reviewed the geographic distributions and hosts of freshwater leeches in Canada.

We became interested in leech parasitism of waterfowl in 1966 while conducting research on diving ducks near Yellowknife, Northwest Territories (62°28′ N, 114°24′ W). During the summer of 1967 we studied leech infestations among waterfowl to determine the incidence of this parasitism. From 1968 through 1970 we made 206 additional observations in spring and summer to increase our understanding of leech–waterfowl relationships. In this paper we describe the nature and occurrence of leech infestations among a boreal waterfowl population. The distribution and significance of leech parasitism of various species of aquatic birds is reviewed elsewhere (Trauger and Bartonek, *in press*).

Study Area

Field work was conducted in the subarctic taiga north of Great Slave Lake where numerous small wetlands occur between low granitic outcroppings of the Precambrian Shield (Murdy 1964, 1966). These water areas are predominantly bog ponds characterized by floating mats of sedges (*Carex* spp.), buckbean (*Menyanthes trifoliata*), cinquefoil (*Potentilla palustris*), and water arum (*Calla palustris*). Other types of wetlands are numerous shallow pools with emergent vegetation and infrequent large lakes with abrupt ericaceous shores. Many wetlands have bottoms of deep loose muck. Most have aquatic plants such as yellow pondlily (*Nuphar variegatum*), pondweeds (*Potamogeton* spp.), watermilfoils (*Myriophyllum* spp.), bladderworts (*Utricularia* spp.), marestails (*Hippuris* spp.), and muskgrasses (*Chara* spp.). Murdy (1964) considered these waters to be generally "hard" with limited fertility. He found median values for composite surface samples taken in mid-July to be as follows: specific conductance 125 μmhos (25°C); total alkalinity 135 ppm; and pH 7.4. Bartonek and Murdy (1970), Murdy et al. (1970), and Trauger (1971) have described the environmental characteristics of the Yellowknife study area in greater detail.

Breeding populations of waterfowl near Yellowknife ranged from 45.9 to 55.2 pairs per square mile and averaged 51.3 between 1962 and 1965 (Murdy et al. 1970). Four species comprised nearly 90% of the breeding population (Murdy 1964): Lesser Scaup (*Aythya affinis*) 48%, Mallard (*Anas platyrhynchos*) 14%, American Wigeon (*Anas americana*) 14%, Green-winged Teal (*Anas crecca carolinensis*) 11%. Less abundant species were the Pintail (*Anas acuta*) 5%, Northern Shoveler (*Anas clypeata*) 4%, Ring-necked Duck (*Aythya collaris*) 2%, and Bufflehead (*Bucephala albeola*) 1%. The Surf Scoter (*Melanitta perspicillata*), White-winged Scoter (*M. deglandi*), Canvasback (*Aythya valisineria*), and Blue-winged Teal (*Aythya discors*), represented less than 1%. Red-necked Grebes (*Podiceps grisegena*), Horned Grebes (*P. auritus*), and Arctic Loons (*Gavia arctica*) were also common breeding species inhabiting wetlands of the study area.

Nature of Infestations

Leeches infesting ducks and other water-birds near Yellowknife were *Theromyzon rude* and *Placobdella ornata*. Although more host records exist for *Theromyzon rude* among various species of waterfowl (Meyer and Moore 1954; Moore 1966; McDonald 1969), Moore (1964, 1966) concluded that *Placobdella ornata* also feeds on blood extracted from various aquatic birds. In addition to *Theromyzon rude* and *Placobdella ornata, Glossiphonia complanata, Helobdella stagnalis,* and *Nephelopsis obscura* were collected in benthic samples from bog ponds or among food items in duck gullets during this study (Bartonek and Murdy 1970; Bartonek 1972). Moore (1964) found these species among leech specimens collected in the Yellowknife area; they also are known to occur widely in adjacent areas of Alberta (Moore 1964, 1966) and Saskatchewan (Oliver 1958). Identification of our specimens was aided by Klemm (1972) and confirmed by Roy T. Sawyer and Frederick J. Vande Vusse.

Mann (1962) has described responses of leeches (*Theromyzon* spp.) to a variety of stimuli favoring encounters with ducks. In our study, leech infestations of waterfowl were categorized according to the site of attachment: (1) eyes, (2) nasal chamber, (3) body, and (4) elsewhere.

Eyes

Leeches attached themselves to the conjunctiva at the medial canthus of the eye beneath the nictitating membrane. This attachment protected the leeches from scratching by the bird (Figure 1). Apparently leeches seldom, if ever, attached themselves to the cornea. Although no more than one leech was usually found per eye, its large size would either restrict the vision of the bird or blind it. Engorged adult leeches were readily apparent to observers, even when the bird was viewed from a distance through binoculars or telescopes. Young leeches, often several per eye, were found beneath both the nictitating membrane and the eyelid. These small leeches were often detectable only by detailed post-mortem examination.

We believe that adult leeches gained access to the eyes from the plumage of the head. Young leeches gained access to the eyes by at least three methods: (1) moving from the plumage of the head to the eye in a manner similar to that of adults, (2) being transported by the parent leech entering the eye, and (3) entering the nasal chamber, either independently or on the parent leech, and then moving to the eye via the lacrimal duct.

Leeches were removed from the eyes of captured birds by applying pressure with a fingertip against the medial edge of the nictitating membrane, which slipped back exposing the leech (Figure 1, inset) and then pulling the leech loose from the conjunctiva with a forceps. After the leech was removed, the conjunctiva remained inflamed and swollen for several hours, but blood exuded from the wound for only a few minutes. The eyelid frequently was closed for a period of time because of the irritation of hirudin, an anticoagulant secreted by the leech.

Although several European workers have reported leeches infesting the eyes of ducks and geese (Herter 1929; Christiansen 1939; Roberts 1955), this type of infestation has not been previously reported in North American waterfowl (Trauger and Bartonek, *in press*).

FIGURE 1. An adult leech (*Theromyzon rude*) attached to the conjunctiva beneath the nictitating membrane of this juvenile Lesser Scaup is conspicuous, while another leech is visible through the nare (arrows). The leech still clings to the conjunctiva after the nictitating membrane was slipped over its body (inset).

Kuznetsova (1955) and Roberts (1955) reported that the cornea of waterfowl became opaque after leeches fed at the conjunctiva. Kuznetsova (1955) also observed that sometimes the eye increased in size, even to the extent that it came out of the orbit. We did not observe any such signs of eye injury to any ducks handled in this study.

Nasal Chamber

Leeches attached themselves to the mucosa anywhere within the bird's nasal chamber, but generally posterior from the nares to, and occasionally inside of, the lacrimal ducts (Figure 2). Adult and young leeches that were deep within the nasal chamber were usually detected only after detailed post-mortem examination, but some adult leeches were visible through the nares (Figure 3). Engorged leeches protruding from the nares were swollen on both ends and constricted in the middle where the body passed through the nare. Such leeches were readily observed from a distance with the aid of binoculars or telescopes.

Entrance to the nasal chambers by both adult and young leeches is probably gained more frequently through the nares following attachment to and movement from the bill, and less frequently through the buccal cavity and then the pharynx following ingestion. In addition, the young leeches may be transported into the nasal chamber on adults.

Ducks react to the apparent discomfort caused by leeches in their nasal chambers by scratching with their feet at leeches protruding

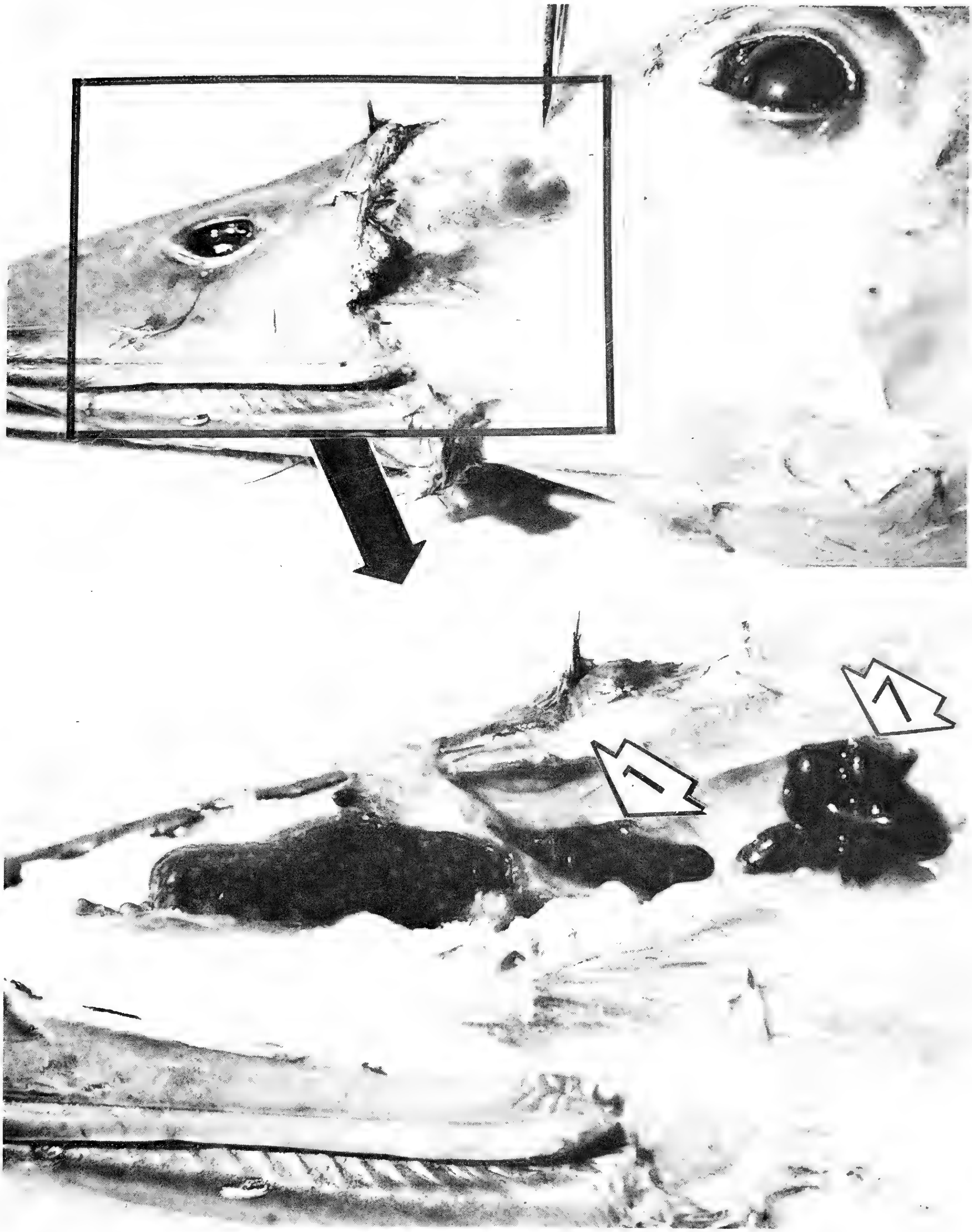


FIGURE 2. Only one adult leech (*Theromyzon rude*) is visible through the nare of this juvenile American Wigeon (above); however, dissection revealed eight leeches in the left nasal chamber (below).

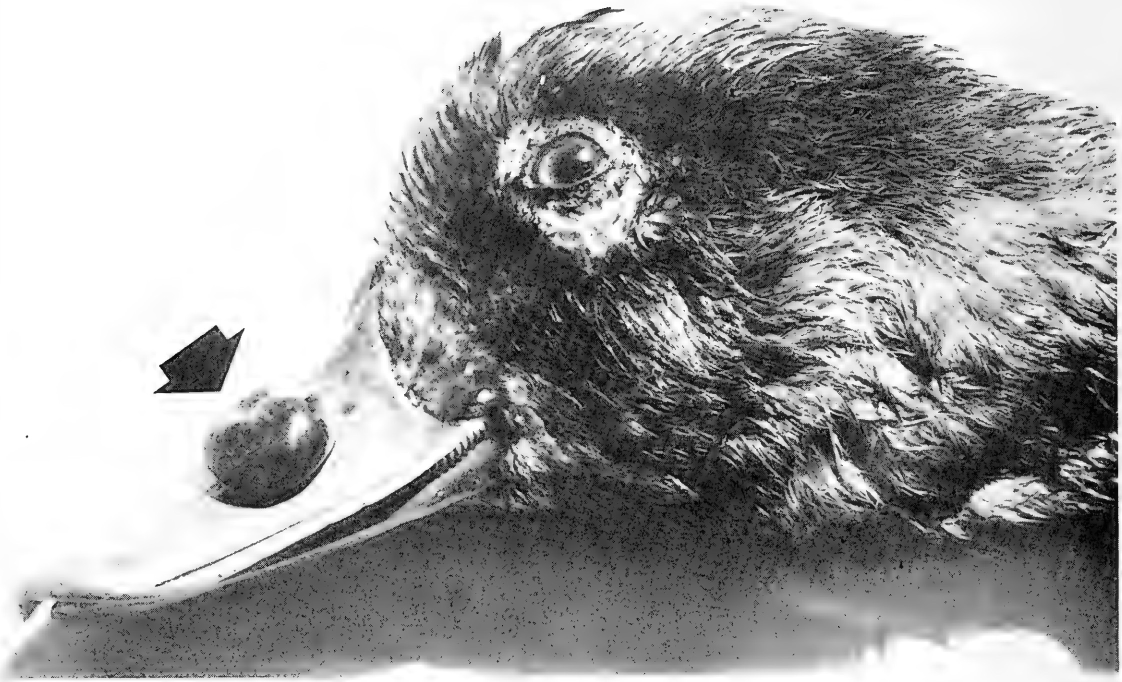


FIGURE 3. An adult leech (*Theromyzon rude*) engorged with blood, partially protrudes through the nare of this adult Lesser Scaup. Such leeches were visible at considerable distance, particularly with the aid of binoculars or telescopes.

from the nares, as we observed, or by shaking their heads and sneezing, forceably expelling air through the nares while the bill is immersed in water, as reported by Kuznetsova (1955). Although we suspect ducks scratch and injure some engorged leeches protuding from their nares, we never observed a duck to free itself of a leech through purposeful effort. Low (1945), however, reported that Redheads (*Aythya americana*) expelled the smaller leeches from their nasal chambers by sneezing.

We used forceps to remove some of the more conspicuous leeches from the nasal chambers of ducks captured for banding. Kuznetsova (1955) suggested as a prophylaxis rinsing the duck's nasal chambers with aqueous solutions of gastric juice, sodium chloride (10%), vinegar, or ammonia.

Apparently the nasal chamber is the most prevalent site of infestation by leeches (Trauger and Bartonek, *in press*). Leeches have been reported in the nasal chambers of waterfowl by a number of North American workers (Kalmbach and Gunderson 1934; Sooter 1937; Low 1945; Erickson 1948; Meyer and Moore 1954; Banko 1960; Moore 1964, 1966). In Europe, Büchli (1924), Herter (1929), Rollinson et al. (1950), Mann (1951), and Kuznetsova (1955) documented the occurrence of leeches in nasal chambers of ducks and geese.

Body

Leeches were attached to the bird's body at places other than the conjunctiva of the eye or the mucosa of the nasal chamber, namely on legs, feet, breast, or cloaca. Leeches that had not yet fed were frequently seen moving on the plumage of recently killed birds. These movements were generally towards the head, suggesting that feather direction may stimulate a taxis movement towards protected feeding sites on the head. Leeches attaching themselves to skin were not as well protected from maintenance activities of the bird as those in the eye and nasal chamber. Erickson (1948), Meyer and Moore (1954), Banko (1960), and Moore (1964, 1966) also reported leeches on the body surfaces of infested waterfowl in North America, but few references have been made to this type of infestation in Europe (Rollinson et al. 1950).

Elsewhere

Leeches were found in the buccal cavity, pharynx, and larynx of autopsied birds; however, we believe that they probably moved from the nasal chamber into these areas after the birds died. In addition, leeches were found in some esophagi, proventriculi, and ventriculi of ducks examined for food habits (Bartonek and Murdy 1970; Bartonek 1972). Although leeches were apparently eaten as food, they also may have been ingested during preening.

Leeches have been reported to occupy the tracheae (Herter 1929; Mann 1951; Moore 1966), bronchi (Quortrup and Shillinger 1941), buccal cavity (Erickson 1948; Meyer and Moore 1954), larynx (Herter 1929), esophagus (Weltner 1887), and brain (Büchli 1924; Herter 1929) of waterfowl. Kuznetsova (1955) found leeches more often in the upper respiratory tracts, especially the nasal chambers, than attached within the esophagus or to the conjunctiva. He characterized severe leech infestations of the upper respiratory system as usually causing short labored breathing and terminating in death from asphyxiation. Quortrup and Shillinger (1941) mentioned that occasional cases of verminous pneumonia developed in ducks infested with leeches in the bronchi.

Incidence of Infestation

Between 1966 and 1970, Mallards, Pintails, Green-winged Teals, American Wigeons, Northern Shovelers, Ring-necked Ducks, Canvasbacks, Lesser Scaups, Buffleheads, White-winged Scoters, and Surf Scoters were found to be infested with leeches on the Yellowknife study area. In addition to these 11 species of ducks, the Red-necked Grebe, Horned Grebe, and Arctic Loon were also parasitized. All of our determinations of leech infestations were of the moment and did not reflect incidences throughout the summer, year, or life of the individual bird. We believe that all species of waterbirds in this locality were parasitized to varying degrees at one time or other by leeches.

Based on our observations, *Theromyzon rude* was the principal leech involved in the waterfowl infestations near Yellowknife. We estimate that *T. rude* was observed in more than 95% of the ducks or other waterbirds infested with leeches in the eyes or nasal chamber, both externally and internally. *Placobdella ornata* was infrequently encountered parasitizing waterfowl. Although *P. ornata* was found in the nasal chamber of a few ducks, this species was usually attached externally to the skin or plumage of the host. We did not discriminate between *T. rude* and *P. ornata* in calculating incidence of infestation. Furthermore, no attempt was made to determine the fate of ducks released following removal of leeches from beneath the nictitating membrane or inside the nasal chamber.

Incidences of infestation among 135 adult and juvenile ducks killed and necropsied specifically for leeches are presented in Table 1. American Wigeon (88%) were infested very significantly ($P < 0.01$) more than the Lesser Scaup (31%). Juveniles were infested slightly more than adults. Of 66 ducks infested in the nasal chamber, only one Lesser Scaup had a leech visibly protruding from the nares. The five ducks infested in the eyes contained young leeches which were apparent only during the post-mortem examination. All leeches on the body were found on the plumage; none were attached to the skin; and none appeared to have fed.

Undisturbed birds were carefully scrutinized at a distance through binoculars and a telescope for leeches in each eye and in each nare. Leeches protruding from the nares were observed in 5 of 130 Lesser Scaup, 2 of 52 American Wigeon (Table 2), and 1 of 102 birds representing seven other species. Leeches

TABLE 1—Incidence of infestation and site of attachment by leeches parasitizing four species of ducks collected and necropsied near Yellowknife, Northwest Territories, summer 1967

Species Age	Number of birds examined	Number of birds infested: Nasal chambers	Eyes	Body[1]	Total	Percent infested	Average number of leeches per infested bird
Lesser Scaup				2	8	24	2.1
Adult	33	7	0				
Juvenile	53	19	1	0	19	36	2.9
American Wigeon							
Adult	11	7	0	3	7	64	3.9
Juvenile	30	28	2	15	29	97	4.1
Mallard							
Juvenile	7	5	2	0	5	71	12.0
Green-winged Teal							
Adult	1	0	0	0	0	0	—
Total	135	66	5	20	68		
Percent infested		49	4	15	50		
Average number of leeches per infested bird		3.4	2.0	2.0	3.9		

1 Leeches were on plumage but not feeding.

were not detected in the eyes of these 284 birds. But young leeches within either the nasal chamber or eye, and adult leeches within the nasal chamber could not be detected by this method of observation.

We superficially examined 485 birds captured by drive-trapping during 1967. Leeches, both protruding from the nares as in Figure 3 and barely visible through the nares as in Figure 1, were found in 36% of 396 Lesser Scaup and 31% of 36 American Wigeon (Table 2). Twelve (23%) of 53 birds of eight other species were infested with leeches: eight birds in the eye, five birds in the nasal chamber, and two birds on the body.

Disturbed ducks were more susceptible to leech infestation than those that were undisturbed. Comparative data on "disturbed" and "undisturbed" Lesser Scaup and American Wigeon were obtained by determining the incidence of infestation using three methods (Table 2), namely: (1) necropsying ducks killed while actively feeding, (2) observing ducks at a distance through either binoculars or telescopes, and (3) examining, in the hand, ducks captured by drive-trapping. The first two methods we regard as causing the least disturbance, or "undisturbed," while drive-trapping caused the most disturbance, or "disturbed."

TABLE 2—Percentage of leech-infested Lesser Scaup and American Wigeon from Yellowknife, Northwest Territories, during the summer of 1967, as determined from three methods: (1) necropsy of ducks collected, (2) examination of birds captured by drive-trapping, and (3) observations of ducks through binoculars and telescopes

Host species site of attachment	Percent of ducks infested by leeches, as determined by: Necroposy	Examination	Observation
Lesser Scaup			
(Sample size)	(86)	(396)	(130)
Nasal chamber	30	28	4
Eye	1	9	0
Body	0	1	0
Total	31	36	4
American Wigeon			
(Sample size)	(41)	(36)	(52)
Nasal chamber	85	19	4
Eye	5	22	0
Body	0	0	0
Total	88	31	4

No ducks examined post-mortem contained adult leeches in their eyes similar to the one shown in Figure 1. One Lesser Scaup and two American Wigeon contained young leeches in their eyes, but these leeches could be detected only during the detailed necropsies. No differences in the incidence of adult leeches infesting the eyes of ducks were found in the two "undisturbed" groups. The incidence of adult leeches infesting the eyes of "disturbed" ducks, however, was greater than observed in the "undisturbed" groups for both the Lesser Scaup ($x^2 = 31.1$, $df = 1$, $P <$ 0.005) and the American Wigeon ($x^2 = 1.78$, $df = 1$, $P < 0.25$). We also believe that the incidence of adult leeches protruding from the nares was greater among the "disturbed" than the "undisturbed" birds. Unfortunately, we did not distinguish between leeches protruding from the nares and those barely visible through the nares, which would be necessary for a test of difference.

During drive-trapping operations, ducks were frequently aware of human intrusion for several hours before the drive was under way. Once ducks entered the trap they usually dived in an effort to escape, which increased their chances of becoming infested by leeches. We believe that birds, when disturbed, are less attentive to normal preening habits, thereby increasing the probability of leeches gaining access to protected feeding sites in the eye and nasal chamber instead of being either preened from or eaten by the intended host. Meyer and Moore (1954) also remarked on the rapidity with which leeches attached themselves to ducks when the birds were chased and forced to dive by humans.

Birds captured by drive-trapping and infested during the disturbance associated with the drive often lost their leeches within an hour after being out of the water. We believe that leeches voluntarily dropped from the ducks after they became satiated or desiccated as a result of the duck's being out of water for prolonged periods, such as being held in pens prior to banding.

The incidence of leech parasitism varied among ponds. Some ponds had more than 40% of the ducklings infested with leeches whereas other ponds had infestation rates less than 20%. Ducklings on a few ponds appeared to be free of leeches. Small sample sizes and possibly inconsistent effort in observing and recording incidence of leech infestations between years and ponds precluded a more detailed analysis. But we believe that differences in infestation rates existed between ponds as well as from year to year. Gallimore (1964) and Colbo (1965) found differences in the infestation rates of *Theromyzon rude* in grebes and coots among pond, slough, and lake habitats in Alberta.

Leeches infested waterfowl throughout their stay in the Yellowknife area. Meyer and Moore (1954) noted that leeches became active prior to the melting of ice in Manitoba. Likewise, our earliest record is that of an adult female Lesser Scaup with a leech protruding from the nostril when collected on 15 May 1968, at a time when most ponds were still frozen. Between 25 and 30 May 1969, a Mallard, a Ring-necked Duck, and three Lesser Scaup were seen with leeches protruding from their nostrils. Infestations of leeches appeared to peak during July and August, coinciding with the peak brooding season for both leeches (Hagadorn 1962) and ducks (Murdy 1964). Gallimore (1964) and Colbo (1965) also reported summer peaks in the *Theromyzon rude* infestations of grebes and coots in Alberta. Ducks were found hosting leeches up to the time of our departure from the study area in early September. We have no reason to assume that ducks did not host the leeches up to and possibly even during migration.

Significance of Infestations

Leech infestations of waterfowl are widespread in North America, but various workers have apparently regarded leeches to be of little consequence to the survival of birds (Trauger and Bartonek, *in press*). Although quantitative data are scarce for evaluating the significance of leeches as a mortality factor, investigators have reported leech parasitism of 17 species of waterfowl.

During five summers we observed the deaths of only two ducks that were directly attributed to leech infestations. During August 1966 we found two emaciated ducklings, a White-winged Scoter and a Surf Scoter, that were blinded in both eyes by many young leeches. These birds were effortlessly caught and placed in the bottom of our canoe where they died shortly afterwards. Although leeches were thought to be the primary cause of death, necropsies were not conducted to determine the extent of other parasitism or the existence of other diseases. The stress associated with capture was probably a contributing factor.

In August 1968 a Surf Scoter duckling was easily caught by hand as it swam aimlessly beside our canoe. This duck was weak and blinded by five engorged leeches in the eyes, three in the left and two in the right. Although the young Scoter did not die while in our possession, it was near death when released after the leeches were removed. Several days later a juvenile Arctic Loon, blinded by leeches and extremely weak, was also captured by hand. Nine leeches were removed from the eyes and three additional leeches were taken from the nasal cavity. When the bird was released, it made a feeble escape and swam away listlessly. Unfortunately, we were unable to determine the fate of these birds because of other field responsibilities. Nevertheless, we believe that other deaths due to leech infestations may have occurred. Juvenile mortality is difficult to detect except indirectly through a decline in the number of ducklings per brood.

Trauger observed one sequence of events that is highly suggestive of duckling mortality due to leeches. On 29 July 1969 he observed a Ring-necked Duck brood consisting of five ducklings (6 to 10 days old). One duckling had an engorged leech protruding from the nares and was lagging behind the other ducklings as the brood swam away from the shoreline. The next day a Ring-necked Duck brood with only four ducklings (6 to 10 days old) was observed on the same pond. No leeches were observed on any of the ducklings. The stray duckling was not located during a thorough search of the area, and it was presumed that this bird had either died or was killed during the night.

Leech parasitism of Green-winged Teal, Bufflehead, White-winged Scoter, Surf Scoter, and Arctic Loon reported in this study represent new host records for these species. Gallimore (1964) and Moore (1964) reported the first host records for the Red-necked Grebe and Horned Grebe. Host records for other waterfowl species are reviewed by Trauger and Bartonek (*in press*).

Acknowledgments

Harold A. Kantrud, Kenneth F. Higgins, Gary L. Krapu, and the late H. W. Murdy, Northern Prairie Wildlife Research Center, aided us in making observations of leech-infested waterfowl. Robert Bromley and David Bartesko, Yellowknife, Northwest Territories, also assisted with field work. Roy T. Sawyer, Department of Biology, College of Charleston, Charleston, South Carolina and Frederick J. Vande Vusse, Department of Biology, Gustavus Adolphus College, St. Peter, Minnesota, identified the leeches. Vande Vusse also provided us with several pertinent references on leeches parasitizing waterfowl. Gary L. Pearson, George A. Swanson, and Gary L. Krapu, Northern Prairie Wildlife Research Center, provided editorial assistance with the manuscript.

Literature Cited

Banko, W. E. 1960. The Trumpeter Swan. North American Fauna No. 63. 214 pp.

Bartonek, J. C. 1972. Summer foods of American Widgeon, Mallards, and a Green-winged Teal near Great Slave Lake, Northwest Territories. Canadian Field-Naturalist 86: 373–376.

Bartonek, J. C. and **H. W. Murdy.** 1970. Summer foods of Lesser Scaup in Subarctic taiga. Arctic 23: 35–44.

Büchli, K. 1924. Bloedzuigers in de neusholte van eenden. Tijdschrift voor Diergeneeskunde 51: 153–155.

Christiansen, M. 1939. *Protoclepsis tesselata* (O. F. Müller), der Entenegel, als Ursache von Krankheit, u.a. Konjunktivitis, bei Gansen und Enten. Zeitschrift für Infektionskrankheiten, Parasitare Krankheiten und Hygiene der Haustiere 55: 75–89.

Colbo, M. H. 1965. Taxomony and ecology of the helminths of the American Coot in Alberta. M.Sc. thesis, University of Alberta, Edmonton, Alberta. 155 pp.

Davies, R. W. 1973. The geographic distribution of freshwater Hirudinoidae in Canada. Canadian Journal of Zoology 51: 531–545.

Erickson, R. C. 1948. Life history and ecology of the canvasback, *Nyroca valisineria* (Wilson) in southwestern Oregon. Ph.D. thesis, Iowa State College, Ames, Iowa. 324 pp.

Gallimore, J. R. 1964. Taxonomy and ecology of helminths of grebes in Alberta. M.Sc. thesis, University of Alberta, Edmonton, Alberta. 167 pp.

Graham, L. C. 1966. The ecology of helminths in breeding populations of Lesser Scaup (*Aythya affinis* Eyton) and Ruddy Ducks (*Oxyura jamaicensis* Gmelin). M.Sc. thesis, University of Alberta, Edmonton, Alberta. 90 pp.

Hagadorn, I. R. 1962. Functional correlates of neurosecretion in the Rhynchobdellid Leech, *Theromyzon rude*. General and Comparative Endrocrinology 2: 516–540.

Herter, K. 1929. Reizphysiologisches Verhalten and Parasitismus des Entenegels *Protoclepsis tessalata* O. F. Müller. Zeitschrift für Vergleichende Physiologie 10: 272–308.

Kalmbach, E. R. and **M. F. Gunderson.** 1934. Western duck sickness, a form of botulism. United States Department of Agriculture Technical Bulletin 411. 82 pp.

Klemm, D. J. 1972. Freshwater leeches (Annelida: Hirudinea) of North America. Biota of Freshwater Ecosystems Identification Manual 8. U.S. Environmental Protection Agency, Washington, D.C. 53 pp.

Kuznetsova, O. N. 1955. Piyaviki-parazitei vodoplavayushchei ptitsei. Ptitsevodstvo 11: 32–34.

Low, J. B. 1945. Ecology and management of the Redhead, *Nyroca americana*, in Iowa. Ecological Monographs 15: 35–69.

Mann, K. H. 1951. On the bionomics and distribution of *Theromyzon tessulatum* (O.F. Müller), 1774 (= *Protoclepsis tesselata*). Annals and Magazine of Natural History 4: 956–961.

Mann, K. H. 1962. Leeches (Hirudinea). Their structure, physiology, ecology, and embryology. Pergammon Press, The Macmillan Company, New York. 201 pp.

McDonald, M. E. 1969. Catalogue of helminths of waterfowl (Anatidae). United States Bureau of Sport Fisheries and Wildlife, Special Scientific Report-Wildlife Number 126. 692 pp.

Meyer, M. C. and **J. P. Moore.** 1954. Notes on Canadian leeches (Hirudinea) with the description of a new species. Wasmann Journal of Biology 12: 63–96.

Moore, J. E. 1964. Notes on the leeches (Hirudinea) of Alberta. National Museum of Canada, Natural History Papers 27: 1–15.

Moore, J. E. 1966. Further notes on Alberta leeches (Hirudinea). National Museums of Canada, Natural History Papers 32: 1–11.

Moore, J. P. and **M. C. Meyer.** 1951. Leeches (Hirudinea) from Alaskan and adjacent waters. Wasmann Journal of Biology 9: 11–77.

Murdy, H. W. 1964. Population dynamics and breeding biology of waterfowl on the Yellowknife Study Area, Northwest Territories. United States Bureau of Sport Fisheries and Wildlife, Northern Prairie Wildlife Research Center, Annual Progress Report. 61 pp.

Murdy, H. W. 1966. When the prairies go dry. Naturalist 17: 8–13.

Murdy, H. W., D. L. Trauger, and **H. K. Nelson.** 1970. Waterfowl research on the Yellowknife study area, 1961–70. Transactions of Federal-Provincial Wildlife Conference 34: 26–29.

Oliver, D. R. 1958. The leeches (Hirudinea) of Saskatchewan. Canadian Field-Naturalist 72: 161–165.

Quortrup, E. R. and **J. E. Shillinger.** 1941. 3000 wild bird autopsies on western lake areas. Journal of the American Veterinary Medical Association 99: 382–387.

Roberts, H. E. 1955. Leech infestation of the eye in geese. Veterinary Record 67: 203–204.

Rollinson, D. H. L., K. N. Soliman, and **K. H. Mann.** 1950. Deaths in young ducklings associated with infestations of the nasal cavity with leeches. Veterinary Record 62: 225–227.

Sooter, C. A. 1937. Leeches infesting young waterfowl in northwest Iowa. Journal of Parasitology 23: 108–109.

Trauger, D. L. 1971. Population ecology of Lesser Scaup (*Aythya affinis*) in subarctic taiga. Ph.D. thesis, Iowa State University, Ames, Iowa. 118 pp.

Trauger, D. L. and **J. C. Bartonek.** 1975. Leech parasitism of waterfowl in North America. Wildfowl. *In press.*

Weltner, W. 1887. *Clepsine tesselata* O. Fr. Müll. aus dem Tegelsee bei Berlin lebend vorzeigen. Sitzungsberichte der Gesellschaft Naturforschender Freunde zu Berlin 17: 85.

Received 7 May 1974
Accepted 8 February 1975

A New Common Murre Colony in British Columbia

R. WAYNE CAMPBELL,[1] JOHN G. WARD,[2] and MICHAEL G. SHEPARD[1]

[1] British Columbia Provincial Museum, Victoria, British Columbia
[2] L G L Limited, 201–10110–124 Street, Edmonton, Alberta T5N 1P6

Campbell, R. W., J. G. Ward, and M. G. Shepard. 1975. A new Common Murre colony in British Columbia. Canadian Field-Naturalist 89: 244–248.

Abstract. The early stages of the establishment of a new Common Murre colony on the central west coast of Vancouver Island, British Columbia are documented. In 1969 at least four pairs of murres attempted nesting. The following year the number increased to six pairs, of which at least one fledged young. In subsequent years (to 1974), however, growth of the murre colony was retarded by a growing Glaucous-winged Gull population which eventually usurped habitat used by murres for nesting. One pair of murres nested (unsuccessfully) in 1974. Notes on success of nesting attempts, breeding cycle, and activity of non-breeding murres is presented. This colony is the third known for the province.

Until recently, the only known colonies of Common Murres (*Uria aalge inornata* Salomonsen) along the British Columbia coast have been those located in the Scott Islands group off the northwest tip of Vancouver Island. In 1949 Guiguet (1950) "conservatively estimated" the breeding population of murres on Triangle Island, the most western in the group, at 3000 birds. Later Hancock (1971) discovered additional small colonies on nearby Sartine Island. In 1969–70 another small colony became established on Cleland Island (49°10′ N, 126°06′ W) northwest of Tofino on Vancouver Island and about 175 miles southeast of the Scott Islands colonies.

Tuck (1961) provides an excellent account for the race *U. a. aalge* in the western sector of the North Atlantic, but little is known about the breeding ecology of the race *U. a. inornata,* which ranges throughout the North Pacific Ocean. This has encouraged us to put on record the material we have accumulated for the small Cleland Island colony.

General Aspect of Cleland Island

The physical and vegetative features of Cleland Island have previously been discussed in detail by Campbell and Stirling (1968), Hartwick (1973), and Ward (1973). The rocky island is small (19 acres) and low (34 feet above sea-level), and its crown is blanketed by shrubs and grasses. A bare, rocky islet, hereafter called Murre Reef, lies to the west and is separated from Cleland by 160 feet of water at low tide. Cleland Island itself supports one of the most varied seabird faunas along the British Columbia coast and for this reason became, in May 1971, the province's first ecological reserve (Krajina 1973). Breeding seabirds include Fork-tailed Storm-Petrels (a few), Leach's Storm-Petrels (5000 pairs), Black Oystercatchers (50–60 pairs), Glaucous-winged Gulls (1400 pairs), Pigeon Guillemots (100 pairs), Rhinoceros Auklets (400–600 pairs), Cassin's Auklets (a few), Tufted Puffins (75 pairs), and Common Murres (a few).

Methods and Observations

Murre Reef was visited briefly during banding trips to Cleland Island from 1967 through 1974. In 1969 and 1970 researchers remained on Cleland Island throughout the entire summer. To minimize disturbance Murre Reef was only occasionally visited in 1969 and all observations the following year were made by telescope from the main island. Whenever time permitted, documentary photographs of the murre colony were taken, copies of which have been added to the photoduplicate files (PDF) in the British Columbia Provincial Museum (see Campbell and Stirling 1971). This information has also been added to a comprehensive file at the Provincial Museum on seabird colonies along the British Columbia coast.

Inventory of Visits

Prior to the late 1960s, Cleland Island had been investigated by several ornithologists and oologists. Drent and Guiguet (1961) summarized this information to 1960 and indicated that breeding for certain species still needed confirmation. This prompted visits to the island in 1967 on 24 July, 4, 14, 25, and 28 August (Campbell and Stirling 1968). Although Common Murres were seen loitering around the island in loose flocks (up to 30 birds), none were seen on the main island or on Murre Reef. About 20 pairs of Glaucous-winged Gulls were noted nesting in widely scattered locations on top of Murre Reef.

Cleland Island was visited on 11 and 12 August 1968 (for the purpose of banding young gulls). R. W. Campbell noted 23 murres in the water along the east side of the main island and seven "standing like penguins" in intertidal areas on the northeast corner of Murre Reef. No thorough search was made.

In 1969 M. Easton and K. R. Summers lived on the island from 16 May to the end of August. A "prospecting" flock (see Tuck 1961, p. 111) of 28 murres was seen inshore on 20 May, and 6 days later 10 landed on the reef. The flight of murres to and from the reef followed a general pattern. In early June murres were absent in the morning (about 0800 hours) and their numbers gradually increased from about noon to early evening. Once eggs were laid murres were always present although often only the incubating adults were seen. The largest number at any one time was 30 murres (at 1730 hours) on 29 June. In July murres occupied the reef in the morning (having probably spent the night there), most leaving to return in the early evening. Figure 1 shows numbers of murres on the reef subsequent to 26 May.

Copulation was noted several times and on 29 June a search of the roosting site revealed fragments of four different eggs (first nesting evidence) over a stretch of about 20 yards between the furthest fragments. By 19 August there were two murre chicks and on 20 August an adult brooding a chick was photographed (PDF 16; Figure 2). On 31 August only one brooding adult remained, indicating that the other chick had fledged. The murres restricted their nesting activities on Murre Reef to a small area just south of a line of brown iron deposits in the rock and about 12 feet above high-tide line on the eastern side of the reef.

The following year (1970) J. G. Ward, M. G. Shepard and B. Baker camped on Cleland Isand from 11 May to 18 August. Murres, 20 in number, first landed on Murre Reef on 17 May (10 days earlier than in 1969) and reached a peak of 104 birds on 16 July (Figure 1). The prospecting stage prior to egg-laying, lasted about a month. That is, in May and early June murres were seen on the reef only in the afternoon and evening, from about 1600 hours to 2150 hours. The first morning observation, therefore, of a bird probably incubating, was on 16 June. During incubation up to 12 murres were counted on the reef in the early morning, probably birds on eggs and their mates. In July non-breeding murres swelled the number occupying the reef with daily peaks occurring in the late afternoon and early evening.

Six incubating adults were identified by telescope during the summer of 1970. Observation indicated that three pairs successfully hatched eggs and at least one of the resulting chicks successfully fledged. The murres nested just north of the line of brown iron deposits in the rocks. On 7 June, prior to the murres' nesting, about 100 pairs of Glaucous-winged Gulls were also nesting on Murre Reef but none were noted in the vicinity of the murre colony.

Apparently notes were not maintained in the summers of 1971 and 1972 although students did spend some time on the island. On 12 August 1973 R. W. Campbell found only three adults, all on pipping eggs (PDF 353). In addition seven murres were perched near the incubating birds. The number of breeding gulls on the reef had increased to about 125 pairs, some of which had nests on the periphery of the murre colony.

In 1974 Campbell visited Cleland Island four times. On 18 and 19 May several pairs of gulls had established territories in the area previously occupied by murres and only one murre was seen there on the 19th. On 28 June small numbers of murres were present around the island but none were found on the reef. At least two gulls now had nests where the murre

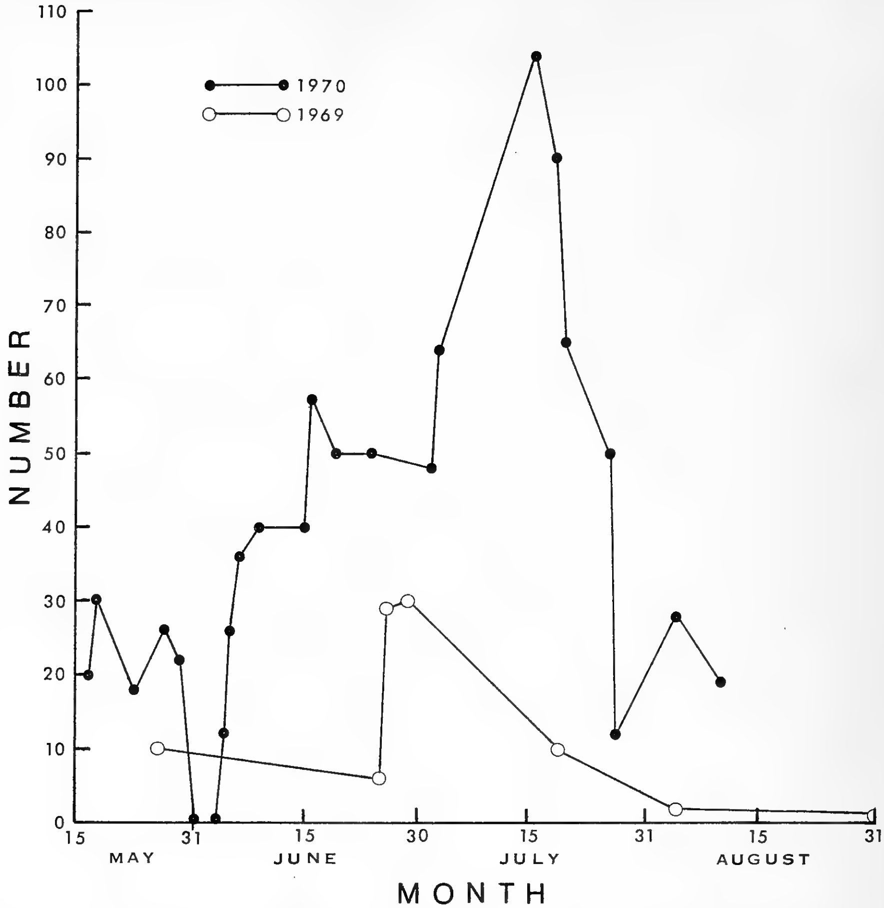


FIGURE 1. Numbers of Common Murres counted on Murre Reef in late afternoon or early evening in 1969 and 1970.

colony was previously established. On 2 and 3 August, 17 murres were roosting on a rocky promontory on the southeast corner of the main island among a flock of Brandt's Cormorants (*Phalacrocorax penicillatus*). A single unattended guano-covered murre egg was discovered here (PDF 355). Since it was slightly addled the egg was collected and subsequently deposited in the oological collections in the British Columbia Provincial Museum. From 15 to 17 August only seven murres were seen among roosting cormorants. No further evidence of nesting was discovered.

Discussion

Although Common Murres were actually roosting on intertidal rocks on Murre Reef in 1967 and 1968, breeding was not proved until 1969. The two chicks fledged in late August 1969 may have resulted from replacement clutches. Studies by Gorbunov (1925), Uspenski (1956), and Tuck (1961) on Thick-billed Murres (*Uria lomvia*) show that if eggs are lost early in incubation up to 80% may be replaced from 15 to 22 days later. Another possibility is that the initial breeding was attempted by sub-adults. According to Tuck (1961) "young Common Murres laying for the first time probably seldom, if ever, succeed in hatching their eggs."

In 1974 murres were apparently forced by the gulls to move to the main island. The nesting attempt was unsuccessful, with cormorant excrement possibly preventing hatch-

FIGURE 2. Adult Common Murre brooding a chick on Cleland Island, British Columbia, 20 August 1969.

TABLE 1 — Breeding cycle of Common Murres at Cleland Island

	1969	1970	1973
First occurence at reef	May 26	May 17	—
Copulation	June 26–29	June 15	—
Eggs laid	June 26–29	June 16–July 6	July 8*
Eggs hatched	July 30*–August 2*	July 20*–August 9*	August 12
First sea-going	August 17–24	August 7–14*	August 30–Sept. 6*
Maximum days on reef	84 to 91*	83 to 90*	—

* These dates are calculated using values given by Tuck (1961) of 32–34 days for incubation and 18–25 days for brooding of young.

ing of eggs. Tuck (1961, p. 151) noted Uspenski's (1956) suggestion that "since the eggs [murre] were very porous, it was difficult for embryos to breathe in eggs plastered over with excrement and that they were able to continue development only if part or all of the calcareous shell was broken away." Murres may be found breeding in association with cormorants along the British Columbia coast in the future, as Johnson (1941) mentions this habit for the race *U. a. aalge* in the Gulf of St. Lawrence.

Table 1 summarizes breeding information for murres on Cleland Island. Not included is an additional landing date in 1974 of 19 May. The laying dates for Cleland Island are in the range of those given in Bent (1919), Tuck (1961), and Drent and Guiguet (1961). Comparing with Tuck (1961), however, we found that murres appeared to be late in arriving on the island each year. This may have been as a result of the small size of the colony and the fact that it had only recently become established.

The murre egg collected on Cleland Island measured 83.19 × 48.83 mm. Twenty-four eggs in the British Columbia Provincial Museum collections from Triangle Island averaged 84.38 × 50.85 mm (with extremes of 95.31 × 54.75 and 77.55 × 49.00 mm). Bent's (1919) measurements for *californica* (now called *inornata*) averaged slightly less than the British Columbia eggs at 82.2 × 50.2 mm (with extremes of 90.0 × 52.0 and 69.5 × 42.5 mm).

Additional Colonies and Prospectus

Brooks and Swarth (1925) reported colonies on Solander and "near Ucluelet" off the west coast of Vancouver Island. The latter colonies are unsubstantiated and have not been accepted either by Munro and Cowan (1947) or Drent and Guiguet (1961). The possibility that a large colony exists on the west coast of Graham Island in the Queen Charlotte Islands (Brooks and Swarth 1925) is also open to question. An unsuccessful nesting attempt by a pair of murres on Florencia Island, south of Long Beach on Vancouver Island, has been recorded. On 15 July 1969 two murres were seen by R. W. Campbell "in their upright position" on a rocky outcropping on the northern end of this forested island. After a short search fragments of egg-shells were discovered. No murres were seen, however, during a visit on 4 August 1974. Although murres, apparently in adult plumage, were common off the west coast of Vancouver Island during the summer of 1974, none were seen on any islands during an inventory of seabird colonies from Cleland Island south to Starlight Reef in Barkley Sound. There are, however, several bare rocky islets in this stretch of coastline which seem suitable for nesting by murres.

No one has suggested that Common Murres may nest in the Strait of Georgia. Drent et al. (1964) do not mention murres as a possible breeding species for Mandarte Island, which is perhaps the island in that strait most attractive to seabirds.

Two recent records, however, may be noteworthy. On 2 July 1974 (at 0850 hours) R. W. Campbell and M. G. Shepard saw five murres, in full nuptial plumage, one of which was perched on rocks (PDF 354) on the southeast corner of Vivian Island (49°50′ N, 124°42′ W). Five days later (at 1735 hours) two murres, in breeding plumage, were seen on rocks at the end of the Tsawwassen jetty. A search revealed no evidence of nesting. Neither group of murres was in any way incapacitated. Such roosting sites should be carefully scrutinized in the future.

Acknowledgments

We acknowledge the encouragement of Rudolf H. Drent, who urged us to take notes on all murres seen during field studies of other seabirds. We are grateful to Ken R. Summers who kindly made available his field notes and to R. Yorke Edwards, Edwin M. Hagmeier, Anthony J. Erskine, Leslie M. Tuck, and Charles J. Guiguet for suggestions and critical review of the manuscript.

Literature Cited

Bent, A. C. 1919. Life histories of North American diving birds. United States National Museum Bulletin 107. Washington, D.C.

Brooks, A. and **H. S. Swarth.** 1925. A distributional list of the birds of British Columbia. Pacific Coast Avifauna 17: 1–158.

Campbell, R. W. and **D. Stirling.** 1968. Notes on the natural history of Cleland Island, British Columbia, with emphasis on the breeding bird fauna. British Columbia Provincial Museum Annual Report for 1967. pp. 25–43.

Campbell, R. W. and **D. Stirling.** 1971. A photoduplicate file for British Columbia vertebrate records. Syesis 4: 217–222.

Drent, R. H. and **C. J. Guiguet.** 1961. A catalogue of British Columbia seabird colonies. British Columbia Provincial Museum Occasional Papers 12. 173 pp.

Drent, R. H., G. F. Van Tets, F. Tompa, and **K. Vermeer.** 1964. The breeding birds of Mandarte Island, British Columbia. Canadian Field-Naturalist 78(4): 208–263.

Gorbunov, G. P. 1925. The bird bazaars of Novaya Zemblya. Transactions of the Institute for Northern Studies, Moscow.

Guiguet, C. J. 1960. Notes on Common Murres nesting in British Columbia. Murrelet 31(1): 12–13.

Hancock, D. 1971. New Common Murre colonies for British Columbia. Canadian Field-Naturalist 85(1): 70–71.

Hartwick, E. B. 1973. Foraging strategy of the Black Oystercatcher. Ph.D. thesis, University of British Columbia, Vancouver. 138 pp.

Johnson, R. A. 1941. Nesting behaviour of the Atlantic Murre. Auk 58(2): 153–163.

Krajina, V. J. 1973. The conservation of natural ecosystems in British Columbia. Syesis 6: 17–31.

Munro, J. A. and **I. McT. Cowan.** 1947. A review of the bird fauna of British Columbia. British Columbia Provincial Museum Special Publication 2. 285 pp.

Tuck, L. M. 1961. The murres. Canadian Wildlife Service Report 1. 260 pp.

Uspenski, S. M. 1956. The bird bazaars of Novaya Zemblya. U.S.S.R. Academy Science. (Canadian Wildlife Service translation.)

Ward, J. G. 1973. Reproductive success, food supply and the evolution of clutch-size in the Glaucous-winged Gull. Ph.D. thesis, University of British Columbia, Vancouver. 119 pp.

Received 5 November 1974
Accepted 8 February 1975

A Postglacial Walrus (*Odobenus rosmarus*) from Bathurst Island, Northwest Territories

C. R. Harington

National Museum of Natural Sciences, National Museums of Canada, Ottawa, Canada K1A 0M8

Harington, C. R. 1975. A postglacial walrus (*Odobenus rosmarus*) from Bathurst Island, Northwest Territories. Canadian Field-Naturalist 89: 249–261.

Abstract. A walrus cranial fragment with tusk from raised beach deposits on central Bathurst Island in the Canadian arctic islands is the earliest record of that species for northern Canada. A radiocarbon date of 7320 ± 120 years B.P. on bone from the specimen indicates that walruses were living in the area about 2000 years after the last ice sheet had vanished from the region. Other Pleistocene and postglacial walrus records for Canada are reviewed.

Fossils of the living walrus (*Odobenus rosmarus*) have been reported from Quaternary deposits on the Atlantic and Pacific coasts of North America (Ray 1960, p. 129; Péwé and Hopkins 1967, pp. 268, 270; Ray et al. 1968, p. 16; Harington 1972, p. 38), but they have not been recorded previously from the Canadian Arctic Islands. Indeed, Pleistocene and postglacial vertebrate remains are seldom reported from that region (Harington 1971, pp. 82–83).

In August 1973 David Gill of the National Museum of Natural Sciences collected part of a walrus cranium near the Museum's research station on Bathurst Island, Northwest Territories. The fossil locality is approximately 10 miles (16.1 km) west of Goodsir Inlet (75°43′ N, 98°25′ W) at an elevation of about 175 feet (53.3 m) above sea-level (Figure 1). When first sighted, the cranial fragment was buried, except for the tip of the tusk, and appeared to have been brought to the surface by frost action in the ground.

Bone collagen from the maxillary region of the fossil was radiocarbon-dated at 7320 ± 120 years B.P. (Before Present) (I-7796). The right tusk is preserved in the Quaternary Zoology collection of the National Museums of Canada (NMC).

The purpose of this report is to describe the Bathurst Island specimen and to comment on the sex, age, and size of the animal it represents using comparative data from recent specimens of known age from the Northwest Territories and Bering Strait. The fossil is considered in relation to the sequence of deglaciation in the area and paleoenvironmental factors. Other Canadian walrus fossils are reviewed.

Systematic Description

Order Carnivora
Family Odobenidae
Genus *Odobenus*
Odobenus rosmarus (Linnaeus, 1758)

The specimen (NMC 13747; Tables 1, 2; Figures 2, 3) consists of the right maxilla, premaxilla, and a portion of the right frontal of a walrus. The complete right tusk (RC^1) is preserved, as are the sockets for the right third incisor (RI^3) and the four postcanines (RPC^1–RPC^4). The fourth postcanine socket is vestigial, as is the case in most recent specimens to which the fossil was compared. The bone surface is heavily eroded, particularly where the outer margin of the tusk root pierces the upper surface of the maxilla (Figure 2). The outer surface of the antorbital foramen is worn away. Part of the frontal portion of the right orbit is preserved.

As previously mentioned, only the tip of the tusk was exposed when the fossil was found. Weathering resulted in flaking and bleaching of the tip which contrasts with the generally smooth, orange-brown surface of the rest of the specimen.

In shape, size and, tooth characteristics the specimen corresponds to the same part of modern walrus skulls, therefore it is referred to

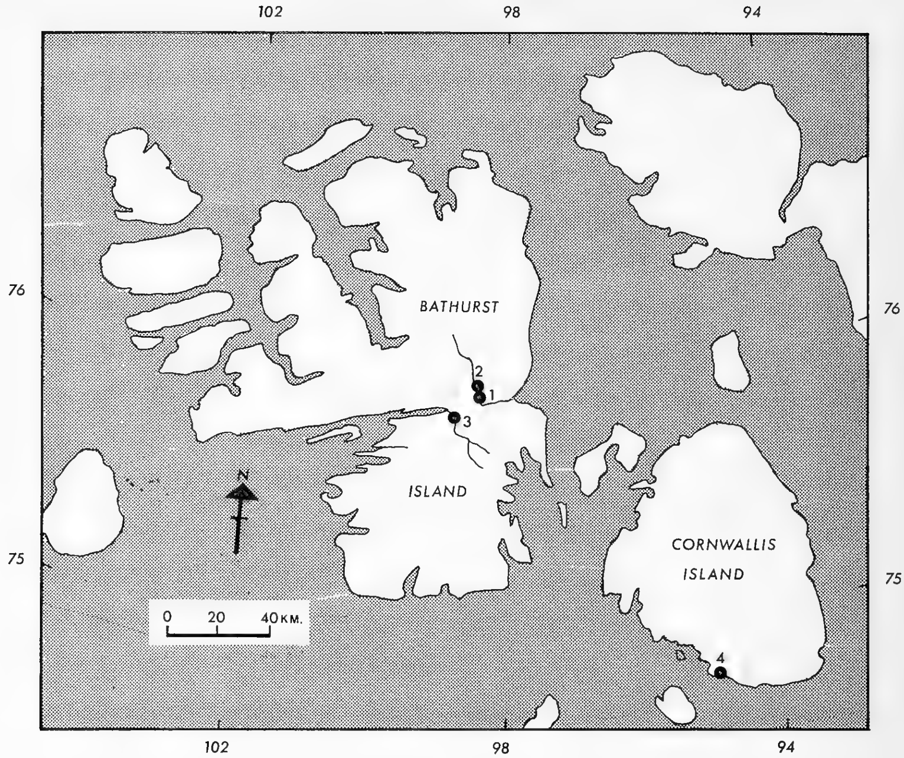


FIGURE 1. Location of the walrus fossil on Bathurst Island, Northwest Territories and nearby fossil localities of paleoenvironmental interest.
1. *Odobenus rosmarus* (walrus), 7320 ± 120 years B.P. (I-7796).
2. *Hiatella arctica*, *Mya truncata* (marine mollusk shells), 8440 ± 150 years B.P. (GSC-377).
3. *Mya truncata* (marine mollusk shells), 7670 ± 150 years B.P. (GSC-736).
4. Cetacea, probably *Balaena mysticetus* (whale), 7380 ± 140 years B.P. (GSC-1193).

Odobenus rosmarus. The relatively recent geological age of the fossil supports this identification.

Sex, Age, and Size

Socially, walruses are usually segregated according to sex and age. Old males keep together, and adult females form herds with the young and immature animals of both sexes (Mansfield 1963, p. 25). An attempt was made to sex and age the animal represented by the fossil in the hope that it would provide knowledge about the type of walruses occupying the central Canadian Arctic Islands about 7000 years ago.

One of the most characteristic features of the walrus is its enlarged upper canine teeth or tusks. Generally, the size of the tusks increases with age, and females tend to have more slender tusks than males. As the fossil included a complete tusk, I tried to match it among a sample of nine recent walrus crania which had been aged by members of the Arctic Biological Station, Fisheries Research Board of Canada. Aging had been carried out by sectioning molariform teeth and counting their annual rings (Mansfield 1958, p. 35). This technique could not be tried on the fossil because the incisors and postcanines were missing. To facilitate comparisons, five graphs were constructed relating tusk dimensions (length, width, and circumference at the alveolar margin, length of tusk exposed, and total length of the tusk) to age. The dimensions of

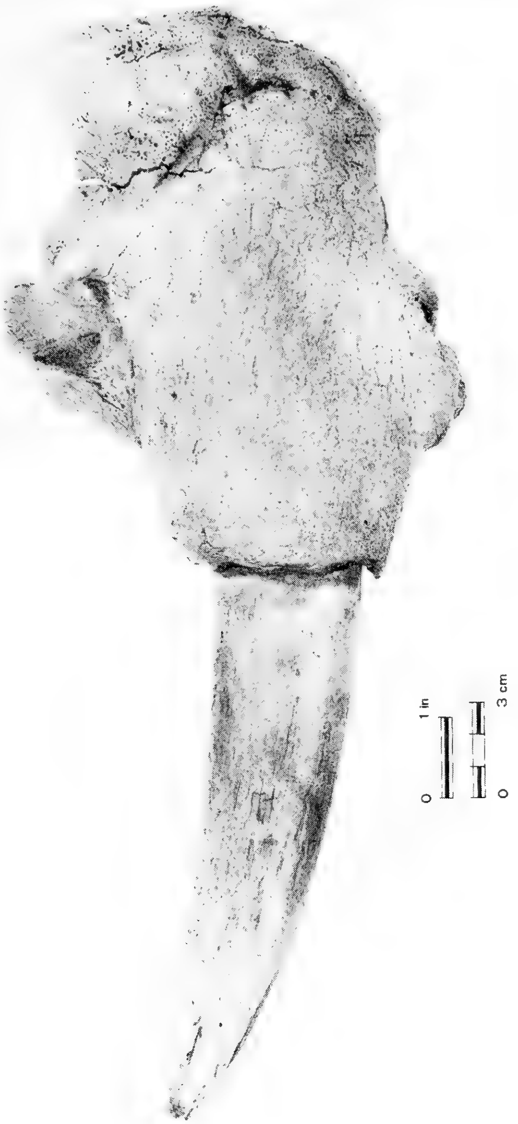


FIGURE 2. Lateral view of right anterior cranial fragment with tusk of *Odobenus rosmarus* (NMC 13747) from Bathurst Island, Northwest Territories. Measurements used in determining the sex and estimated age of the specimen were taken at the alveolar margin where the tusk leaves the maxilla. Note the weathered, flaked surface at the tip of the tusk and the heavily eroded bone near the top of the maxilla where the tusk root is partly exposed.

FIGURE 3. Medial view of right anterior cranial fragment with tusk of *Odobenus rosmarus* (NMC 13747) from Bathurst Island, Northwest Territories. Note slightly eroded sockets for the molariform teeth above the visible part of the tusk. The vestigial alveolus of the fourth postcanine is discernable near the right margin of the fossil.

TABLE 1—Comparative tusk measurements of a postglacial walrus, *Odobenus rosmarus*, from Bathurst Island, N.W.T. and of recent Canadian Atlantic walruses (*O. r. rosmarus*) and Pacific walruses (*O. r. divergens*) from the Bering Strait

Specimens	Estimated age of individual (years)	Sex	Standard length (cm)	Measurements (mm)* 1	2	3	4	5
NMC 13747 postglacial, Bathurst I., N.W.T.	8.7?	♂?	280?	45.0	27.2	120.0	172.7	323.0
Atlantic walruses (Recent, N.W.T.)								
NMC 32384	7.2	♂	274	38.2	23.2	106.0	143.0	273.0
NMC 32321	8.3	♂	262	43.5	27.3	118.0	162.0	290.0
NMC 32352	9.3	♂	267	47.8	27.3	129.0	188.6	330.0
NMC 32375	10.2	♂	287	48.6	30.3	132.0	221.0	360.0
NMC 32323	12.2	♂	314	49.0	31.0	139.0	227.2	385.0
NMC 32317	15.2	♂	294	57.9	37.7	164.0	278.0	420.0
NMC 32376	8.2	♀	257	36.9	24.5	107.0	190.0	306.0
NMC 32377	8.2	♀	254	37.0	25.5	108.0	189.0	295.0
NMC 32303	22.2	♀	268	41.2	26.9	114.0	330.0	446.0
Pacific walruses** (Recent, Bering Strait)								
32	3.0	♂	209	25.5	17.4	73.0	89.0	224.0
458	5.0	♂	231	43.6	29.6	117.0	168.0	324.0
1236	6.0	♂	252	—	—	121.0	197.0	—
244	10.0	♂	311	57.2	38.2	153.0	375.0	—
267	10.0	♂	263	45.2	30.4	121.0	248.0	—
276	12.0	♂	280	57.5	32.8	149.0	337.0	—
243	15.0	♂	312	83.0	57.3	224.0	413.0	—
275	15.0	♂	327	73.1	49.0	195.0	489.0	—
1233	15.1	♂	315	—	—	200.0	590.0	784.0
1	3.0	♀	202	20.6	14.0	57.0	79.0	181.0
1247	7.0	♀	228	—	—	78.0	145.0	—
1263	8.0	♀	280	—	—	136.0	352.0	—
511	11.0	♀	238	44.3	27.0	115.0	171.0	—
513	11.0	♀	270	45.9	31.0	123.0	280.0	—
533	13.0	♀	263	51.2	32.0	134.0	279.0	438.0
531	14.0	♀	266	48.8	32.3	130.0	34.0	480.0

* 1. Anteroposterior diameter of tusk at alveolar margin.
2. Mediolateral diameter of tusk at alveolar margin.
3. Circumference of tusk at alveolar margin.
4. Length of exposed tusk (alveolar margin to tip).
5. Maximum length of tusk from root to tip in a straight line.

** Specimen numbers and measurements are those of F. H. Fay, Institute of Marine Science, University of Alaska.

the fossil tusk were then plotted on the appropriate graphs and approximate ages read off on the horizontal axes. The first three graphs showed a marked separation between male and female tusk dimensions. The Bathurst Island specimen fitted well into the range of recent male Atlantic walruses and presumably represents that sex. A. W. Mansfield (personal communication 1974) thinks it is almost certainly an Atlantic walrus; F. H. Fay (personal communication 1974) comments that from the large size of the cheek teeth according to measurements of the sockets (Table 2), NMC 13747 seems to be clearly a male. The graph relating tusk circumference at the alveolar margin to age (Figure 4) appears to be the most useful one for determining the sex and approximate age (8.7 years) of NMC 13747. Graphs relating tusk length and width at the alveolar margin yielded approximate ages of 8.5 and 8.8 years, respectively, for the specimen. Graphs in which length of tusk exposed

TABLE 2—Comparative alveolar measurements of right upper molariform teeth of a postglacial walrus, *Odobenus rosmarus*, from Bathurst Island, N.W.T. and of recent Canadian Atlantic Walruses (*O. r. rosmarus*)

	Measurements (mm)*											
	I^3		PC^1		PC^2		PC^3		PC^4		I^3–PC^3	I^3–PC^4
Specimens	L	W	L	W	L	W	L	W	L	W	L	W
NMC 13747 Postglacial, Bathurst I., N.W.T.	23.3	19.0e	13.2	12.0^{+}e	22.4	12.0^{+}e	17.4	14.0^{+}e	6.4	4.8	85.0	100.8
NMC 32384 Recent, N.W.T.	16.8	13.0	15.0	12.3	20.8	16.4	20.5	13.9	5.0	5.0	80.5	99.2
NMC 32321 Recent, N.W.T.	16.5	15.2	15.4	12.1e	19.6	11.0e	14.8	12.4e	5.4	5.2	72.6	92.1
NMC 32352 Recent, N.W.T.	—	—	14.6	11.0e	19.0	15.0e	17.0	14.3e	7.3	5.2	—	—
NMC 32375 Recent, N.W.T.	18.1	15.8	14.2	12.1	20.8	17.1	22.7	16.4	4.0	4.5	87.4	100.7
NMC 32323 Recent, N.W.T.	19.7	16.0	15.7	13.1	21.8	16.3	19.0	15.6	4.7	4.7	83.6	97.0
NMC 32317 Recent, N.W.T.	22.1	14.0	16.8	14.4	24.4	17.9	18.3	14.5	—	—	86.5	99.2e
NMC 32376 Recent, N.W.T.	12.2	10.2	14.5	10.9	17.6	13.0	13.9	12.1	3.6	3.4	72.0	84.8
NMC 32377 Recent, N.W.T.	9.1	8.7	11.4	8.4	18.8	13.0	12.9	10.4	—	—	65.2	—
NMC 32303 Recent, N.W.T.	11.8	10.4	13.3	12.7	15.7	15.4	12.9	11.6	—	—	67.0	—

* L = Maximum length of aveolus; W = Maximum width of alveolus.
NOTE: e = estimated measurement. $^{+}$ = original measurement larger.

and total length of tusk were related to age were not useful in ascertaining sex, but seemed to provide reasonable age estimates of 8.4 and 9 years, respectively, for NMC 13747. Evidently the Bathurst Island specimen represents an 8- to 9-year-old male walrus. It should be kept in mind, however, that postglacial walruses in the central Queen Elizabeth Islands may have had rather different growth rates (possibly affecting tusk dimensions) than recent specimens from the Northwest Territories. Yet, Mansfield (1958, p. 48) notes that recent walruses of northern Foxe Basin appear to differ little in tusk size from those in northern Hudson Bay although the former group is larger in average size.

If we take 8.7 years as an average estimated age for the fossil, its standard length in life may have been about 280 cm (Mansfield 1958, Figure 12). An average weight for a male Atlantic walrus of this age would be about 1500 pounds (680 kg) (Mansfield 1958, Figure 13).

Although NMC 13747 probably represents an Atlantic walrus, there appears to be no way of proving it without having cheek teeth for sectioning to establish definitely the age of the individual represented by the fossil. Because cheek teeth are lacking, the possibility must be entertained that the specimen is derived from a Pacific walrus. If so, a graph relating tusk circumference at the alveolar margin to age indicates that it would likely be from either a 7-year-old male, or less likely an 11-year-old female (Figure 5). Graphs relating tusk length and width at the alveolar margin yielded approximate ages of 7 and 6½ years old (male), and 11 and 10½ years old (female), respectively, for the specimen. A graph in which length of exposed tusk is plotted against age suggests that if NMC 13747 were derived from a Pacific walrus male it would be about 5½ years old; if from a female it would be about 8 years old. The great variability of tusk dimensions with age in this sample should be noted.

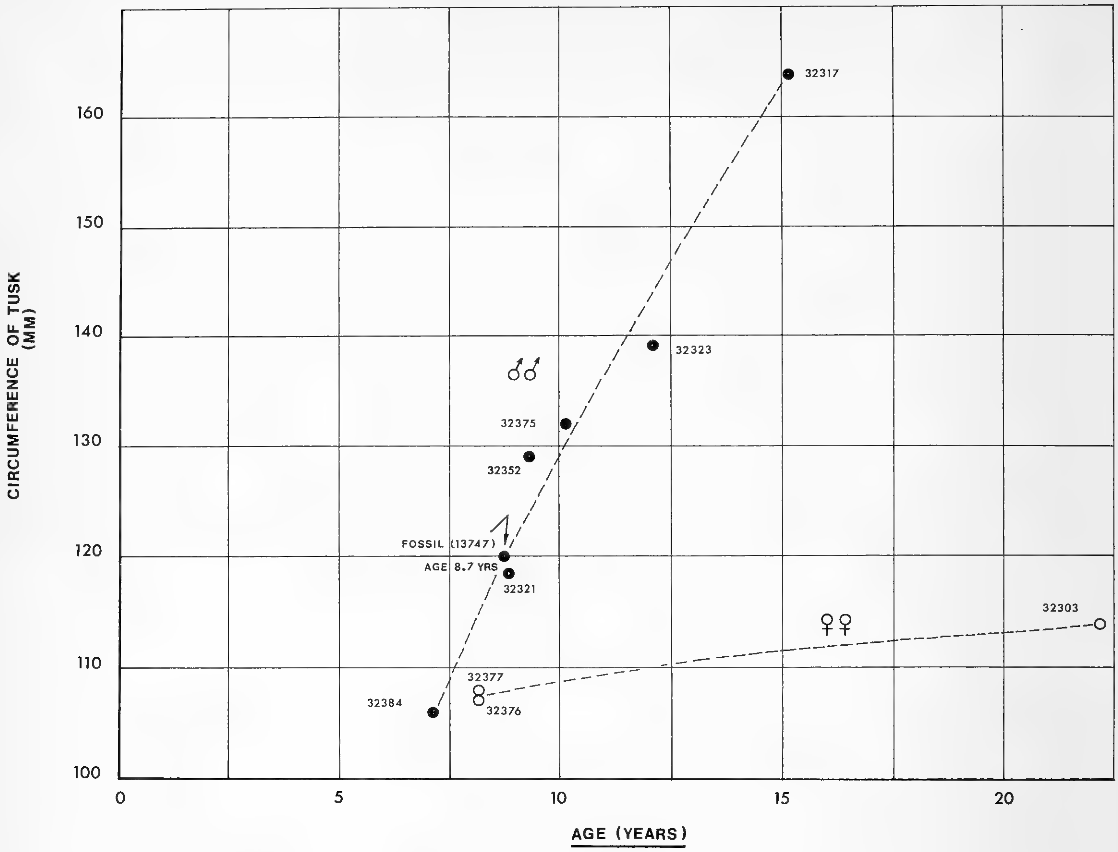


FIGURE 4. Graph of circumference of tusk at alveolar margin in relation to age of some recent specimens of *Odobenus rosmarus rosmarus* from the Northwest Territories. Sex (male) and estimated age (8.7 yr) of the Bathurst Island fossil (NMC 13747) are calculated by locating its tusk circumference on the graph.

The main difference between Atlantic and Pacific subspecies is in the larger physical size of the latter, but it does not allow resolution of this particular problem.

Sequence of Deglaciation and Paleoenvironment

Blake (1970, p. 634) indicates that a major ice sheet covered the Queen Elizabeth Islands during the last (Wisconsin) glaciation. It seems to have been thickest in the eastern and central part of the archipelago where uplift has been greatest during the last 5000 years. Prest's (1969) map of Wisconsin and recent ice retreat in North America suggests that glacial ice had not disappeared from central Bathurst Island until some time after 9500 years ago. Blake (1964, p. 5; 1974, p. 237) concludes that much of the island was ice-free by 9000 years ago and gives a detailed description of the transition from glacial cover to exposure of the land in this region.

Presumably, encroaching seawater would have accelerated the melting of the ice sheet. Marine mollusks such as *Mya* and *Hiatella* (an important part of the diet of walruses (Mansfield 1958, Table IV)) returned to the region with the reinvading sea. *Hiatella arctica* and *Mya truncata* occupied a position very close to the fossil walrus locality about 1000 years after the local glacier ice had disappeared; their shell fragments were collected from the surface on the east side of Goodsir River (75°45′ N, 98°25′ W; Figure 1) at an eleva-

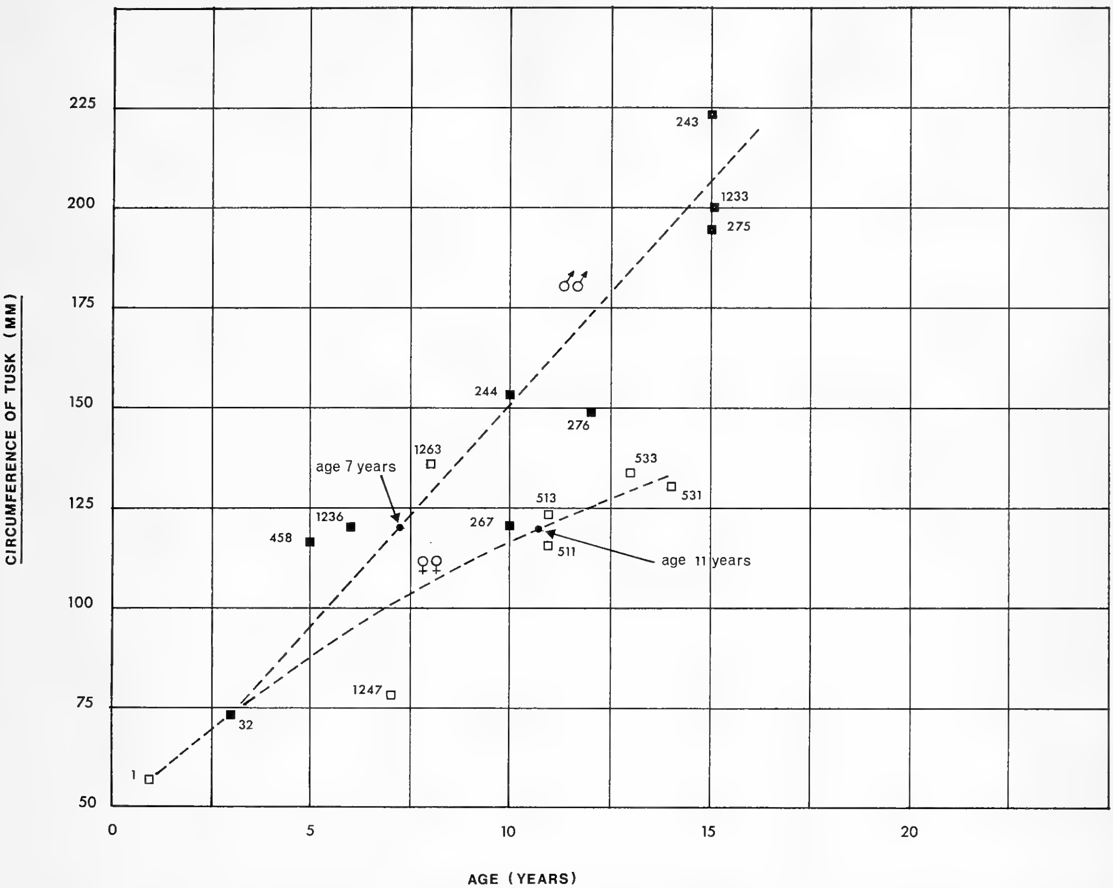


FIGURE 5. Graph of circumference of tusk at alveolar margin in relation to age of some recent specimens of *Odobenus rosmarus divergens* from the Bering Strait. If the Bathurst Island fossil (NMC 13747) were a male Pacific walrus it would probably be about 7 years old; if female, about 11 years old.

tion of about 73 m above sea-level. These shells are the highest found in the Bracebridge-Goodsir Inlet trough and yielded a radiocarbon age of 8400 ± 150 years B.P. (GSC-377; Lowdon et al. 1967, p. 35). Presumably walruses could have entered the region by that time, as suitable *uglit* or hauling-out sites probably were available on the rocky northern side of the trough. But there is no evidence that walruses were present in the area until about 7300 years ago. We know that *Mya truncata* occupied the sea bottom on central Bathurst Island at about the same time as walruses, for shells found *in situ* along Caledonian River (75°41′ N, 98°48′ W; Figure 1) at about 23 m above sea-level yielded a date of 7670 ± 150 years B.P. (GSC-736; Blake 1970, pp. 656–657). A layer of *Mya truncata* shells just above them (24.5 m above sea-level) at the same site were radiocarbon-dated at 4750 ± 140 years B.P. (GSC-783; Blake 1970, pp. 656–657).

It is interesting to note that whales (probably bowhead whales, *Balaena mysticetus*) also lived in the region about the same time as the walruses, for whale bone from 50 ± <10 m above sea-level near Resolute on Cornwallis Island (74°42′ N, 94°59′ W, Figure 1) yielded a radiocarbon date of 7380 ± 140 years B.P. (GSC-1193; Blake 1970, pp. 656–657).

Additional Quaternary Walrus Records for Canada

Pleistocene and postglacial walrus reports for Canada are not abundant (Table 3, Figure 6). In addition to the Bathurst Island specimen, the only other arctic coastal records are from a Dorset-culture archaeological site on Sugluk Island on the south side of Hudson

TABLE 3—Some records of walrus fossils from Canada

Specimens	Locality	Remarks
Walrus bone; walrus and bearded seal bone	Sugluk Island, N.W.T., south side of Hudson Strait	Tyara Early Dorset archaeological site. Walrus bone yielded a radiocarbon date of 2630 ± 130 years B.P. (GSC-703), and a combination of walrus and bearded seal (*Erignathus barbatus*) bone gave a date of 2200 ± 130 years B.P. (GSC-702; Lowdon et al. 1969, p. 37).
Piece of tusk 9½ in (241 mm) long	Baie St. Paul, Quebec	Found approximately 15 ft (4.6 m) below the surface by Rev. A. Larouche about 1956. Preserved in the Museum of Geology, Laval University, Quebec City.
Left and right tusk, about 20 in (508 mm) long	Near La Pocatière, Quebec	In 1973 D. Deschênes found a pair of tusks side by side, embedded perpendicularly in horizontally-bedded sands, evidently preserved *in situ* while the remainder of the skull had been eroded or washed away. Found at a depth of about 35 ft (10.7 m). In possession of Mr. Deschênes at L'Islet, Quebec.
Almost complete skeleton about 13 ft (4 m) long	Bic (Sainte Cécile du Bic), Quebec	Excavated from a depth of 14 ft (4.3 m) in compact clay at an elevation of over 100 ft (30 m) above sea-level. First reported by Provancher (1869, p. 19). Evidently the specimen was destroyed by fire at the Collège de Rimouski in 1881 (Huard 1908, p. 51).
Complete skull with tusks 20 in (508 mm) long	Rimouski, Quebec	Collected by J. C. Taché about 1874. Preserved in the Museum of Geology, Laval University, Quebec City.
Nearly complete skull with a 4½-in (114 mm) long tusk	Havre St. Pierre, Quebec	Collected by Rev. M. Perron. Preserved in the Museum of Geology at Laval University, Quebec City.
Cranium with tusks and an associated mandible lacking teeth	La Chaloupe between Moisie and Sheldrake ("Shalderee"), Quebec	Found by Abraham Couillard about 1900 on a sandy hill 30 ft (9 m) above sea-level and 285 ft (250 m) from the sea. Preserved in the Redpath Museum, McGill University, Montreal.
Two small tusks (ROM 213)	Prices Mills, Matane, Quebec	Preserved in the Royal Ontario Museum, Toronto.
Posterior cranial fragment (NMC 37375)	Les Capucins, Quebec	Collected by P. Hovington in 1970 at a depth of 15 ft (4.6 m) in sandy gravel. Preserved in Mammal Collection, National Museums of Canada, Ottawa.
Most of a large, right tusk (PU 12433; plaster cast NMC 21313)	Kegashka Lake, Quebec, about 10 mi (16 km) from the sea	Collected from sand on the lake shore by James Forman. John M. Reynolds presented it to Princeton University in 1922. It is heavily permineralized and may be of Champlain Sea age or older. A cast is preserved in the Quaternary Zoology Collection, National Museums of Canada, Ottawa.
Walrus tusk, lacking the tip	Clifton, New Brunswick	Collected from a gravel pit about 100 yd (91 m) from the Baie de Chaleur. Presumably from a layer of marine mollusk shells approximately 30 to 40 ft (9.1 to 12.2 m) below the surface. Specimen returned to Raymond Duguay of Caraquet, New Brunswick after examination by A. W. Mansfield.

TABLE 3—(Continued)

Specimens	Locality	Remarks
Heavily eroded anterior cranial fragment of an adult with well-worn third incisors and the stub of the right tusk (NMC 10426)	Near Tracadie, New Brunswick	Collected from an offshore bar east of Tracadie by Jean-Marie Paulin. On display in the National Museum of Natural Sciences, Ottawa.
A mandible lacking teeth (NMC 37054-i), a heavily eroded anterior half of a mandible (NMC 37054-j), six tusks (NMC 37054-a to f), a right squamosal fragment (NMC 37054-g), and a rib fragment (NMC 37054-h)	Near Entry Island, Magdalen Islands, Quebec	Collected by D. Dickson in 1968 while dredging the ocean bottom. Preserved in the Mammal Collection, National Museums of Canada, Ottawa.
Mandible lacking teeth (NMC 17555)	Bridgeport, Cape Breton Island, Nova Scotia	Collected in 1890 by P. Neville. Preserved in the Quaternary Zoology Collection, National Museums of Canada, Ottawa.
Skull of adult (ANSP); an adult male cranium (NMC 26073), a damaged juvenile cranium with a forward-growing left tusk (NMC 26077), five cranial fragments (NMC 26074-6, 27078-9), and the shaft of a left humerous (NMC 26080)	Sable Island, Nova Scotia	A well preserved skull was found in 1869 and donated to the Academy of Natural Sciences of Philadelphia by J. R. Willis of Halifax in 1871. He comments that many walruses must have occupied the island in ancient times "as a great many of their skulls have been thrown up on the beaches at intervals after heavy gales" (Rhoads 1898, p. 197). Of eight specimens from the beaches of Sable Island that were donated to the Quaternary Zoology Collection, National Museums of Canada, four were collected by A. W. Mansfield in the early to mid-1960s, three were collected by W. Hoek in 1971–72, and one was collected by G. Sleno in 1974.
Tusk (NMC 36769)	Georges Bank, about 200 miles (322 km) southwest of Yarmouth, Nova Scotia	Collected by D. Comeau in 1966 while dragging for scallops at a depth of 30 fathoms (55 m). Preserved in the Mammal Collection, National Museums of Canada, Ottawa.
Large mandible lacking teeth (NMC 17556)	Laberge area?, Yukon Territory, about 61°35′ N, 134°54′ W	Preserved in the Quaternary Zoology Collection. Donated by Mr. Blackett of Atlin, British Columbia. Evidently it represents a Pacific Coast walrus, for faint lettering on the right ramus states: "Found at the confluence of the 30 mile and Hootalinqua [= Teslin] rivers, Yukon Territory." It is a mystery how this fossil could have been found so far inland, unless it had been transported by man. The specimen was catalogued recently and there is no information as to when it was found or donated.
Small tusk fragment (BCPM uncatalogued)	Queen Charlotte Islands, British Columbia	It may be of Pleistocene age, but no more information was available. Preserved in the British Columbia Provincial Museum, Victoria.
Skull fragment (BCPM 467)	Exact locality unknown. Probably from British Columbia	Listed in the catalogue of the British Columbia Provincial Museum as: "Portion of skull of walrus, found on beach [near] outer wharf Jan. '96 by Mr. F. O'Reilly —." It was reported to Dr. Newcombe who brought it to the museum.

Strait. Other walrus fossils from the east coast of Canada appear to be mainly of Champlain Sea age (approximately 12 000 to 8000 years B.P.). There is no evidence that the species penetrated this inland sea (i.e., west of Quebec City) as its limits are presently defined (Harington 1972, Figure 1), but its remains have been found as close as Baie St. Paul[1]. A few of these specimens such as the heavily stained tusk from Kegashka Lake may have been deposited in the region well before the development of the Champlain Sea. It would be interesting to obtain radiocarbon dates on some of the specimens, particularly on those from Sable Island, for walruses are known to have bred that far south within historic time (Ray et al. 1968, p. 17). A few enigmatic walrus records exist for the Pacific coast of Canada. They should be treated with caution because critical data are lacking for each specimen.

Discussion

Presumably during one of the interglacial phases (Sangamon?) of the last ice age, there was a continuous, holarctic walrus population. In the course of a subsequent glacial interval (Wisconsin?), this population was divided by a growing ice barrier in the Canadian Arctic. Some walruses were forced into the North Atlantic and others survived in the North Pacific where evidently changes occurred, while the two groups were isolated, to the point that they are now recognized as separate subspecies (Davies 1958). The main difference between them is the larger physical size of the Pacific group, which in part may be accounted for by the availability of richer nutritional resources for walruses in the North Pacific.

Probably walruses reached their most southerly-known geographic limits (e.g., Kittyhawk, North Carolina (Hay 1923, p. 29; Ray 1960, p. 137); Montrouge near Paris (Gratiolet 1858, p. 620; Kellogg 1922, p. 50); northern Sakhalin Island (Matsumoto 1926, p. 15), and as far south as Tokyo, where the left anterior part of a cranium with cheek teeth and tusk was collected from the Tokyo beds of late Pleistocene age (Y. Hasegawa, personal communication 1974)) during glacial maxima. As Wisconsin ice sheets began to recede some 14 000 years ago in the Canadian Arctic (Prest 1969), walruses from the Atlantic and Pacific Oceans again converged there.

Much of Bathurst Island was ice-free 9000 years ago, and marine mollusks on which walruses commonly feed, had entered the region by about 8400 years ago. Presumably walruses could have survived in the area then, provided other habitat factors were suitable, but there is no evidence that they reached it until about 7300 years ago. These walruses are represented by a cranial fragment with tusk perhaps derived from an 8- to 9-year-old male of the Atlantic subspecies. Whales (probably bowheads) may have entered this part of the Canadian Arctic at about the same time as the walruses.

Did walruses first reach the Bathurst Island region from the Pacific or Atlantic? The answer is uncertain. NMC 13747 is very similar in cranial size and character to Atlantic walruses and may represent *O. r. rosmarus* rather than the Pacific subspecies. But a decision one way or the other cannot be made without having cheek teeth for sectioning to establish definitely the age of the individual represented by the fossil. Although the two subspecies are presently separated in the west-central part of the Canadian Arctic Islands by an environmentally-induced sea ice barrier about 300 miles (480 km) in breadth (Harington 1966, p. 511, Figure 1), this barrier may have been

[1] It is worth noting that two walrus (*Odobenus* sp.) and three whale (*Physeter* sp., *Balaenoptera* sp., and *Balaena?* sp.) specimens were evidently collected from late Wisconsin beach deposits in the southern peninsula of Michigan (Hussey 1930, p. xiv; Handley 1953, p. 253; Wilson 1967, pp. 212–213). These specimens indicate that there was a far western arm of the "Champlain Sea" that had not been recognized previously. As a hypothesis for testing, I suggest that about 11 800 to 11 700 years ago there was a narrow arm along the Laurentide ice front connecting the western extremity of the Champlain Sea (as it is presently defined) with the northeastern extremity of Glacial Lake Algonquin (Prest 1970, p. 718), which allowed cold seawater with marine mammals to penetrate to the shores of eastern Michigan. I postulate that this episode would have been of relatively short duration. Efforts are being made to obtain samples of the Michigan specimens for radiocarbon dating.

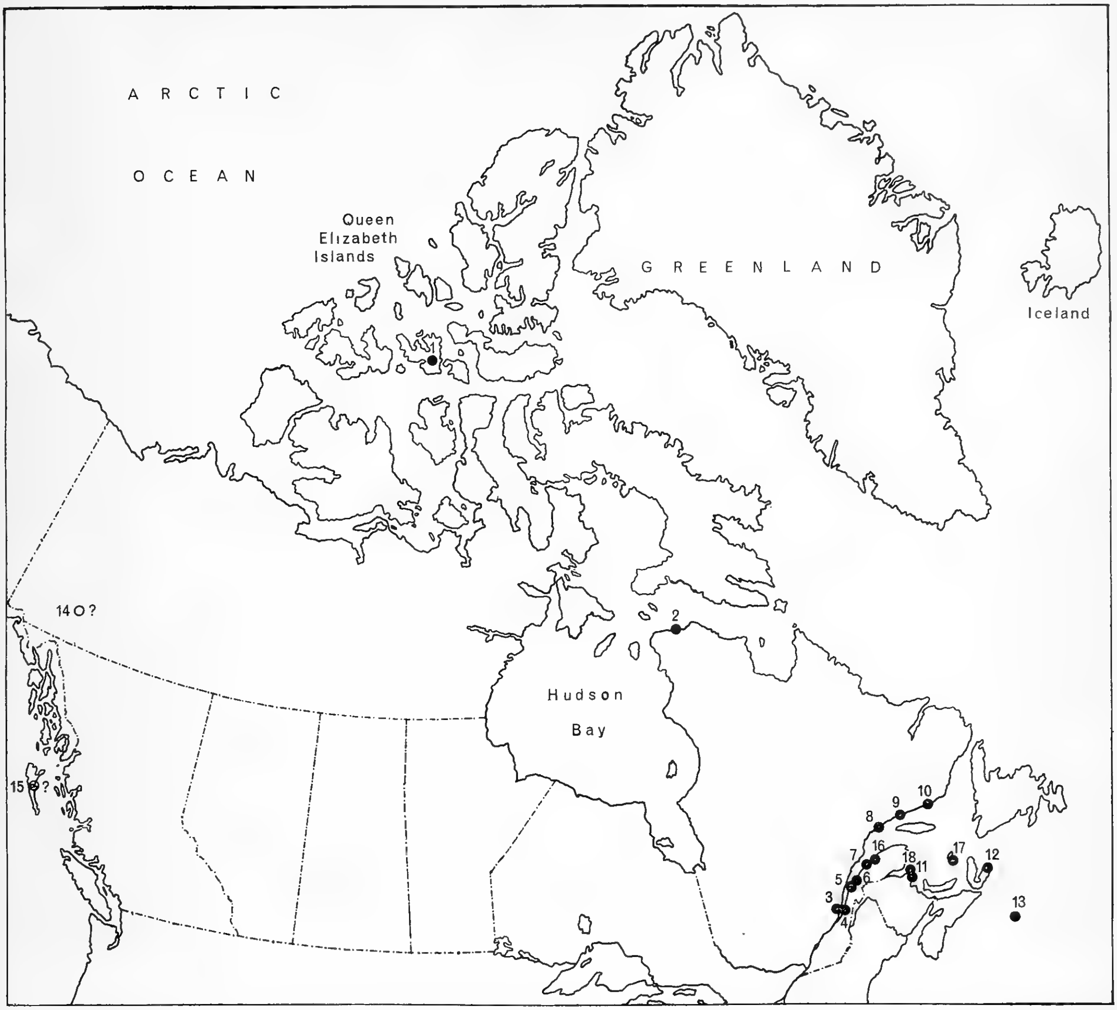


FIGURE 6. Some Quaternary walrus (*Odobenus rosmarus*) records for Canada. Each dot represents one or more specimens. 1. Bathurst Island, N.W.T.; 2. Sugluk, Quebec (Tyara site); 3. Baie St. Paul, Quebec; 4. La Pocatière, Quebec; 5. Bic, Quebec; 6. Rimouski, Quebec; 7. Matane, Quebec; 8. La Chaloupe, Quebec; 9. Havre St. Pierre, Quebec; 10. Kegashka Lake, Quebec; 11. Tracadie, New Brunswick; 12. Bridgeport, Nova Scotia; 13. Sable Island, Nova Scotia; 16; Les Capucins, Quebec; Entry Island (Magdalen Islands), Quebec; 17. Clifton, New Brunswick. The specimen from Georges Bank south of Nova Scotia is not mapped.
Questionable records: 14. Laberge area, Yukon Territory; 15. Queen Charlotte Islands, British Columbia.

less effective earlier in the postglacial period when ice sheets were melting most rapidly.

Apart from the Bathurst Island report, there are relatively few Pleistocene walrus records for Canada. Two radiocarbon dates on walrus bone in the 3000- to 2000-years-B.P. range are known from an archaeological site on southern Hudson Strait. Specimens of Champlain Sea age or earlier have been collected from seven localities along the shores of the St. Lawrence River east of Quebec City. As yet, there is no evidence that walruses invaded the Champlain Sea proper, although other cold-adapted pinnipeds such as ringed and harp seals were there (Harington and Sergeant 1972, pp. 1045, 1047). But remains of two walruses from near Gaylord and Mackinac Island suggest that the species spread, via a hitherto unrecognized western arm of the "Champlain Sea," into a relatively transient body of marine or brackish water which existed in eastern Michigan during the late Wisconsin. Five walrus fossils are known from the shores of the Gulf of St. Lawrence and, in addition to a specimen from Cape Breton Island, walrus fossils have been recovered from two localities off the Nova Scotia coast. There are three other uncertain records for the Pacific coastal region.

Acknowledgments

I am particularly grateful to David Gill (National Museums of Canada) for collecting and donating the important specimen from Bathurst Island. Weston Blake, Jr. (Geological Survey of Canada), Arthur Mansfield (Environment Canada), and Francis Fay (University of Alaska) kindly read drafts of the manuscript and offered helpful advice. Dr. Fay supplied valuable measurements on a series of Pacific walruses which he had aged by tooth sectioning. Lila Jeletzky assisted by searching the literature and gathering much of the information on walrus fossils from Quebec. René Bureau (Geological Museum, Laval University) supplied data on specimens from Baie St. Paul, Rimouski, and Havre St. Pierre; as did Maurice L'Heureux (Institut de Technologie Agricole) for the La Pocatière specimen. Donald Baird (Princeton University) kindly loaned the tusk from Kegashka Lake, and Robert Carroll (McGill University) allowed me to examine the fossil from La Chaloupe. I am grateful to the Director and staff of the British Columbia Provincial Museum for permission to look at their Quaternary vertebrate collection and catalogues pertaining to it. C. Van Zyll de Jong and David Campbell (National Museums of Canada) helped by providing a few Pleistocene or postglacial specimens in addition to recent comparative material. Gerry Anderson (National Museums of Canada) supplied the photographs, and Charles Douglas (National Museums of Canada) drafted Figures 1 and 4 to 6.

Literature Cited

Blake, W., Jr. 1964. Preliminary account of the glacial history of Bathurst Island, Arctic Archipelago. Geological Survey of Canada Paper 64-30: 1–7.

Blake, W., Jr. 1970. Studies of glacial history in Arctic Canada. I. Pumice, radiocarbon dates, and differential postglacial uplift in the eastern Queen Elizabeth Islands. Canadian Journal of Earth Sciences 7(2): 634–664.

Blake, W., Jr. 1974. Periglacial features and landscape evolution, Central Bathurst Island, District of Franklin. Geological Survey of Canada Paper 74-1, Part B: 235–244.

Davies, J. L. 1958. Pleistocene geography and the distribution of northern pinnipeds. Ecology 39: 97–113.

Gratiolet, P. 1858. Note sur un fragment de crâne trouvé à Montrouge, près Paris. Bulletin de la Société géologique de France 15: 620–624.

Handley, C. O., Jr. 1953. Marine mammals in Michigan Pleistocene beaches. Journal of Mammalogy 34(2): 252–253.

Harington, C. R. 1966. Extralimital occurrences of walruses in the Canadian Arctic. Journal of Mammalogy 47(3): 506–513.

Harington, C. R. 1971. Ice age mammals in Canada. Arctic Circular 22(2): 66–89.

Harington, C. R. 1972. The Champlain Sea and its vertebrate fauna. Part II. Vertebrates of the Champlain Sea. Trail & Landscape 6(1): 33–39.

Harington, C. R. and **D. E. Sergeant.** 1972. Pleistocene ringed seal from Champlain Sea deposits near Hull, Quebec — a reidentification. Canadian Journal of Earth Sciences 9(8): 1039–1051.

Hay, O. P. 1923. The Pleistocene of North America and its vertebrated animals from the states east of the Mississippi River and from the Canadian provinces east of longitude 95°. Carnegie Institution of Washington Publication 322. 499 pp.

Huard, V. A. 1908. Capture d'une morse. Le Naturaliste Canadien 35(4): 49–51.

Hussey, R. C. 1930. Items. Science (Washington) (N.S.) 72(1875): xiv.

Kellogg, R. 1922. Pinnipeds from Miocene and Pleistocene deposits of California. University of California Publications, Bulletin of the Department of Geological Sciences 13(4): 23–132.

Lowdon, J. A., R. Wilmoth, and **W. Blake Jr.** 1969 Geological Survey of Canada radiocarbon dates VI. Geological Survey of Canada Paper 67-2, Part B: 1–42.

Lowdon, J. A., J. G. Fyles, and **W. Blake Jr.** 19679 Geological Survey of Canada radiocarbon dates VIII. Geological Survey of Canada Paper 69-2, Part B: 22–42.

Mansfield, A. W. 1958. The biology of the Atlantic walrus *Odobenus rosmarus rosmarus* (Linnaeus) in the eastern Canadian Arctic. Manuscript Report Series (Biology) 653. 146 pp.

Mansfield, A. W. 1963. Seals of arctic and eastern Canada. Fisheries Research Board of Canada Bulletin 137. 30 pp.

Matsumoto, H. 1926. On two species of fossil Pinnipedia from Kazusa and Saghalin. Scientific Reports of Tôhoku Imperial University, Sendai, Series 2 (Geology) 10(1): 13–16.

Péwé, T. L. and **D. M. Hopkins.** 1967. Mammal remains of pre-Wisconsin age in Alaska. *In* The Bering Land Bridge. *Edited by* D. M. Hopkins. Stanford University Press. pp 266–270.

Prest, V. K. 1969. Retreat of Wisconsin and Recent ice in North America; speculative ice-marginal positions during recession of last ice-sheet complex. Geological Survey of Canada, Map 1253A.

Prest, V. K. 1970. Quaternary geology of Canada. *In* Geology and economic minerals of Canada. Economic Geology Report Number 1. Fifth edition. Department of Energy, Mines and Resources, Ottawa. pp. 676–764.

Provancher, L. 1869. Un morse fossile. Naturaliste Canadien 2: 19.

Ray, C. E. 1960. *Trichecodon huxleyi* (Mammalia: Odobenidae) in the Pleistocene of southeastern United States. Bulletin of the Museum of Comparative Zoology at Harvard University 122(3): 129–142.

Ray, C. E., A. Wetmore, and **D. H. Dunkle.** 1968. Fossil vertebrates from the marine Pleistocene of southeastern Virginia. Smithsonian Miscellaneous Collections 153(3): 1–25.

Rhoads, S. N. 1898. Notes on the fossil walrus of eastern North America. Proceedings of the Academy of Natural Science of Philadelphia 50: 196–201.

Wilson, R. L. 1967 The Pleistocene vertebrates of Michigan. Papers of the Michigan Academy of Science, Art, and Letters 52: 197–234.

Received 1 November 1974
Accepted 10 February 1975

Addendum

Dr. W. Blake, Jr. has drawn to my attention a significant report of walrus specimens in the central Canadian Arctic Islands by R. Thorsteinsson (Geological Survey of Canada Memoir 294. 1958, p. 17) who states, "Four complete walrus skeletons were seen at elevations from 225 to 300 feet above sea-level, 3 on Cornwallis Island and 1 on Little Cornwallis Island. It is difficult to explain the occurences of walrus skeletons all several miles from the present shore except as being deposited when these parts were submerged." The exact locations of the specimens are shown on Thorsteinsson's Map 1054A. Tentative plans have been made to collect these skeletons. According to radiocarbon dates on raised shorelines on adjacent Bathurst Island, the fossils mentioned by Thorsteinsson are probably over 8000 years old.

The Waterfowl of Chick Lake, Northwest Territories

IAN D. THOMPSON

Beak Consultants Limited, 4216–10th Street, N.E., Calgary, Alberta T2E 6K3

Thompson, I. D. 1975. The waterfowl of Chick Lake, Northwest Territories. Canadian Field-Naturalist 89(3): 262-267.

Abstract. Species composition and numbers of breeding waterfowl at Chick Lake, Northwest Territories were studied during late May and June 1973. Evidence for breeding in 17 species was found, the most common being American Wigeon (*Anas americana*), Lesser Scaup (*Aythya affinis*), and White-winged Scoter (*Melanitta deglandi*). Range extensions, supported by nests, are included for Ring-necked Duck (*Aythya collaris*) and Bufflehead (*Bucephala albeola*).

While studying passerine populations in the Mackenzie River Valley for LGL Limited, I also investigated the waterfowl of Chick Lake, Northwest Territories (65°52′ N, 128°07′ W). The lake is 55 miles (89 km) northwest of Norman Wells, and about 17 miles (27 km) north of the Mackenzie River (Figure 1). Chick Lake is 6 miles (10 km) long and just over 2 miles (3 km) wide, at an elevation near 400 ft (120 m). In June, its average depth was about 5 ft (1.5 m). The Gibson ridge lies 3 miles (5 km) to the south and an unnamed range is 4 miles (6 km) to the north; both rise to about 2500 ft.

Little previous information on species composition of breeding waterfowl of northern boreal lakes is available. The few studies done indicate the most common ducks occurring throughout the Mackenzie Valley are Mallard (*Anas platyrhynchos*), Pintail (*A. acuta*), American Wigeon (*A. americana*), Lesser Scaup (*M. perspicillata*), and Red-breasted Merganser (*Mergus serrator*). Other less common species known to breed north to the Mackenzie Delta are Green-winged Teal (*Anas crecca carolinensis*), Northern Shoveler (*A. clypeata*), and Common Goldeneye (*Bucephala clangula*). Blue-winged Teal (*Anas discors*), Canvasback (*Aythya valisineria*), Ring-necked Duck (*A. collaris*), Greater Scaup (*A. marila*), Bufflehead (*Bucephala albeola*), and Common Merganser (*Mergus merganser*) are rare north of Fort Simpson (Prebble 1908; Porsild 1943; Godfrey 1966; Weller et al. 1969; Murdy et al. 1970; Broch 1974). Barrow's Goldeneye (*Bucephala islandica*) was found to be common in the southern Yukon to as far east as Macmillan River (Rand 1946; White and Haugh 1969). Pairs of Oldsquaw (*Clangula hyemalis*) have been seen on boreal lakes, but this species has not been recorded breeding south of the Mackenzie Delta (Porsild 1943; Godfrey 1966; Broch 1974).

Description of Study Area

The major vegetation type of the region is boreal forest, mostly black spruce (*Picea mariana*) muskeg (Rowe 1972). Ground cover is predominantly sphagnums and feather mosses, lichen (*Cladonia* spp.), some sedges (*Carex* spp.), and mountain cranberry (*Vaccinium vitis-idaea*). There is a dwarf shrub layer dominated by Labrador tea (*Ledum palustre* and *L. groenlandicum*), bearberry (*Arctostaphylos rubra*), bilberry (*Vaccinium uliginosum*), and dwarf birch (*Betula glandulosa*). Willow (*Salix* spp.), alder (*Alnus crispa*), and young black spruce from 5 to 8 ft (4.5–7 m) high comprise the shrub layer. Black spruce with white spruce (*P. glauca*) and white birch (*Betula papyrifera*) are the major tree species in drier or better-drained areas such as the lake shoreline. Most ponds are shallow with either abrupt shorelines or discontinuous sedge marshes usually 5 to 10 ft (1.5–3 m) wide at the shores. Black spruce, willow, and sweet gale (*Myrica gale*) are common at the edges of ponds. Many sphagnum bogs at various stages of succession, bays, and ponds are also located near the east end of Chick Lake. Signs of an old burn, probably more than 30 years old, were seen in many areas, and a site at the west end was burned about 1969. Extensive sedge–horsetail (*Equisetum fluviatile*) marshes occur along the east shore, especially where the Donnelly

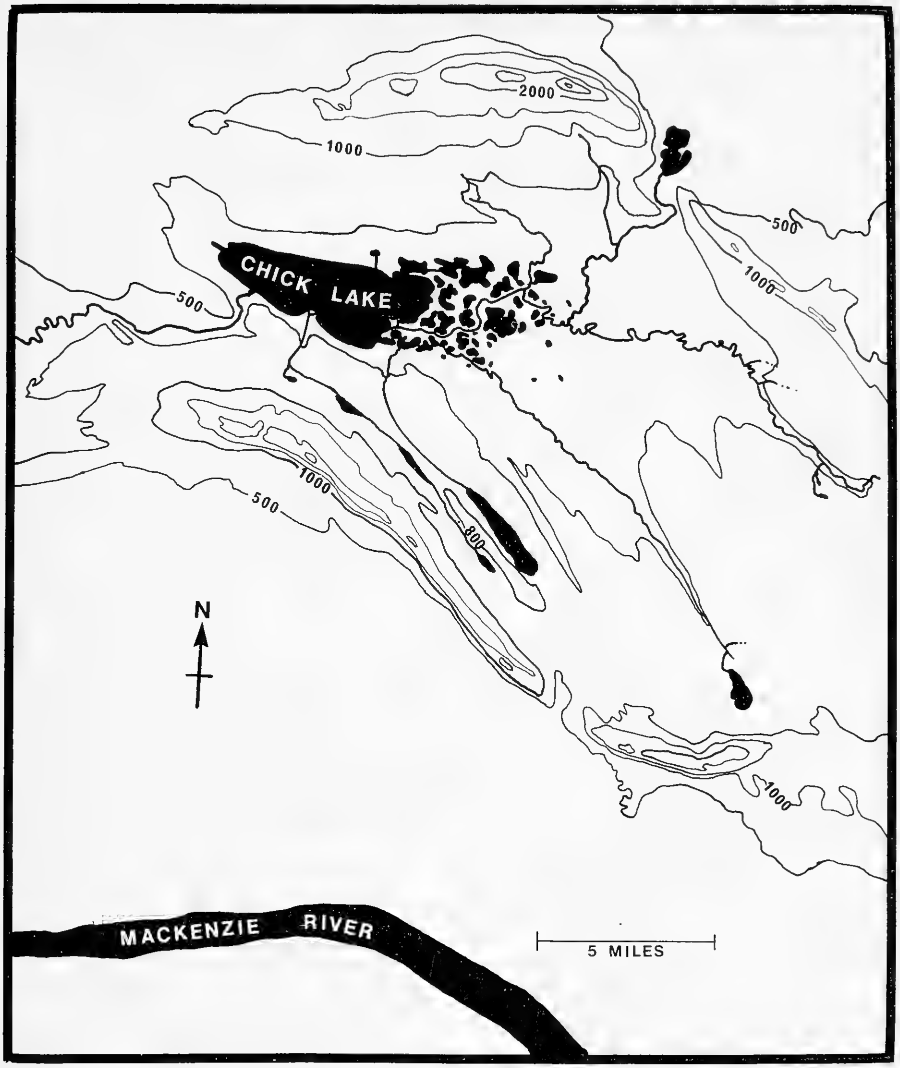


FIGURE 1. The study area, Chick Lake, Northwest Territories.

River flows into the lake. Major submerged species included *Potomogeton richardsoni, P. vaginatus, P. foliosus*, and *Hippuris vulgaris fluviatilis*.

Methods

The study was conducted from 26 May to 23 June 1973. Most of the breeding waterfowl, with the exception of Surf and White-winged Scoters, were observed at the east end of the lake. Most effort was expended in this area.

Censusing followed Dzubin's (1969) suggestions where possible, although counts could not be conducted in the morning when other work had priority. Surveys from a motorized rubber boat were made on 27 May, 4 June, and 20 June, between 2200 and 0100 hours MDST (Mountain Daylight Saving Time). Approximately 12 miles (19 km) of shoreline was censused, including ½ mile of the Donnelly River, at the east end of the lake. Num-
of the lake were estimated from counts during other work. Waterfowl were observed at all
bers of breeding waterfowl on the remainder

opportunities to record as many species as possible. Four ponds were also monitored for use by ducks.

An effort was made to locate as many nests as possible to determine nesting chronology, habitat, and clutch size. Much of the shoreline, islands, and peninsulas were searched on foot. All nests were revisited at least once to check advancement of incubation (Weller 1956) or hatching success.

Counts of groups of ducks, primarily drakes not yet in eclipse plumage, were done twice, on 14 June and at the same time as the third breeding-pair count on 20 June.

Results and Discussion

Names of ducks used in this paper follow the AOU Check-list (1957) and its amendment (AOU 1973).

It was felt that reasonably accurate counts were obtained for most species using Chick Lake itself. The counts of breeding pairs on the neighboring ponds are undoubtedly incomplete. Little knowledge of waterfowl breeding behavior at northern latitudes exists, so application of breeding census techniques generally employed in more southerly areas may be of dubious value. As only three counts were done, no estimate of breeding population is given.

Species Composition

Seventeen species of ducks were considered to be breeding at Chick Lake (Table 1). Nests of eight species were found (Table 2).

When the maximum number obtained (except in Surf Scoters, see *Nesting*) in the three counts was used, the majority were American Wigeon, 101 pairs; Lesser Scaup, 57 pairs; and White-winged Scoter, 47 pairs. Mallard and Pintail were less common than expected, but most pairs of these species had started to breed before the counts were made, and may thus have been less visible. Two other species, Canvasback and Ruddy Duck (*Oxyura jamaicensis*), were also seen on the lake but no evidence of breeding was found.

For diving ducks, the behavior of migrating vs. resident pairs and of breeding vs. nonbreeding pairs is not known to differ (Smith and Hawkins 1948; Dzubin 1969). Dzubin (1969) suggested that a nesting study is the only accurate method for censusing populations of most species of diving ducks. A complete nesting study was not practical; for divers, only pairs and lone drakes frequenting a particular segment of shoreline were counted. While this did not eliminate all bias, it was felt it provided the best possible estimate.

Small groups of ducks, predominantly males not yet in eclipse plumage, about 1000 in total,

TABLE 1—Numbers of pairs and lone drakes at Chick Lake, 1973

	May 27			June 4			June 20		
Species	Pairs	Lone drakes	Total	Pairs	Lone drakes	Total	Pairs	Lone drakes	Total
American Wigeon	90	11	101	31	52	83	5	34	39
Lesser Scaup	41	11	52	46	11	57	28	6	34
White-winged Scoter	30	0	30	39	8	47	8	3	11
Surf Scoter	32	0	32	12	1	13	9	2	11
Mallard	16	4	20	8	10	18	1	0	1
Pintail	7	11	18	5	5	10	0	0	0
Green-winged Teal	15	0	15	9	1	10	1	0	1
Greater Scaup	10	3	13	9	2	11	3	0	3
Bufflehead	3	7	10	3	6	9	2	3	5
Northern Shoveler	2	6	8	0	4	4	0	0	0
Barrow's Goldeneye	6	0	6	7	1	8	1	0	1
Red-breasted Merganser	3	0	3	3	1	4	0	0	0
Common Goldeneye	1	0	1	1	1	2	2	0	2
Ring-necked Duck	0	0	0	2	0	2	1	0	1
Blue-winged Teal	0	0	0	2	0	2	0	0	0
Common Merganser	1	0	1	1	0	1	0	0	0
Oldsquaw	0	0	0	1	0	1	1	0	1

started to gather at the east end of the lake about 12 June. The majority of these were Mallard, Pintail, American Wigeon, Shoveler, Goldeneye, and Surf Scoter. I left the area in late June and therefore was unable to determine use of Chick Lake for molting by waterfowl.

Nesting

By noting groups of post-breeding drakes and comparing numbers of breeding pairs between counts, an impression of nesting chronology was gained. Mallard, Pintail, Green-winged Teal, and Shoveler were the earliest breeders. Most of their nests were probably initiated prior to my arrival. Thus an accurate count for these species was not obtained. American Wigeon, Greater Scaup, Lesser Scaup, and Bufflehead initiated nests in late May and throughout the first two weeks of June. White-winged Scoters were the latest breeders, as their nesting apparently did not peak until after the first week in June. It was uncertain when or where Surf Scoters nested, but they were undoubtedly later nesters than Mallards. Apparently courting and pair formation in Surf Scoters occurred on the lake and nesting and loafing ensued on ponds away from the lakeshore. Few Surf Scoters were seen after late May, and only 13 pairs were thought to breed in the vicinity of Chick Lake. Most pairs seen in May were probably migrants of this species.

Table 2 summarizes the number of nests found for each species at Chick Lake, including estimated initiation dates and number of eggs found in each nest. No parasitic egg-laying was observed.

Three nests were taken by predators on one of the ponds. One was that of a Ring-necked Duck, while the other two were destroyed before being found. All three nests were dishevelled and none of the eggs were located. Possible nest predators observed in the area included mink (*Mustela vison*), Mew Gulls (*Larus canus*), and Common Ravens (*Corvus corax*).

The discovery of nests of Ring-necked Duck and Bufflehead is evidence for northward extensions of the known breeding ranges of these species by about 250 miles (400 km). Previously published records of the northernmost breeding of the Ring-necked Duck were those that occurred at Fort Simpson (Bent 1962; Godfrey 1966) and in the upper Yukon River area (White and Haugh 1969). Buffleheads have also been recorded breeding at Fort Simpson (Godfrey 1966; Erskine 1972).

Five other species recorded were outside their known breeding ranges. These included Blue-winged Teal, Northern Shoveler, Barrow's Goldeneye (which was more abundant than the Common Goldeneye), Oldsquaw, and Common Merganser. With the exception of Oldsquaw, which is predominantly a tundra breeder, and Barrow's Goldeneye, which nests in British Columbia and southern Yukon, all of these species have been recorded breeding as far north as Great Slave Lake (Preble 1908; Godfrey 1966; Weller et al. 1969). Although only a few pairs of each of these species were recorded, in all cases there was a reluctance of lone drakes or pairs to vacate a pond or a specific area of shoreline.

TABLE 2—Nests located at Chick Lake, 1973

Species	Number of nests	Number of eggs*	Estimated initiation dates
Mallard	3**	8, 7	23 May; 11 June
Pintail	2	8, 8	17 May; 19 May
American Wigeon	5	7, 7, 7, 7, 9	26 May; 3 June; 6 June; 6 June; 8 June
Ring-necked Duck	1	6 (incomplete)	6 June
Greater Scaup	2	7, 10	4 June; 10 June
Lesser Scaup	4	7, 6, 7, 10	3 June; 6 June; 8 June; 9 June
Bufflehead	1	6	27 May
White-winged Scoter	2***	9	8 June
Unidentified Ducks	2	Unknown	—

* Corresponds to list of initiation dates.
** One nest had hatched when found on 21 June.
*** One nest had been destroyed when found on 20 June.

Nesting Sites

Nests of two Mallards near the lake were by bays at the northeast side; both nested in large willow bushes close to the shore above ground. Another Mallard nest was on a sedge hummock on the shore of an island in a pond. One Pintail nest was located under a sweet gale bush in sedges on a small island in a pond, while the other was in a very open situation at the base of a large birch tree close to the shore of a bay. This latter nest hatched successfully on 18 June. Most pairs of Green-winged Teal were located on ponds; no nests were found.

Wigeon nested predominantly near the lakeshore in black spruce muskeg. Four of the nests were bowls dug in moss under young 3-ft (1 m) spruce trees. The fifth nest was constructed under a willow bush near the shore of a bay. Distances to shore varied from a few to several hundred feet.

Many Lesser Scaup pairs were found in the east bay areas, but all four nests found were on the shores of ponds, two on small peninsulas and two on islands. In all cases sedge and sweet gale were the cover species. Relatively few Greater Scaup were seen. One nest was on a sedge island in a pond and another in sedges under a willow bush on the shore of a bay.

White-winged Scoters were never seen on ponds and the entire population probably fed and loafed on Chick Lake. Of the two nests found, one was 600 yards (550 m) from shore beside a cutline, the other over 1000 yards (910 m) inland. The latter had been destroyed by a predator before it was located. Several females were observed landing in spruce muskeg far from shore.

Of the hole-nesters seen on the study area, only Buffleheads were found on the lake. While both species of goldeneye were seen flying over the lake, no loafing pairs or attendant drakes were observed at the shore. Two Common Goldeneye females were noted several times loafing in the Donnelly River about 200 yards (180 m) upstream. A pair of Barrow's Goldeneye probably nested by a pond near the south shore where a creek entered the lake. A Bufflehead nest was found 12 ft (3.7 m) up in the 18-ft (5.5 m) stump of a dead birch, 15 ft (4.6 m) from the lake. Many holes in dead birches were seen around the lake, but most were not deep enough for nesting sites and in many cases the wood was totally rotted.

The nest of the Ring-necked Duck was found 15 ft (4.6 m) from shore in a sedge marsh on a pond of 4 to 5 acres (1.6–2.0 ha). The female had not completed her clutch when the nest was found. When the nest was revisited 6 days later, down had been added but the eggs had been destroyed and the pair was no longer on the pond.

Other Species Nesting in the Study Area

Nests of the Common Loon (*Gavia immer*) and Red-necked Grebe (*Podiceps grisegana*) were found on islands in ponds and in bays. Mew Gulls nested alone or in colonies of 5 to 10 pairs on those ponds with dead timber along the shore. Arctic Loons (*Gavia arctica*) likely nested on most ponds, although no nests were located.

Acknowledgments

Funding for LGL Limited research in the Mackenzie Valley was provided by Canadian Arctic Gas Study Limited through Northern Engineering Services Company Limited, Calgary, Alberta. I am indebted to G. G. Anweiler, K. J. Finley, and A. L. Wormington for their assistance in obtaining data. I am grateful to C. D. Fowle who reviewed the manuscript.

Literature Cited

American Ornithologists' Union. 1957. Check-list of North American birds. 5th edition. Ithaca, New York.

American Ornithologists' Union. 1973. Thirty-second supplement to the American Ornithologists' Union Check-list of North American birds. Auk 90: 411–419.

Bent, A. C. 1962. Life histories of North American wild fowl. Volumes 1 and 2. Dover Publishing Incorporated, New York.

Broch, N. B. 1974. Birds near Fort Good Hope, Northwest Territories. Blue Jay 32: 172–176.

Dzubin, A. 1969. Assessing breeding populations of ducks by ground counts. Saskatoon Wetlands Seminar, Canadian Wildlife Service Report Number 6: 187–230.

Erskine, A. J. 1972. Buffleheads. Canadian Wildlife Service Monograph Series 4.

Godfrey, W. E. 1966. The birds of Canada. National Museum of Canada Bulletin 203. 428 pp.

Murdy, H. W., D. L. Trauger, and **H. K. Nelson.** 1970. Waterfowl research on the Yellowknife study area, 1961–70. Transactions of the Thirty-fourth Federal-Provincial Wildlife Conference: 26–29.

Porsild, A. E. 1943. Birds of the Mackenzie Delta. Canadian Field-Naturalist 57: 19–35.

Preble, A. E. 1908. A biological investigation of the Athabaska–Mackenzie Region. United States Department of Agriculture Bureau of Biological Survey, North American Fauna 27.

Rand, A. L. 1946. List of Yukon birds and those of the Canol Road. National Museum of Canada Bulletin 105. 76 pp.

Rowe, J. S. 1972. Forest regions of Canada. Canadian Forestry Service Publication 1300. 172 pp.

Smith, R. H. and **A. S. Hawkins.** 1948. Appraising waterfowl breeding populations. Transactions of the North American Wildlife Conference 13: 57–69.

Weller, M. W. 1956. A simple field candler for waterfowl eggs. Journal of Wildlife Management 20(2): 111–113.

Weller, M. W., D. L. Trauger, and **G. L. Krapu.** 1969. Breeding birds of the West Mirage Islands, Great Slave Lake, N.W.T. Canadian Field-Naturalist 83: 344–360.

White, C. M. and **J. R. Haugh.** 1969. Recent data on summer birds of the upper Yukon River, Alaska and adjacent parts of the Yukon Territory, Canada. Canadian Field-Naturalist 83: 257–271.

Received 26 November 1974
Accepted 25 March 1975

Observations of the Fall Migration of Greater Snow Geese across Southern Quebec

H. BLOKPOEL,[1] J. D. HEYLAND,[2] J. BURTON,[3] and N. SAMSON[2]

[1] Canadian Wildlife Service, Eastern Region Headquarters, 2721 Highway 31, Ottawa, Ontario K1A 0H3

[2] Service Québecois de la Faune, B.P. 7200, Orsainville, Quebec G1G 5E5

[3] Centre de Recherches écologiques de Montréal, 4101 Sherbrooke Street East, Montreal, Quebec H1X 2B2.

Blokpoel, H., J. D. Heyland, J. Burton, and N. Samson. 1975. Observations of the fall migration of Greater Snow Geese across Southern Quebec. Canadian Field-Naturalist 89(3): 268–277.

Abstract. The route of the 1971 fall migration of Greater Snow Geese from their staging grounds on the St. Lawrence River near Quebec City across southern Quebec was determined from visual and radar observations. Most geese departed during only two periods: 30 October, 0600 hours to 31 October, 0600 hours; and 8 November, 0600 hours to 9 November, 0200 hours. On 30 and 31 October the geese migrated in directions between southwest and south-southwest and on 8 and 9 November the directions were southerly. The wind conditions during those two periods were the most favorable for migration.

Greater Snow Geese (*Chen caerulescens atlantica*) breed in the Canadian Arctic and winter on the Atlantic coast of the USA in New Jersey, Delaware, Virginia, and North Carolina. In general, geese do not migrate in one flight from their summer to their winter grounds, but spend several weeks at traditional "staging areas," where they feed and rest.

Greater Snow Geese have a major staging area on the St. Lawrence River downstream from Quebec City. Each fall, large numbers of birds concentrate near Cap Tourmente, just north of the northern tip of Ile d'Orléans. From an estimated total of 2000–3000 birds at the beginning of this century (Lemieux 1959), the population has increased to approximately 155 000 in fall 1973 (Heyland, unpublished data).

The fall migration route of Greater Snow Geese from the St. Lawrence River to their wintering grounds is not well known (Déry 1938; Morrison 1952; Lemieux 1959). The route is, however, of interest to wildlife managers wishing to ensure protection of important staging areas and to the National Research Council Associate Committee on Bird Hazards to Aircraft. Greater Snow Geese weigh 4.5 to 7.5 lb (2 to 3.4 kg) (Heyland 1973) and migrate in flocks. A collision between a flock of geese and an aircraft might cause serious damage (e.g., Blokpoel 1974). The possible proximity of the migration route to Montreal International Airport is of special concern to flight safety authorities. This paper reports the results of observations of the migration of the Greater Snow Geese across southern Quebec.

Methods

1. *Literature Search*

The following journals were examined for observations of Greater Snow Geese for the period 1915–1973: *The Auk*, *The Wilson Bulletin*, *Audubon Field Notes*, *Annual Report of the Province of Quebec Society for the Protection of Birds*, and *Bulletin Ornithologique*.

2. *Visual Observations in 1971*

Questionnaires and a description of the project were distributed to reliable bird watchers throughout southern Quebec who were asked to watch for Snow Geese during the fall.

3. *Radar Observations in 1971*

A screen of the AASR-1 surveillance radar of Quebec City Airport was filmed from 21 October to 11 November using the time-lapse film technique described by Solman (1969). The radar operated at 23-cm wavelength and the range was set at 60 nautical mi (111 km). For further information on the radar see Canada Department of Transport (1967), and for bird detection by radar see Eastwood (1967). Effects of the use of radar "fixes" on the bird detection capabilities of the AASR-1 radar are discussed by Richardson (1972).

The radar films were projected on a sheet of white paper, and the tracks of "goose echoes" were traced by hand to determine their directions. "Goose echoes" were large, fast-moving bird echoes travelling at a steady speed, usually on a straight course and mostly in groups. We have no proof that these echoes represented flocks of migrating Greater Snow Geese, because the targets that produced the "goose echoes" were not identified either from the ground or from aircraft. There is, however, the following circumstantial evidence:

(1) all "goose echoes" came from the Cap Tourmente staging area, or the area slightly south of it (the geese have to climb to a certain minimum altitude in order to be detected by the radar);

(2) there was good agreement between dates when major departures were reported and dates when many "goose echoes" appeared on the radar screen;

(3) the size, range, and speed of the "goose echoes" indicated that large flocks of birds flying at relatively high speeds must have been responsible for the "goose echoes"; and

(4) we know of no other bird species in the area at that time that could have caused the "goose echoes."

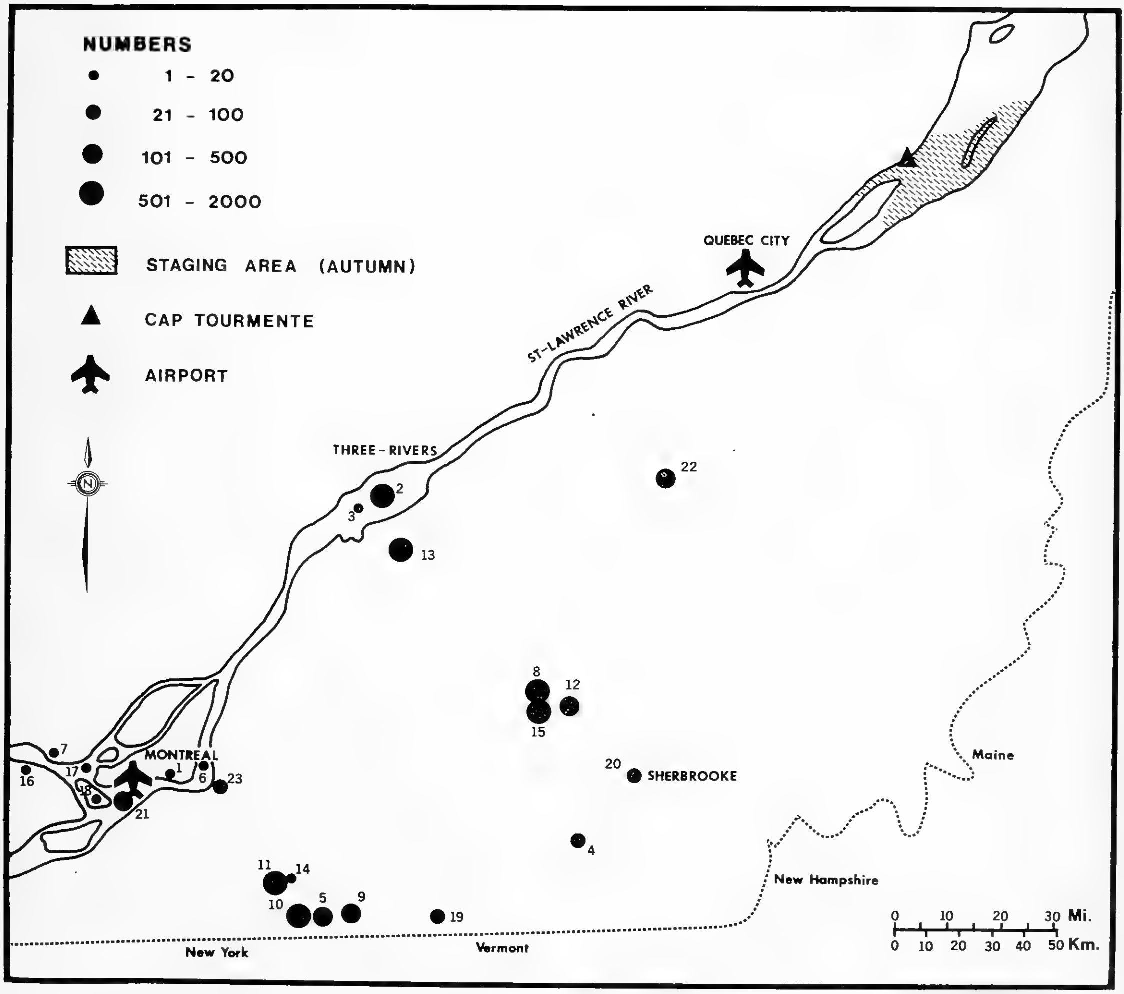


FIGURE 1. Locations of the visual observations of Greater Snow Geese, tabulated in Table 1.

Directions of tracks of "goose echoes" are given in degrees True North. Times are given in Eastern Standard Time.

Results and Discussions

1. *Migration routes*

Data from the literature are tabulated in Table 1 and plotted in Figure 1. Table 1 shows remarkably small numbers of sightings, mainly pertaining to small numbers of geese suggesting a high, non-stop flight over southern Quebec. Larger numbers of Greater Snow Geese outside of the staging area were reported at Lac St-Pierre, Baie Missisquoi, Rivière Richelieu, and Ulverton, but not in the vicinity of Montreal. Most records were from localities southwest and south-southwest of the St. Lawrence River staging area.

Records of sightings in 1971 as obtained from the questionnaires are tabulated in Table 2 and plotted in Figure 2. The data for 1971 confirm the geographical distribution as determined from the literature. The visual estimates judged that the directions of flight were generally south or southwest. Again, in general only small numbers of geese were reported. Observations of large numbers are all relatively close to the St. Lawrence River. For instance, on 8 November 12 000 geese were seen near St. Nérée and were estimated to be flying at 3000 ft (920 m). Because no birds were reported further south on that day in Quebec, we believe that the geese made an unobserved, non-stop flight into the USA.

The results of the radar observations are tabulated in Table 3 and illustrated in Figures 3a, b, c, and d. "Goose echoes" observed on 30 and 31 October first appeared on the radar screen between 25 and 40 nautical mi (46 and

TABLE 1—Visual observations of Greater Snow Geese in southern Quebec obtained from literature. Locations within 20 miles (33 km) of the St. Lawrence River staging area are omitted

Year	Date	Number (from Figure 1)	Locality	Estimated number of geese	Source
1947	25 Sept.	1	Lasalle	4	P.Q.S.P.B.[1] 1947
1950	21, 22 Oct.	2	Lac St-Pierre	2000	P.Q.S.P.B. 1950
1951	12,15 Oct.	3	Lac St-Pierre	a few	P.Q.S.P.B. 1951
1952	12 Oct.	4	Magog	75	P.Q.S.P.B.
1952	10 Nov.	5	Baie Missisquoi	115	A.F.N[2] 1953, Vol. 7(1)
1952	13 Dec.	6	Ile Ste-Hélène	8	P.Q.S.P.B. 1952
1953	12 Dec.	7	Hudson	400–500	P.Q.S.P.B. 1953
1958	15 Nov.	8	Ulverton	1000	P.Q.S.P.B. 1958
1958	15 Nov.	9	Phillipsburg	400	P.Q.S.P.B. 1958
1958	20 Nov.	10	Baie Missisquoi	600	A.F.N. 1959, Vol. 13(1); P.Q.S.P.B. 1958
1958	30 Nov.	11	St-Pierre	1200	B.O.[3] 1959, Vol. 4(1)
1959	7–20 Nov.	12	Ulverton	Large flocks	P.Q.S.P.B. 1959
1959	9 Nov.	13	Riv. St-François	1000	A.F.N. 1960, Vol. 14(1)
1959	12 Dec.	14	St-Pierre	20	B.O. 1960, Vol. 5(1)
1960	14–28 Nov.	15	Ulverton	800	P.Q.S.P.B. 1960
1961	3 Sept.	16	Rigaud	2	B.O. 1962, Vol. 7(1)
1962	21 Oct.	17	Lac des Deux-Montagnes	2	P.Q.S.P.B. 1962
1962	4 Nov.	18	Ile Perrot	12	P.Q.S.P.B. 1962
1962	2 Dec.	19	Abercorn	100	P.Q.S.P.B. 1962
1963	13 Nov.	20	Sherbrooke	100	B.O. 1964, Vol. 9(1)
1965	23 Oct.	21	Lac-St-Louis	125	P.Q.S.P.B. 1965
1970	26 Nov.	22	Plessisville	135	B.O. 1970, Vol. 15(5)
1972	5 Nov.	23	Ste-Catherine	75	B.O. 1972, Vol. 17(4)

[1] Province of Quebec Society for the Protection of Birds.
[2] Audubon Field Notes.
[3] Bulletin Ornithologique.

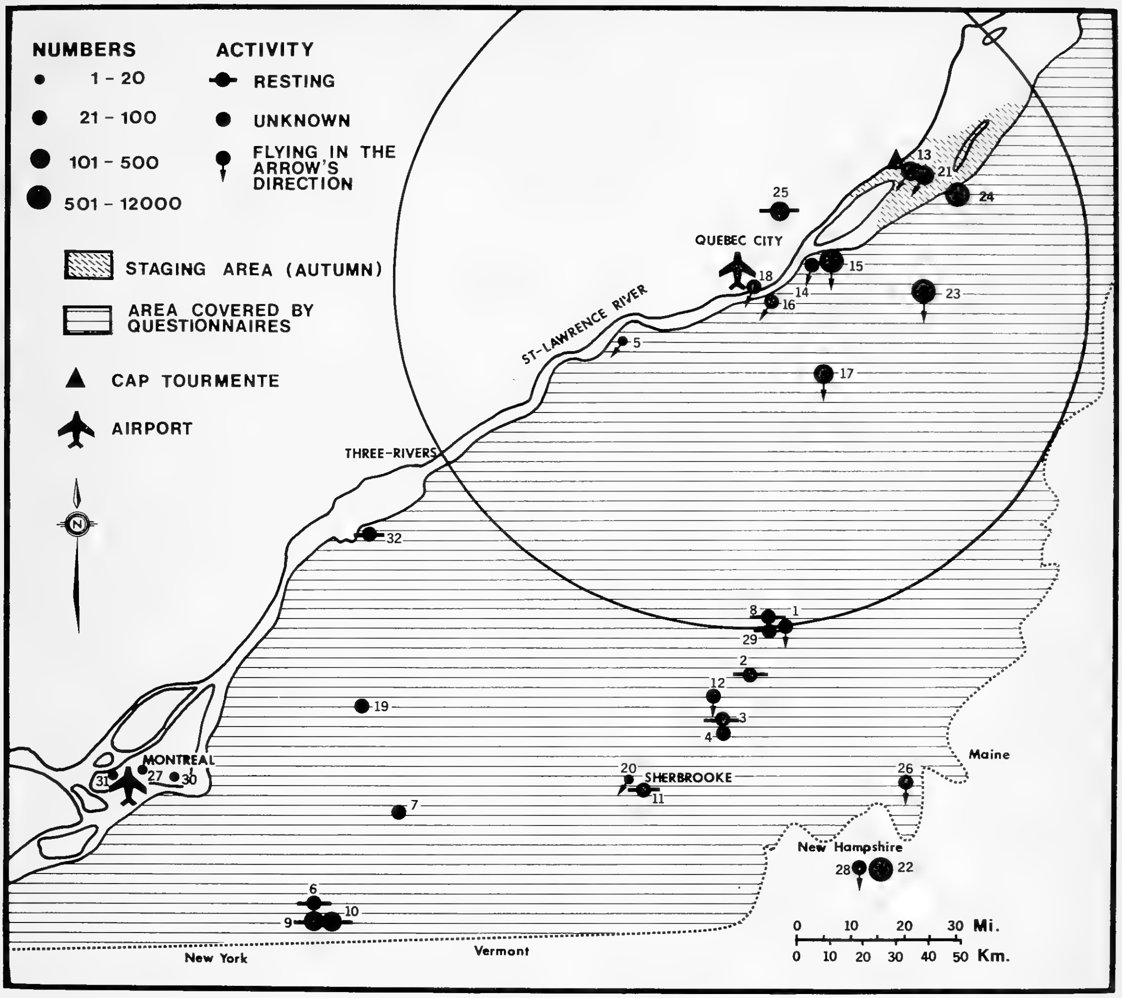


FIGURE 2. Locations of the 1971 visual observations of Greater Snow Geese tabulated in Table 2. Circle (radius 60 nautical mi, or 111 km) indicates area surveyed by AASR-1 radar at Quebec City Airport.

74 km) from the radar site at an azimuth of about 70°. Average direction of the echoes during the period varied between 210° and 222° (Table 3), except for the early morning of 31 October, when the average direction was 235°. The difference arose mainly because three of the eight measured tracks on the morning of 31 October were between 240° and 245°. Thus, in general, the goose flocks flew in directions between southwest and south-southwest on 30 and 31 October. On 30 October between 0600 and 1600 hours there were a few "goose echoes" that moved in southwesterly directions initially, but shifted towards a more south-southwesterly course at about 30 nautical mi (56 km) from the radar site (Figure 3a). Later that day the directions of all tracks were south-westerly (Figure 3b).

During the morning of 8 November, "goose echoes" were first seen at 95° between 20 and 30 nautical mi (37 to 56 km) from the radar site (Figure 3c). Those departing flocks must have been climbing more slowly than the ones on 30 and 31 October, when the "goose

TABLE 2—Visual observations of Greater Snow Geese in southern Quebec (obtained from questionnaires) in fall 1971

Date	Time	Number (from Figure 2)	Locality	Number of geese (estimated)	Activity: Migrating	Activity: Resting	Estimated direction of migration	Observer
5 Oct.	1700	1	Garthbay	50	X		S	A. Belisle
8 Oct.	0830	2	Weedon	20–50		X		A. Belisle
9 Oct.	0915	3	Bishopton	20–50		X		A. Belisle
14 Oct.	2030	4	Bishopton	20–50				A. Belisle
16 Oct.	0700	5	Lotbiniere	3	X		SW	L. Roy
17 Oct.	0800	6	Baie Missisquoi	30		X		G. H. Montgomery
17 Oct.	2100	7	Granby	34				M. Fleury
20 Oct.	0930	8	Garthbay	20–50		X		A. Belisle
23 Oct.	0800	9	Baie Missisquoi	200		X		G. H. Montgomery
24 Oct.	1100	10	Baie Missisquoi	200		X		G. H. Montgomery
25 Oct.	0730	11	Lennoxville	80–100		X		R. Dionne
27 Oct.	1430	12	St-Adolphe	20–50	X		S	A. Belisle
30 Oct.	1000–1030	13	Cap Tourmente	Numerous	X		SW	R. Naud
30 Oct.	1100	14	Lauzon	100	X		SSW	J. P. Savard
30 Oct.	1455–1500	15	Lauzon	900	X		S	J. P. Savard
30 Oct.	1645	16	St-Romuald	25	X		SW	J. P. Savard
31 Oct.	1045	17	St-Barnard	350	X		S	J. P. Savard
31 Oct.	1130	18	Ste-Foy	60	X		SW	F. Fisette
31 Oct.	1130	19	St-Hyacinthe	34				L. Fleury
6 Nov.	1630	20	Sherbrooke	7	X		SW	H. Lavoie
8 Nov.	0700–1200	21	Cap Tourmente	Numerous	X		SW	P. A. Boucher
8 Nov.	0730	22	Parmachenee Lake (Me)	525–700				A. Belisle
8 Nov.	1400–1700	23	St-Nerée	12 000	X		S	H. Arbour
9 Nov.	1945	24	Montmagny	2 000				J. Desrosiers
13 Nov.	0830	25	Notre Dame des Laurentides	300–400		X		H. Lavoie
15 Nov.	0745	26	Wodurn	20–50	X		S	A. Belisle
15 Nov.	0830	27	Montreal	5				C. B. Meyers
16 Nov.	0700	28	Parmachenee Lake (Me)	20–50	X		S	A. Belisle
17 Nov.	1500	29	Garthbay	20–50		X		A. Belisle
17 Nov.	1500	30	Montreal	16				B. L. Lapin
22 Nov.		31	Dollard-des-Ormeaux	7				C. B. Meyers
1 Dec.	1930	32	Riv. St.François	20–50		X		A. Belisle

echoes" were first seen almost directly above the staging area. Early on 8 November the average direction was 190° (Table 3). Later that day the heading shifted more to the south with an average of 176° (Figure 3d). Thus for most of that day geese were migrating in a more southerly direction than on 30 and 31 October, and with less variation between individual tracks (Table 3).

Both the visual and radar observations indicated that the geese did not migrate up the St. Lawrence River and, therefore, were unlikely to interfere with air traffic into or out of Quebec City and Montreal.

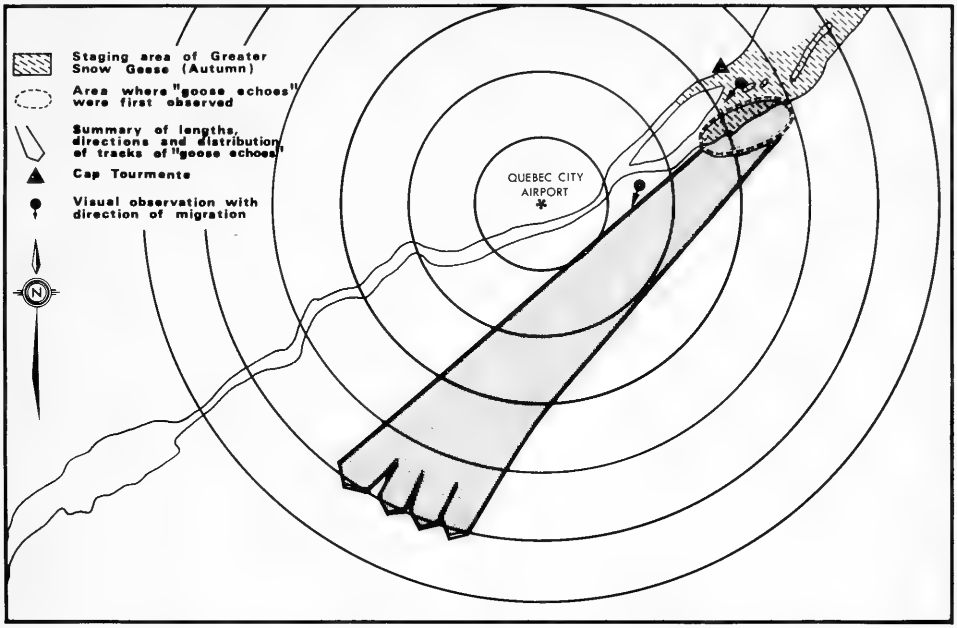


FIGURE 3a. Tracks of "goose echoes" across southern Quebec on 30 October 1971, 0600–1600 hours. Radar range rings are 10 nautical mi (18.5 km) apart.

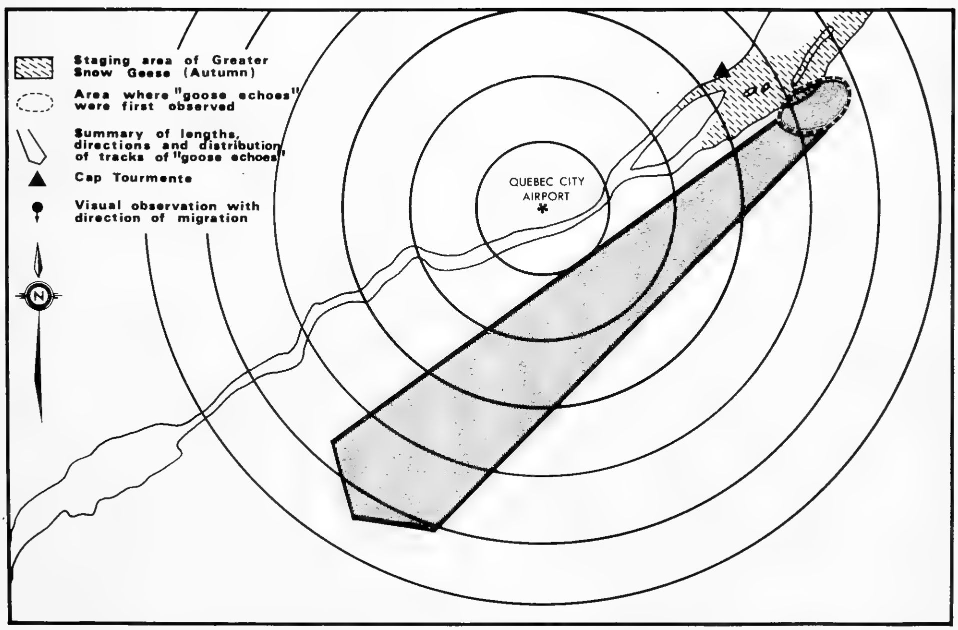


FIGURE 3b. Tracks of "goose echoes" across southern Quebec on 30 October 1971, 2000–2400 hours. Radar range rings are 10 nautical mi (18.5 km) apart.

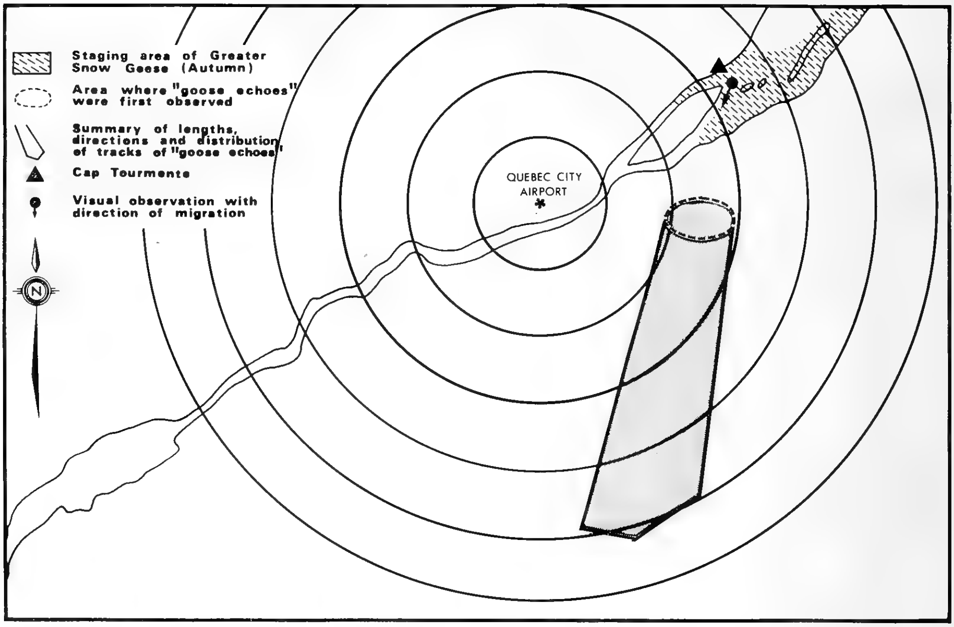


FIGURE 3c. Tracks of "goose echoes" across southern Quebec on 8 November 1971, 0600–1200 hours. Radar range rings are 10 nautical mi (18.5 km) apart.

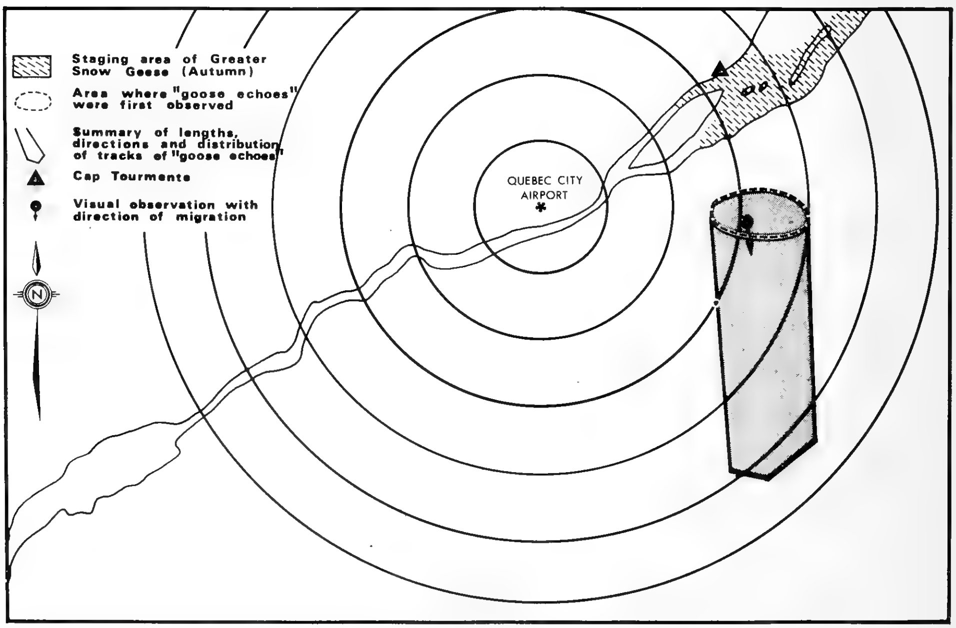


FIGURE 3d. Tracks of "goose echoes" across southern Quebec on 8 November 1971, 1200–2000 hours. Radar range rings are 10 nautical mi (18.5 km) apart.

2. *Chronology*

Almost all "goose echoes" were seen in two periods: 30 October, 0600 hours to 31 October, 0600 hours and 8 November, 0600 hours to 9 November, 0200 hours (Table 3). On 30 October two peaks of activity were observed: one between 0800 and 1600 hours and the other later that night between 2200 and 0200 hours. On 8 November, two peaks in the numbers of "goose echoes" were observed: one between 0800 and 1000 hours and the other from 1200 to 1800 hours.

Comparison of the data in Tables 2 and 3 shows that the two main departures observed on radar coincided with large departures from the staging area and with sightings of large numbers of migrating geese. In fact, the only visual observations of large numbers of geese were made during those two periods (30 and 31 October and 8 and 9 November).

The 2000 geese seen on 9 November at Montmagny possibly were making a local flight at low altitude and could thus not be detected by the radar. An aerial survey on 10 November showed that only a few thousand birds remained on the St. Lawrence River staging grounds (Bourget 1972).

The dates of the main departures in 1971 cannot usefully be compared with the dates of observations given in Table 1 because the latter often pertain to accidental sightings of small numbers of birds and were all made further than 20 mi (32 km) from the staging area. During the fall of 1972 and 1973, however, the Canadian Wildlife Service made regular aerial surveys of the staging grounds (Mongeon 1972; Dupuis 1974). From those counts it appears that in 1972 the major departure(s) occurred between 26 October and 31 October. In 1973 at least one major departure occurred between 24 October and

TABLE 3—Estimated numbers and directions of "goose echoes" travelling across southern Quebec, fall 1971

Date	Time period	Estimated number of echoes	Track direction (degrees): Sample size	Mean	SD	Range
24 Oct.	0800–1000	10	1*	208		
30 Oct.	0600–0800	5				
	0801–1000	30	16	222	6.3	205–230
	1001–1200	30				
	1201–1400	20	13	211	10.2	196–227
	1401–1600	20				
	1601–1800	5	6	210	6.4	203–218
	1801–2000	3				
	2001–2200	5	8	221	7.7	206–233
	2201–2400	25				
31 Oct.	0001–0200	30				
	0201–0400	2	8	235	6.6	227–245
	0401–0600	1				
8 Nov.	0600–0800	5				
	0801–1000	12	12	190	5.0	184–199
	1001–1200	3				
	1201–1400	10				
	1401–1600	10	13	176	2.3	173–182
	1601–1800	20				
	1801–2000	4				
	2001–2400	0				
9 Nov.	0001–0200	6	4	199	4.0	194–203

* The "goose echoes" travelled one after another, along the same track.

29 October, and the last major departure(s) took place between 5 November and 15 November. Thus, there was good general agreement between departure dates in 1971 and in the two following years.

3. *Weather Conditions during the Main Departures*

On 30 and 31 October the center of a high-pressure system moved from the southern tip of James Bay in an easterly direction across northern Quebec. The synoptic weather situation at 1300 hours on 30 October is shown in Figure 4a. At Quebec City on that day temperatures were above freezing, cloudiness varied, and there was no precipitation. The direction of the surface wind varied between northeast and east all day on 30 October and well into 31 October. On 30 October the wind at about 5000 ft (1520 m) above sea-level (as determined from the 850 mB maps) was from the west in the early morning. By midday it was about northwest and at 1900 hours it was due north (at about 25 knots or 46 km/h).

Average directions of the "goose echoes" on 30 and 31 October varied from about 210° to 220°, a course almost directly towards the wintering grounds near the Atlantic Ocean. We do not know at what height the birds were migrating but somewhere between surface and 5000 ft (1520 m) they would have encountered a tailwind and it is not unlikely that the climbing geese levelled off at that altitude in order to make use of those favorable wind conditions.

The first period of major departures ended in the early morning of 31 October. It is unknown at what time the wind at 5000 ft (1520 m) changed from north (on 30 October, 1900 hours) to south-southwest (on 31 October, 0700 hours) but it is probable that the shift coincided with the end of the first major departure (0200–0400 hours on 31 October).

On 8 November the Quebec City region was sandwiched between a large high, centered south of the Great Lakes and a trough of low pressure extending between Labrador and insular Newfoundland (Figure 4b). At Quebec

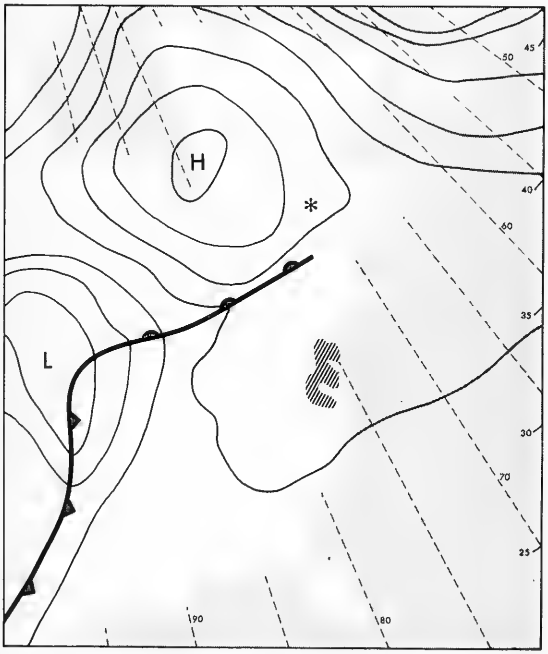


FIGURE 4a. Surface weather map for eastern North America on 30 October 1971 at 1300 hours. The asterisk indicates the St. Lawrence River staging grounds and the hatching, the wintering grounds.

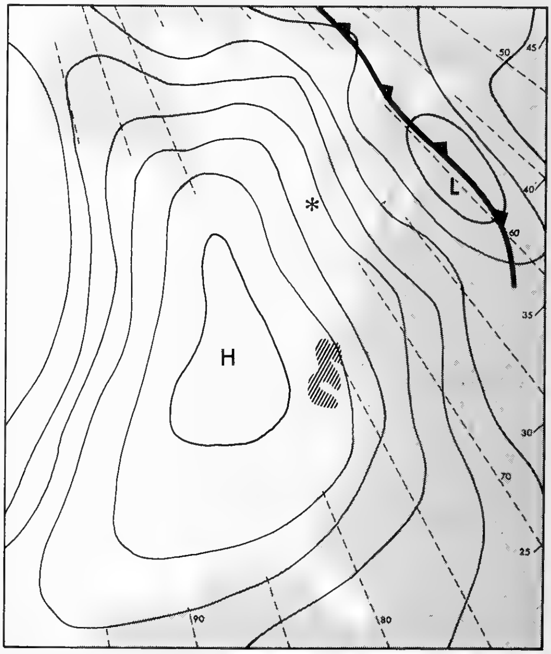


FIGURE 4b. Surface weather map for eastern North America on 8 November 1971 at 1300 hours. The asterisk indicates the St. Lawrence River staging grounds and the hatching, the wintering grounds.

City temperatures were below freezing all day and very light snow flurries were reported from 0900 to 1400 hours. The heavy cloud-cover gradually cleared late at night. All day the direction of the surface wind fluctuated between west and northwest. The wind at 5000 ft (1520 m) was northwest at 25 knots (46 km/h) at 0700 hours, north-northwest at 20 knots (37 km/h) at 1300 hours, and north at 20 knots (37 km/h) at 1900 hours.

Average directions of the "goose echoes" on 8 November varied between 190° and 176°. If the migrating geese maintained that course they would have arrived at the Atlantic Ocean north of their wintering areas. Assuming that the geese were heading for their wintering grounds, it is apparent that they did not compensate completely for wind drift.

Examination of the 850 mB maps for the period that the radar films were taken (21 October to 11 November) showed that northerly upper-air winds prevailed only during the two periods of major departures and during a short period on 23 October. The geese apparently selected weather conditions with the most favorable upper-air winds.

Acknowledgments

We thank the National Research Council Associate Committee on Bird Hazards to Aircraft for financial support and for making camera equipment available. We are grateful to the head and staff of Air Traffic Control at Quebec City Airport for making a radar screen available and for their assistance in the filming of that screen. The head of the Meteorological Office at Quebec City Airport was kind enough to make weather records available to us. We are indebted to M. Laperle, then Officer-in-Charge of the Cap Tourmente National Wildlife Area, for recording dates of migration departures. We are especially thankful to those who returned questionnaires. Their names and contributions are given in Table 2. A. Bourget, H. Boyd, J. E. Bryant, and R. McNeil read the draft and made useful comments and suggestions.

Literature Cited

Bellrose, F.C. 1967. Establishing certain parameters of hazards to aircraft by migrating birds in the Mississippi Flyway. Report for the Bureau of Sports Fisheries and Wildlife, U.S. Department of the Interior. 74 pp.

Bellrose, F. C. and **J. G. Sieh.** 1960. Massed waterfowl flights in the Mississippi Flyway, 1956 and 1957. Wilson Bulletin 72: 29–59.

Blokpoel, H. 1974. Migration of Lesser Snow and Blue Geese in spring across southern Manitoba. Part 1: Distribution, chronology, directions, numbers, heights and speeds. Canadian Wildlife Service Report Series 28. 29 pp.

Bourget, A. 1972. Inventaire de la sauvagine le long du St-Laurent, Québec, automne 1971. Rapport du Service canadien de la faune. 11 pp.

Canada Department of Transport. 1967. Air traffic control manual of equipment. Part 1. Radar. Civil Aviation Branch. 254 pp.

Déry, D. A. 1938. Migration automnale de la Grand Oie blanche. Rapport de la Société Provencher 1938: 120–131.

Dupuis, P. 1974. Recensements aériens de la sauvagine dans l'estuaire du St-Laurent, Québec, automne 1973. Rapport du Service canadien de la faune. 15 pp.

Eastwood, E. 1967. Radar ornithology. Methuen, London. 278 pp.

Heyland, J. D. 1973. Greater Snow Goose. Canadian Wildlife Service Hinterland Who's Who Series.

Hochbaum, H. A. 1967. Travels and traditions of waterfowl. Third printing. University of Minnesota Press, Minneapolis. 301 pp.

Lemieux, L. 1959. Histoire naturelle et aménagement de la Grande Oie blanche *Chen hyperborea atlantica*. Naturaliste Canadien 86: 133–192.

Mongeon, M. 1972. Inventaire de la sauvagine le long du St-Laurent, Québec, automne 1972. Rapport du Service canadien de la faune. 13 pp.

Morrison, A. 1952. The Greater Snow Goose. Bulletin of the Massachusetts Audubon Society 36: 285–291.

Richardson, W. J. 1972. Temporal variations in the ability of individual radars in detecting birds. National Research Council Associate Committee on Bird Hazards to Aircraft, Field Note 61. 57 pp.

Solman, V. E. F. 1969. Photography in bird control for air safety. Journal of the Biological Photographical Association 37: 150–155.

Received 13 January 1975
Accepted 25 March 1975

Oil Threat to Birds on the Canadian West Coast

KEES VERMEER[1] and REBECCA VERMEER[2]

[1] Canadian Wildlife Service, 5421 Robertson Road, Delta, British Columbia V4K 3N2
[2] 8968 Mainwaring Road, North Saanich, British Columbia

Vermeer, K. and R. Vermeer. 1975. Oil threat to birds on the Canadian west coast. Canadian Field-Naturalist 89(3): 278-298.

Abstract. The potential effects of oil spills on aquatic birds and their feeding habitat on the Canadian west coast are assessed and the related literature on oil pollution is reviewed. Present shipping and transport of oil and increased tanker traffic along the entire British Columbia coast in 1977 constitute a threat to the destruction of birds from oil spillage.

Concentrations of seabirds will be most vulnerable to spills. Three major colonies along the coast of British Columbia are the Langara Region, the southeast coast of the Queen Charlotte Islands, and the Scott Islands. Alcids and storm petrels are the most numerous seabirds along the British Columbia coast. Alcids are among the birds most vulnerable to oil pollution whereas storm petrels are less threatened by spills than alcids because they spend more time in the air and only dive occasionally. Waterfowl, especially diving ducks, will be vulnerable to spills during the winter as they concentrate in large numbers in estuaries and inlets along the British Columbia coast. The large wintering populations of ducks, geese, and grebes along the Fraser Delta foreshore and Boundary Bay will be endangered because of their nearness to tanker and shipping traffic. Approximately one million loons, shearwaters, phalaropes, ducks, gulls, and geese migrate north in the spring along west Vancouver Island. These migrants, because of their concentration in large numbers, may be very temporarily but critically vulnerable to oil pollution.

The birds most likely to be directly affected by spills are breeding populations of alcids and wintering diving ducks, whereas ducks, geese, and shorebirds, which feed in the intertidal zone, may be hardest hit indirectly through destruction of their feeding habitat. Of the ducks threatened by destruction of their feeding habitat, seaducks are most vulnerable of all ducks as they rely most on the marine habitat for feeding purposes.

Shipping and the transport of oil in British Columbia (B.C.) waters constitute a threat to aquatic bird populations. The completion of the Trans-Alaskan Pipeline in 1977 will result in increased tanker traffic along the entire B.C. coast and consequently this poses a great danger that birds will be destroyed from oil spillage. An evaluation is made in this paper to determine where, when, how many, and which birds may become victims of minor and major spills along the B.C. coast.

The aquatic birds utilizing the B.C. coast can be classed as breeders, visitors, and migrants. All aquatic birds breeding on land adjacent to, and feeding in, marine waters are included here as seabirds. The breeding seabirds along the Canadian west coast are two species of storm petrel, three of cormorant, one gull, and seven of auk. Visitors spend part of their lives along the B.C. coast but breed elsewhere. They may be visiting seabirds such as albatrosses or shearwaters or freshwater nesters such as loons, ducks, geese, and swans. Migrants such as Black Brant (*Branta nigricans*), Black-legged Kittiwakes (*Rissa tridactyla*), and Northern Phalaropes (*Lobipes lobatus*) travel through the region. Some species are classed as both visitors and migrants. For instance some Arctic Loons (*Gavia arctica*) remain in B.C. waters during the winter but most winter farther south. Hundreds of thousands of loons migrate north along the B.C. coast in May. All three groups of aquatic birds, with the exception of some non-stop travelling migrants, feed in coastal waters; they will be most vulnerable to oil pollution as they concentrate in small areas such as breeding colonies, and resting and feeding areas. Therefore it is important to determine where bird concentrations occur along the B.C. coast.

Methods

The literature on oil pollution of birds was abstracted in a bibliography by the authors (Vermeer and Vermeer 1974). In addition to the bibliography, literature on seabirds, information on transportation of oil in B.C. waters, and data collected under contracts with the Canadian Wildlife Service on the distribution of birds at sea, bird migration, and breeding colonies along the B.C. coast provided important and relevant information for discussing the subject matter below.

Discussion

Oil Transport

The principal sources of oil pollution of the seas are the intentional discharges of tanker ballasts and ship bilges and spills during oil transfer operations (Hawkes 1961). In recent years, since the *Torrey Canyon* disaster in 1967, there has been a growing incidence of massive oil pollution from tanker accidents (Wardley Smith 1973). The rapid rise in production and marine transport of oil has been associated with an increase in the influx of oil into the seas. Blumer (1971) estimated that in 1970, between 5 and 10 million tons of oil were discharged annually into the sea. Of this, about 3 million tons is from tanker-ballast discharges and another 500 000 tons from bilges of vessels other than tankers. In-port losses from collisions and during loading and unloading operations contribute an estimated 1 million tons. Other sources of oil pollution, whose magnitude are not assessed, are spills from tanker accidents and of other vessels outside harbors, losses during exploration and production, in storage and pipeline breaks, submarine seeps, and untreated domestic and industrial wastes.

British Columbia ranks third among the Canadian provinces in the total volume of commercial shipping (Statistics Canada 1972a, b, c, 1973). In 1971* total cargo of 68 258 346 short tons was handled at B.C. ports. Nearly 80% of this total was handled at ports in the Juan de Fuca Strait – Strait of Georgia region where shipping traffic is heaviest. Seventy-four and 81% of the total 40 604 vessel and 13 649 tug departures, respectively, in British Columbia originated from that region. In addition to shipping vessels and tugs, the B.C. marine waters are utilized by ferries, fishing and pleasure boats. There were about 7000 licensed fishing boats in 1972 (Fisheries Service, personal communication). Lea and Associates (*in* Paish and Associates 1972) estimated nearly 84 000 pleasure boats in the Strait of Georgia area alone in 1972.

* All figures subsequently cited are from 1971 except where noted otherwise.

The volume of crude and refined oil products handled at B.C. ports totalled 4 395 152 short tons. The ports within the Juan de Fuca Strait – Strait of Georgia region handled 84% of this volume (Statistics Canada 1972c, 1973). If we take into consideration the volume of oil in coastal shipping (i.e., between two B.C. ports) which is handled twice, the total volume of oil transported on B.C. coastal waters amounts to 2 644 521 short tons. Oil products are moved between B.C. ports by barges and tankers varying in size from a few hundred to 6000 tons (Paish and Associates 1972). There had been very little transport of crude oil (mainly it has been from Vancouver to California) until the Arab embargo in the fall of 1973. From 22 November 1973 to 18 February 1974, a total of 31 tankers, ranging in capacity from 20 000 to 50 000 tons, left Westridge Terminal carrying approximately 1 million tons of crude oil to eastern Canada (Trans-Mountain Pipeline, personal communication). In the adjacent American waters, the movement of oil is much heavier. In 1970 nearly 12.9 million tons of oil were transported on Puget Sound waters (Vagners and Mar 1972). Crude oil accounts for only 1.9 million tons whereas the various types of refined products made up the bulk of the volume being moved.

Forty-three oil spills in B.C. harbors and inshore waters have been documented by Environmental Protection Service (EPS) since 1972. Very little is known about the incidence of spills in international waters along the B.C. coast. The main source of oil pollution is shipping. Eighty-eight percent of the oil spills between March 1972 to December 1973 directly involved shipping vessels (Table 1). Although most spills occurred during oil transfer operations, the total outflow of oil from these accidents is far less than the oil spilled in groundings or collisions. The vessels most frequently involved in oil spills are freight boats and they account for the largest quantity of oil spilled (Table 2). There is a high frequency of spills from oil-transporting barges but the amount of oil spilled is only 4% of the total, as spills mainly occurred during the transfer of oil when they could be quickly controlled.

The proposed movement of North Slope Alaskan crude oil to the USA west coast will replace oil shipment by foreign tankers into the USA west coast ports (Alyeska Pipeline Service Co. 1971). When the Trans-Alaskan Pipeline becomes operational, it will have an initial capacity of 600 000 barrels per day (bpd) and will increase to an ultimate capacity of 2 000 000 bpd in a period of about 5 years. The North Alaskan crude will be carried by tankers, ranging prevalently from 70 000–120 000 tons in size, from Valdez southwards at about 60 miles off the B.C. coast to Puget Sound, San Francisco, and Los Angeles. Alyeska has estimated one sailing per day from Valdez to the USA west coast during the initial throughput of 600 000 bpd. Of these sailings, about six are destined for Puget Sound each month, delivering a volume of 162 000 bpd (Paish and Associates 1972). The movement of the Alaskan oil will increase the tanker traffic along the entire B.C. coast. At present most tankers delivering crude oil to the USA west coast arrive from the south. A tanker accident resulting in oil spillage along the north-south route from Valdez to Juan de Fuca might endanger the large breeding colonies of the seabirds in the Queen Charlotte Islands and along the west coast of Vancouver Island. In the analysis of 266 tanker casualties which resulted in some pollution (excludes burst hoses, leaky valves, tank overflows, and other tanker-related oil pollution sources), Keith and Porricelli (1973) found that 56% of the total oil outflow occurred in the high sea (i.e., more than 50 miles from any shoreline). Structural failures accounted for 90% of the pollution in the high sea and 49% of the total outflow in the 266 accidents. Groundings made up 29% of the total outflow while collisions and explosions accounted for 8% each.

TABLE 1—Known instances of oil spills involving ships and shoreline installations along the B.C. coast, March 1972 to December 1973

Type of accidents	Number of spills	Quantity of oil spilled, in gallons
Shipping vessels		
Oil transfer operations	20	16 000
Ship ran aground and/or sank	7	163 000
Oil leak on ship	3	6 500
Collision between ships	2	63 000
Ship caught fire	1	Small unspecified amount
Oil pumped into sea	1	200
Unspecified accidents with ships	4	1 500
Shore installations	5	4 800
Total	43	255 000

TABLE 2—Type of ships involved in oil spills along the B.C. coast, March 1972 to December 1973

Type of ships	Number of spills	Quantity of oil spilled, in gallons	Type of oil spilled
Large freight boats	18	238 000	94% bunker
Oil barges	11	10 500	99% diesel
Tankers	2	200	100% diesel
Tow tugs	3	Unspecified small amount	diesel
Navy vessels	1	1 400	100% bunker
Crab boat	1	Unspecified small amount	diesel
Ferry	1	150	100% diesel
Unspecified vessel	1	Unspecified small amount	diesel
Total	38	250 250	

At the present time, crude oil is transported to Puget Sound by tankers. Paish and Associates (1972) reported a delivery of 1.5 million tons of crude oil by tankers to Cherry Point for 1972. There is a large possibility of major oil spills due to poor navigational conditions, presence of reefs and islands, irregular currents and tidal streams, and complex traffic patterns along the tanker route to the ARCO refinery at Cherry Point (Figure 1). Cole et al. (1973), Murty and Khandekar (1973), and Paish and Associates (1972) predict that a spill near Cherry Point would likely spread to the Fraser Delta foreshore and Boundary Bay which are the largest staging areas of ducks, geese, and grebes, along the B.C. coast (Figure 2). One major oil spill at the wrong time of year in the vicinity of Cherry Point could conceivably wipe out that wintering population and destroy an important feeding ground.

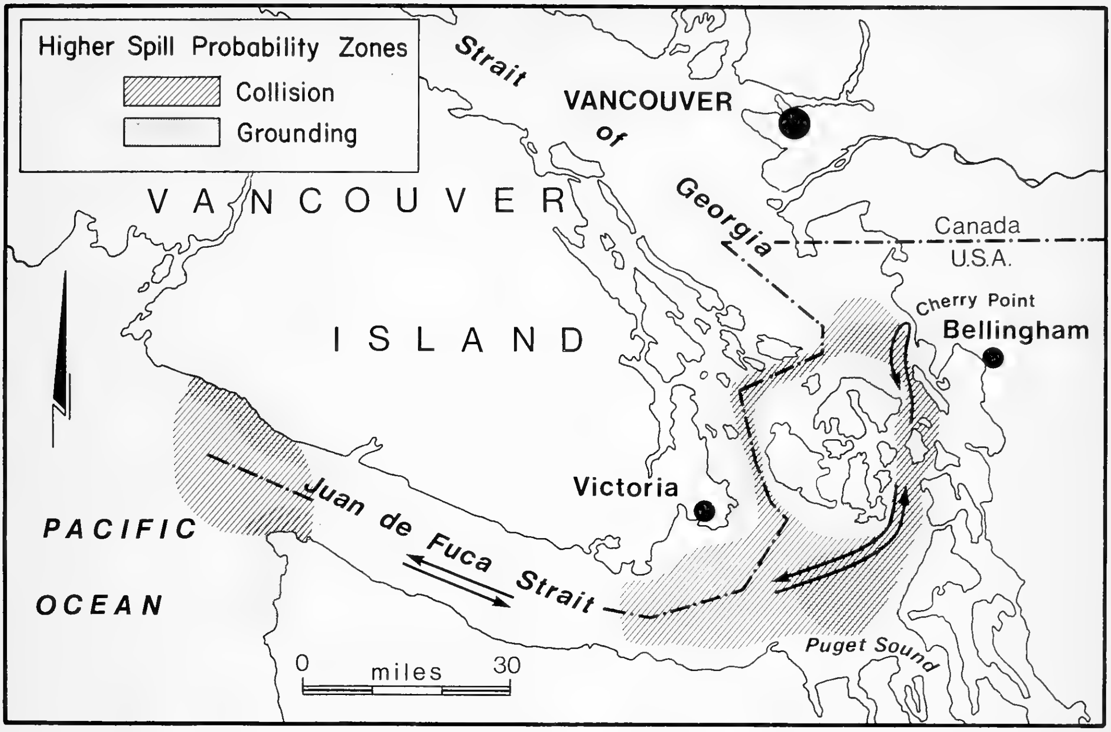


FIGURE 1. Oil spill probability zones (Paish and Associates 1972). Tanker route indicated by arrows.

Effects of Oil Pollution on Birds

Among the damages caused by oil to the marine fauna and flora, the oiling of birds is one of the most striking. Oil destroys the waterproof qualities of the plumage by disrupting feather arrangement and allows chilling by water or air, especially during the winter months. The oil may saturate not only the outer contour feathers but also penetrate the down feathers which insulate the bird. Soaked with oil and water, the bird loses its buoyancy and may drown or make its way to shore to die eventually. Continued exposure to cold and inability to feed render the bird incapable of maintaining its body temperature (Hartung 1967; McEwan and Koelink 1973). Complications such as pulmonary, kidney, liver, gallbladder, and gastrointestinal infections, and shock combined with the depletion of body fat eventually kill the bird (Beer 1968; Guillon 1967).

The toxic nature of oil also plays a role in the mortality of oiled birds. Hartung (1963) showed by means of isotope studies that oiled birds preen about 50% of the oil from their feathers in the first 8 days after oiling and ingest most of this in the process. Hartung and Hunt (1966) tested a number of unweathered industrial oils for their toxic effects on waterfowl and found all the oils to cause lipid pneumonia, gut irritation, fatty livers, and adrenocortical hyperplasia when fed to ducks. Diesel oil resulted in acinar atrophy of the pancreas. Fuel oil produced toxic nephrosis of the kidneys; cutting oil reduced cholinesterase levels in the plasma. The authors concluded that the toxicity of oils is a definite factor in the observed mortalities due to oil pollution. Postmortem work by Guillon (1967) on several species of seabirds and Beer (1968) on auks, all oiled with Kuwait crude in the *Torrey Canyon* disaster showed similar pathological conditions of the adrenal glands, respiratory tracts, liver, intestines, pancreas, and kidneys as those observed by Hartung and Hunt (1966).

Oil presents serious hazards to the reproduction of birds through contamination of eggs

FIGURE 2. Fraser Delta foreshore and Boundary Bay.

and ingestion of oil. Rittinghaus (1956) reported numerous Sandwich Terns (*Sterna sandvicensis*) and other terns and shorebirds becoming contaminated with oil which had been washed ashore. Eggs which were subsequently oiled by the plumage of the females did not hatch. This effect has been purposely used with great success in the population control of gulls and cormorants. By spraying eggs with oil, 90% of the eggs failed to hatch (Gross 1950). Experimental studies by Hartung (1965) showed that very small quantities of mineral oil coated on eggs reduced their hatchability to 21% compared to 89% for the unoiled eggs. Hartung demonstrated that ducks which became oiled during incubation coated their eggs with oil. The ingestion of 2 g/kg body weight of a relatively nontoxic lubricating oil temporarily inhibited the egg-laying activity of mallards and pekins.

The occurrence of oil pollution involving seabird mortalities has been reviewed by Battelle-Northwest (1967), Bourne (1968a), and Clark (1968). Oil pollution from tanker accidents and from oil discharges from other sources (mainly tanker ballasts and ship bilges) have caused the deaths of seabirds in the tens of thousands (Tables 3 and 4). Although the quantity of oil involved in a ballast or bilge discharge (Table 4) is relatively small compared to that spilled during a tanker accident, it has resulted in bird mortalities of similar magnitude. Such heavy mortalities have frequently occurred in the Baltic and Danish waters as a result of small discharges in or near staging and wintering grounds of birds (Grenquist 1956; Joensen 1972). The bird mortality in the North Sea and the North Atlantic from "routine" pollution (excluding tanker accidents) is estimated at 150 000–450 000 seabirds annually (Tanis and Mörzer Bruijns 1968). During the winter 1951–52 it was estimated that the number of oiled birds around the British Isles was over 50 000 (Barclay-Smith 1967). In a 4-month period, from November 1969 to March 1970, an estimated 14 000 birds perished around the British coast as a result of routine oil pollution (Anonymous 1970a).

Of all aquatic birds, auks, seaducks,* and penguins appear to be the chief victims of oil pollution (Tables 3 and 4). That those birds constitute the most frequent and largest casualties is related to their presence in heavily trafficked sealanes, their large numbers, time spent on the water, and their behavior towards oil slicks. Auks, eiders, scoters, and Oldsquaws (*Clangula hyemalis*) are birds of the northern hemisphere and Jackass Penguins (*Spheniscus demersus*) of the southern African shores where shipping and tanker traffic is heavy. Auks spend little time on land except for breeding, and congregate in offshore areas to feed. Like the auks, seaducks spend a considerable time in the water. Both auks and seaducks dive for their food so that when they break surface in an oil slick, they become covered with oil. Oldsquaws have been observed to land on oil patches where the deep-sea rolls are less heavy (Curry-Lindahl 1960). During an encounter with an oil slick, Common Murres (*Uria aalge*) escaped by diving, but risked oil contamination on surfacing (Bourne 1968b). The penguins, being flightless marine birds, stand little chance of avoiding oil slicks.

* Seaducks are defined here as those diving ducks which spend most of their time feeding in marine waters when they are away from their breeding grounds.

Although gulls, like auks and seaducks, are numerous in the North Atlantic and Pacific, they are much less vulnerable to oil pollution, because of their more aerial habits, than diving birds. Gulls can fly over surface pollution and usually have little cause to descend on it (Bourne 1968b). Moffitt and Orr (1938) reported that gulls escaped the major destruction of an oil spill off San Francisco because of their habits of feeding on the wing from the water and resting on the sea to a lesser extent than the affected diving birds. Smail et al. (1972) reported many more grebes and murres to be oiled during a spill in San Francisco Bay than gulls and cormorants even though the latter two groups were using the oil-polluted waters just as frequently.

Whereas other seabirds become thoroughly oiled, waders are merely stained. Smith and Bleakney (1968) reported that Purple Sandpipers (*Erolia maritima*) built up a thin coating of oil from wading in pools along an oil-polluted shore in Nova Scotia. No sandpiper was observed flightless and no dead ones were found. Sandpipers (*Calidris alba*) and Snowy Plovers (*Charadrius alexandrinus*) were stained with oil after a spill off San Francisco Bay, but no mortality was observed among those waders (Moffitt and Orr 1938).

Gulls and waders are vulnerable, however, to serious oil pollution under certain conditions. These birds were the chief casualties when an underwater valve of the tanker *Seestern* had been left open and 1700 tons of Nigerian crude oil escaped at night, polluting the land-locked basin of the Medway Estuary (Harrison and Buck 1967). The height of the tide was such that it reached the level of the upper tidal flats, contaminating about 8000 acres. Of 2778 casualties found, 77% were gulls and 19% were waders. The oil was carried into their roosting areas on the night tides and caught the gulls at rest on the tideway. The waders became contaminated by stranded oil when they were feeding at low tide. Short-legged waders such as the Dunlin (*Calidris alpina*) were relatively hardest hit.

The Western Grebe (*Aechmophorus occidentalis*) is a gregarious bird wintering in bays and inlets along the west coast of North America and it is therefore no surprise that

TABLE 3—Documented bird mortalities resulting from oil-tanker accidents

Year	Tanker and location	Type of accident	Estimated oil spilled	Estimated bird casualty	Predominant victim	Reference
1937	*Frank Buck*, San Francisco Bay, California, USA	collision	11 800 tons crude oil	10 000	Common Murre	Moffitt and Orr 1938; Aldrich 1938
1952	*Fort Mercer* and *Pendleton*, Monomoy Island, Massachusetts, USA	break-up	22 400 tons	> 3 500	Common Eider	Burnett and Snyder 1954
1955	*Gerda Maersk*, Elbe, Germany	grounding	8 000 tons crude oil	500 000	Black Scoter	Goethe 1968
1956	*Seagate* (freighter), Olympic Peninsula, Washington, USA	grounding	undetermined	> 3 000	White-winged Scoter, Common Murre	Richardson 1956
1961	Poole Harbour, England	collision	270 tons fuel oil	150 (counted)	Grebes, Red-breasted Merganser, Shelduck, Curlew	Ranwell and Hewett 1964
1966	Medway Estuary, England	valve open	1 700 tons light crude oil	5 000	Black-headed Gull, Great Black-headed Gull	Harrison and Buck 1967
1967	*Torrey Canyon*, Seven Stones Reef, Great Britain	grounding	100 000 tons crude oil	30 000	Common Murre, Razorbill	Bourne et al. 1967
1968	*Esso Essen*, Cape Peninsula, South Africa	ramming	4 000 tons crude oil	1 250 (counted)	Jackass Penguin, Cape Gannet	Westphal and Rowan 1970
1968	*Tank Duchess*, Tay Estuary, Scotland	leaky hull	87 tons crude oil	1 400 (counted)	Common Eider	Technical Advisory Committee for oil pollution on the Tay 1968
1969	*Hamilton Trader*, Liverpool Bay, England	collision	700 tons fuel oil	4 400 (counted)	Common Murre, Razorbill	Hope-Jones et al. 1970
1969	*Palva*, Utö, Finland	grounding	150 tons Russian crude oil	3 000	Common Eider	Soikkeli and Virtanen 1972
1970	*Delian Apollon*, Tampa Bay, Florida, USA	grounding	43 tons of oil	thousands	Loons, cormorants, mergansers, scaups	Smithsonian Institution Centre for Short-lived Phenomena, Card # 873 & 874
1970	*Arrow*, Chedabucto Bay, Nova Scotia, Canada	grounding	10 000 tons Bunker C	7 000	Murres, Dovekie, Old Squaw, Fulmar	Brown et al. 1973
1970	*Irving Whale* (barge), Newfoundland, Canada	plug leak	13–30 tons Bunker C	5 000	Murres, Black Guillemot	Brown et al. 1973
1971	San Francisco Bay, California, USA	collision	3 600 tons Bunker C	20 000	Western Grebe, Surf Scoter, White-winged Scoter, Common Murre	Smail et al. 1972
1972	*Dewdale*, Cromarty Firth, Scotland	valve leak	30 tons fuel oil	1 000 (oiled but alive)	Pink-footed Goose	Smithsonian Institution Centre for Short-lived Phenomena, Card # 1372

TABLE 4—Bird mortalities resulting from oil discharges other than tanker accidents

Year	Location	Estimated casualty	Predominant victim	Source
Feb. 1945	Apsheron Peninsula, Caspian Sea	30 000–35 000	Tufted Duck, Coot	Vereshchagin 1946
1952	off Gotland, Baltic Sea	35 000	Oldsquaw Duck	Lemmetyinen 1966
1954	off Gotland, Baltic Sea	10 000	Oldsquaw Duck	Lemmetyinen 1966
1955	off Aland, Baltic Sea	10 000	Oldsquaw Duck	Lemmetyinen 1966
1957	off Gotland, Baltic Sea	40 000	Oldsquaw Duck	Lemmetyinen 1966
1960	Danish Archipelago	20 000	Black Scoter	Lemmetyinen 1966
1962	off Gotland, Baltic Sea	tens of thousands	Oldsquaw Duck	Lemmetyinen 1966
Feb.–Mar. 1969	N. Sealand, Denmark	>10 000	Common Eider, Black Scoter, White-winged Scoter	Joensen 1972
Dec. 1969	Laeso-Vendsyssel, Denmark	>5 000	Common Eider, Black Scoter, White-winged Scoter	Joensen 1972
Feb.–Mar. 1970	east coast of Jutland, Denmark	>12 000	Common Eider, Black Scoter, White-winged Scoter	Joensen 1972
Dec. 1970–Jan. 1971	S. Kattegat, Denmark	>15 000	Common Eider, Black Scoter, White-winged Scoter	Joensen 1972
Mar. 1971	Djursland-Anholt, Denmark	1 500	Common Eider, Black Scoter, White-winged Scoter	Joensen 1972
1958–1962	Dutch and Belgian coast	1.9 birds/month/km of coast	Black Scoter, Common Murre	Tanis and Mörzer Bruyns 1968
1962–1968	Dutch and Belgian coast	3.8 birds/month/km of coast	Black Scoter, Common Murre	Tanis and Mörzer Bruyns 1968
1969	off Terschelling, North Sea	35 000–41 000	Common Eider, Black Scoter	Swennen and Spaans 1970
Nov. 1969–Mar. 1970	around Great Britain	14 000	Common Murre	Anonymous 1970a
1971	Shetland Islands, Great Britain	10 000	Common Murre	Wright 1971; Smithsonian Institution Centre for Short-lived Phenomena, Card #1234–1235
1959	off southern Newfoundland, Canada	12 000 (counted)	Common Eider	Horwood 1959
1956	Patrick's Cove, Avalon Peninsula, Newfoundland, Canada	464 birds/linear mile of coast	Common Murre	Tuck 1960
1970	Kodiak Islands, Alaska, USA	10 000	—	Anonymous 1970b

they constituted the largest casualty as a result of a tanker collision in San Francisco Bay at which 840 000 gal of bunker C fuel oil were spilled (Smail et al. 1972). Of 3690 bird casualties, 56% were Western Grebes, 20% were scoters, and 15% were murres.

Geese appear to be especially vulnerable to oil pollution during migration. Approximately 1000 Pink-footed Geese (*Anser brachyrynchos*) arriving during migration from Iceland at Invergordon, Scotland, became contaminated with oil after 30 tons of fuel were spilled there from a leaky valve during unloading (Smithsonian Institute 1972). None of the geese, however, which were roosting in a shallow bay at the time of the spill were found dead. In the autumn of 1963, the world's population of Greater Snow Geese (*Chen caerulescens atlantica*) was threatened with pollution as oil dumped into the St. Lawrence had drifted onto the marshes where the birds reside for two months. Disaster was averted by removing and burning the oiled vegetation in the marshes before the geese arrived (Eagles 1964). Ouweneel (1971) reported that 2000–2500 geese became contaminated with oil on their staging areas, the Biesbos and Hollands Diep, in the Netherlands after a spill of over 9000 tons of fuel oil. Species soiled with oil were Greylag Geese (*Anser anser*), White-fronted Geese (*Anser albifrons*), Barnacle Geese (*Branta leucopsis*), and Bean Geese (*Anser fabalis*). Only 23 geese were found dead but the total number killed is unknown owing to the departure of the birds from the area.

The assessment of the immediate impact of oil pollution has been based mainly on the counts of the numbers of oiled birds found on the shore. Beach counts do not give the true mortality as a result of inaccessibility of some areas and inadequate surveys which are often started after the initial drift of corpses and are terminated before the end of the drift because of lack of regular observers. Furthermore, oiled birds resort to nearby fresh water (Ticehurst 1938), and these are not accounted for in the final assessment. The main factor that makes short counts inadequate is the larger number of birds which perish at sea whose corpses do not reach shore during beach surveys. Tanis and Mörzer Bruijns (1968) estimated that 8 to 11 times more birds die at sea than could be counted on the shore. After a heavy paralytic shellfish-poisoning of shags and other seabirds in northeast England, Coulson et al. (1968) calculated from the number of corpses recovered and from shag populations before and after the disaster, that the corpses found on the coast accounted for only one-quarter of the shags that perished. An experiment involving the dropping at sea of ringed auk corpses showed that only one-fifth were recovered over a 4-month period (Hope-Jones et al. 1970). Thus estimates of the actual mortality are no more than guesses.

In most oil-pollution disasters involving birds, it was impossible to determine how populations as a whole were affected as the population sizes of seabirds prior to a disaster were often unknown. In some cases where such information had been obtained, the resulting reductions in populations were dramatic. As a consequence of the recurring heavy mortality from oil pollution in the Baltic, the number of Oldsquaws migrating through Finland had been reduced by 1960 to 1/10 the number recorded in the late 1930s (Bergman 1961). The number of puffins on Ile Rouzic in the Sept-Iles, Brittany, dropped from 5000 birds to about 600 as a result of the *Torrey Canyon* disaster (Milon and Bougerol 1967). The local population of Common Murres at the Ormes was depleted by 75% in an oil-pollution incident that followed a collision involving the tanker *Hamilton Trader* in the Irish Sea (Hope-Jones et al. 1970). The breeding populations of Common Eiders (*Somateria mollissima*) in the oil-polluted Kökar and Föglo archipelago decreased by 25–33% and 20.6%, respectively, after the grounding of the tanker *Palva* (Soikkeli and Virtanen 1972). A tanker accident in 1968 in South African waters resulted in oil pollution which wiped out the entire population of Jackass Penguins of Dyer Island, estimated at 8000 birds in 1963 (Westphal and Rowan 1970). Along with the estimated 14 000–19 000 penguins killed in the *Esso Essen* disaster, both incidents may have destroyed 1/10 of all the Jackass Penguins breeding on Cape Islands. Of all the seabirds severely stricken by oil pollution, the Jackass Penguin is in the most precarious position. This species occurs only on southern African shores and is in the path of oil transporting vessels from the Persian Gulf. Already exploited for its eggs and in competition with man for its food, the Jackass Penguin faces the additional hazards from discharges of tanker ballasts and major oil spills from tanker accidents (Westphall and Rowan 1970).

Because of their low replacement rate, auk populations which suffered severe depletion in numbers from oil pollution may require decades to recover their original numbers. Thick-billed Murres (*Uria lomvia*) produced 0.4 young per breeding pair at Cape Hay, Newfoundland in 1957 (Tuck 1960) and at Whinneyfold, Aberdeenshire, in 1951 and 1952 (Southern et al. 1965). Nettleship (1972) found a fledging success of approximately 0.6 per breeding pair of Common Puffins (*Fratercula arctica*) at Newfoundland in 1969. Taking into account the reproductive success and an assumed annual mortality, excluding losses from oiling, Leslie (1966) has calculated that it would take a population of murres 53 years to double its numbers by natural growth.

Distribution of Birds at Sea

Aquatic birds will be vulnerable to oil spills where they are congregated along the B.C. coast. Robertson (1974) conducted aerial surveys on birds within the first 50 miles of the outer coast-line of British Columbia from June 1972 to March 1973. He observed that birds were congregated west of Dixon Entrance, along the west coast of Vancouver Island, and at the entrance of Juan de Fuca Strait (Figure 3). At Dixon Entrance, Common Murres dominated in the winter and small auklets in the fall. Small auklets were also congregated 30 to 40 miles further westward from there. Along the west coast of Vancouver Island, most birds were found within 10 miles from the shore; shearwaters dominated in the summer and gulls in the fall. At Juan de Fuca Strait, the highest bird densities occurred 20 to 30 miles out at sea and consisted mostly of California Gulls (*Larus californicus*) in the fall and gulls and shearwaters in the winter. The high bird-densities observed 20 to 40 miles out to sea from Dixon Entrance and Juan de Fuca Strait perhaps relate to the convergence of different surface waters or effects of upwelling where the continental shelf drops, or both. The phenomena of convergence and upwelling provide a nutrient-rich surface water, an abundant phytoplankton and zooplankton, and fishes to which seabirds are attracted (Murphy 1936; Bourne 1963; Bailey 1966; Hempel 1971).

Robertson (1974) also conducted aerial surveys directly along the exposed shoreline and protected inlets of the west coast of Vancouver Island during August and October of 1972. In August many more birds were found along the exposed shoreline than in protected inlets (Table 5). Most numerous along the exposed shoreline in summer were California and Glaucous-winged Gulls (*Larus glaucescens*), which roosted in large flocks on sandy beaches and offshore rocks. Most cormorants were also resting on offshore rocks, while murres were most common in shallow waters and near rocky islands. More than half the observed birds were migrants such as Arctic Loons, shearwaters, California Gulls, Bonaparte Gulls (*Larus philadelphia*), and Heermann's Gulls (*Larus heermanni*). A shift from the exposed to protected waters occurred in the autumn, which appears to be mainly a result of the lower density of the large gulls along the exposed shoreline at the time and the arrival of migrant waterfowl in inlets (Table 5).

One species that may have been missed during the aerial surveys is the Marbled Murrelet (*Brachyramphus marmoratus*) because of difficulty of observing them from the air. Marbled Murrelets were the most numerous birds observed in surveys conducted by boat in protected waters of Vancouver and Queen Charlotte Islands during the summer (Table 6). Most Marbled Murrelets disappeared from those protected inlets during the autumn.

During autumn and winter, waterfowl concentrate in certain coastal inlets and marine deltas where they are protected from wind and wave action or where food is abundant to them, or both. One of the largest wintering areas along the B.C. coast is at Boundary Bay and the Fraser Delta foreshore. Boundary Bay consists of extensive tidal mud flats and the Fraser Delta foreshore of the estuarine marshes of Roberts and Sturgeon Banks (Figure 2).

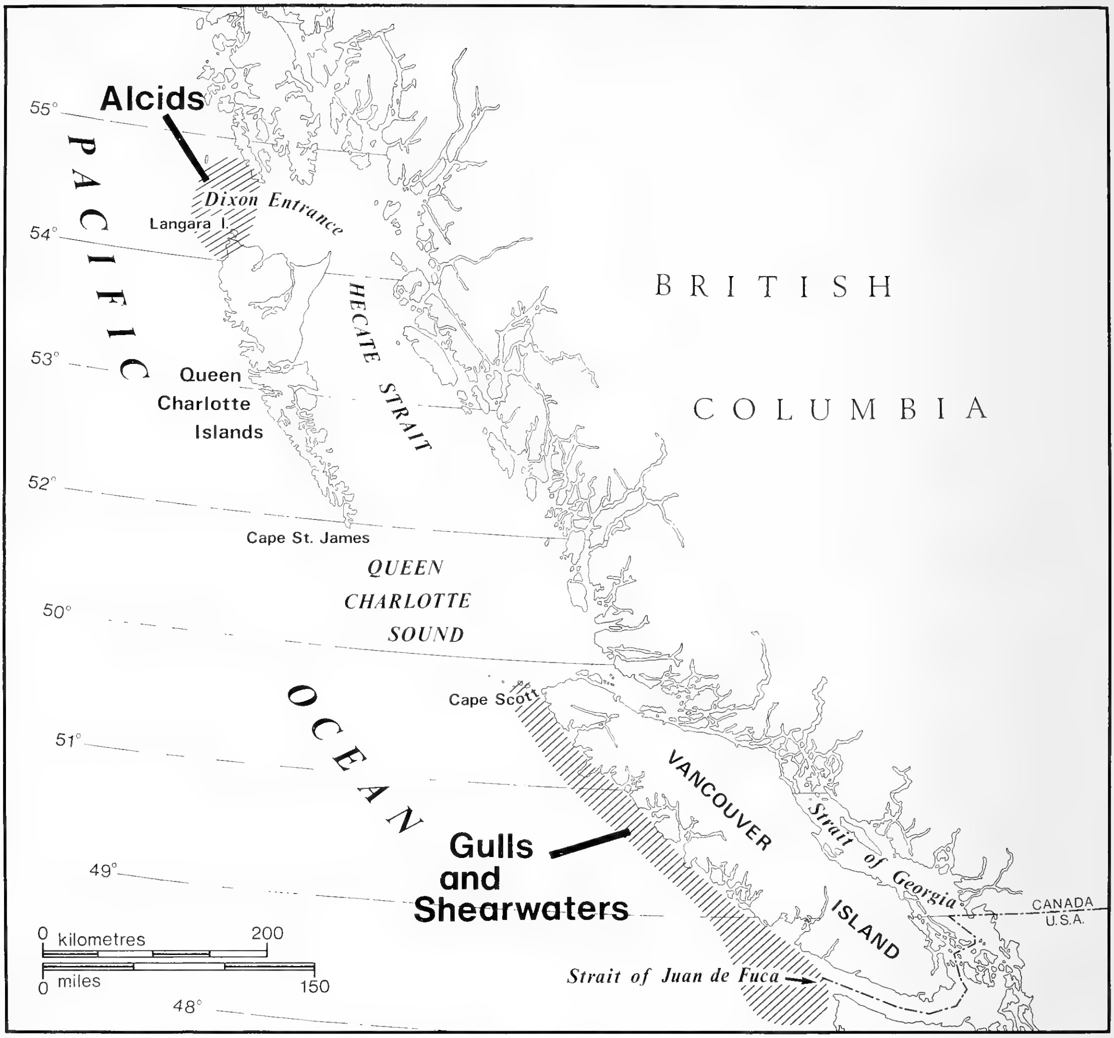


FIGURE 3. Concentrations of alcids, gulls, and shearwaters within the first 50 miles of the outer coastline of British Columbia, June 1972–March 1973.

Tens of thousands of ducks, geese, and Western Grebes rest and feed there (Table 7). These mud flats and estuarine marshes also serve as a roosting place for Glaucous-winged Gulls from October to March. Counts at roosts there ranged from 36 000 Glaucous-winged Gulls in 1969 to 46 000 in 1970. One of the most abundant shorebirds foraging on the intertidal area is the Dunlin. Christmas counts revealed that 26 000 (1969) to 41 000 (1970) Dunlins wintered there (Campbell et al. 1972). Other B.C. wintering areas contain far fewer birds than Boundary Bay and the Fraser Delta foreshore (Tables 7 and 8), but the total number of birds at all the other areas combined may be equal or greater than those at the Fraser Delta.

Migrants in large numbers may be very temporarily but critically vulnerable to oil pollution. Arctic Loons, Sooty Shearwaters (*Puffinus griseus*), and Northern Phalaropes are the main spring migrants along west Vancouver Island in May and June. K. Summers (personal communication) estimated that

TABLE 5—Comparison of numbers and density of birds observed during aerial surveys along the shoreline and inlets of the west coast of Vancouver Island, August and October 1972 (Robertson 1974)

	Number of birds observed			
	August		October	
Birds	Exposed shoreline	Protected inlet	Exposed shoreline	Protected inlet
Loons	449	22	10	35
Grebes	—	—	140	145
Cormorants	1 895	38	418	54
Shearwaters	99	3	—	—
Canada Goose	—	—	30	230
Mallards	—	—	—	148
American Wigeon	—	—	—	200
Scaup	—	—	—	400
Harlequin Duck	40	—	10	—
Scoters	237	149	68	2
Mergansers	—	77	26	—
Unidentified ducks	—	—	126	597
California and Glaucous-winged Gulls	27 015	1 845	1 830	1 610
Mew Gull	—	143	—	183
Bonaparte's Gull	—	279	5	807
Heermann's Gull	51	—	—	—
Common Murre	876	20	59	105
Alcids	22	15	—	—
Unidentified birds	68	30	380	73
Total	30 752	2 621	3 102	4 589
Nautical miles surveyed	258.1	416.5	109.6	99.0
Number of birds per nautical mile (linear density)	119.1	6.3	28.3	46.4

660 000 aquatic birds, of which the above three species constituted 85%, migrated northwest along Vancouver Island in May and June 1973. Of the 148 000 birds counted, there were 47 000 Arctic Loons, 34 000 shearwaters (all or mostly Sooty Shearwaters), 44 000 Northern Phalaropes, and the remainder was mostly made up of Black Brant, White-winged Scoters (*Melanitta deglandi*), Surf Scoters (*Melanitta perspicillata*), Bonaparte Gulls, and Black-legged Kittiwakes. Arctic Loons along the B.C. coast and those wintering farther south, initiate their migration northward about the middle of April, with their peak migration occurring in May (Martin and Myres 1969; K. Summers, personal communication). Sooty Shearwaters migrate northward in large numbers both in May and June, while Northern Phalaropes migrate north, most numerously of all species, in May. The peak spring migration of Black Brant (Einarsen 1965; Martin and Myres 1969), Surf and White-winged Scoters along the B.C. coast is in March and April, but was missed during the 1973 spring migration survey conducted by Summers. But 4000 Black Brant and 6300 scoters still were counted during their northward migration in May 1973. Thousands of Black Brant and scoters feed on herring spawn in inlets on the west coast of Vancouver Island (Captain Anderson via K. Summers, personal communication). It can be concluded that approximately 1 000 000 migrants may be temporarily vulnerable to oil pollution on the Canadian west coast in the spring, of which Arctic Loons, Sooty Shearwaters, Northern Phalaropes, Black Brant, Surf and White-winged Scoters, Bonaparte Gulls, and Black-legged Kittiwakes are the most numerous.

Very little survey work has been done on the southward migration of aquatic birds along the B.C. coast. From a review of the fall migration of geese (Taylor 1973), it appears that most geese other than Snow Geese (*Chen caerulescens*) bypass the B.C. coast, and their migration at that time is very rapid compared

TABLE 6—Comparison of numbers and density of birds observed from a boat in protected waters of southern Vancouver Island and the west coast of the Queen Charlotte Islands during the summer of 1972 (Robertson 1974)

	Vancouver Island		Queen Charlotte Islands	
Species	Number of birds observed	Number of birds per naut. mi²	Number of birds observed	Number of birds per naut. mi²
Sooty Shearwater	4	0.36	—	—
Brandt's Cormorant	5	0.45	—	—
Pelagic Cormorant	6	0.54	6	1.51
Glaucous-winged Gull	34	3.04	4	1.01
California Gull	89	7.97	—	—
Mew Gull	2	0.18	—	—
Bonaparte's Gull	2	0.18	—	—
Heerman's Gull	14	1.25	—	—
Common Murre	24	2.15	—	—
Marbled Murrelet	429	38.41	90	22.67
Rhinoceros Auklet	—	—	4	1.01
Ancient Murrelet	2	0.18	1	0.25
Pigeon Guillemot	—	—	2	0.50
Tufted Puffin	3	0.27	—	—
Unidentified small alcids	—	—	1	0.25
Unidentified birds	—	—	1	0.25
Total	614	54.98	109	27.45

TABLE 7—Aquatic birds staging at Sturgeon Bank, Robert's Bank, and Boundary Bay (calculated from Campbell et al. 1972 and Canadian Wildlife Service Reports 1966–1970)

Species	Average monthly total from October to December	Months present
Western Grebe	12 000–15 000	Sept.–May
Common Murre	variable–900 (1969)	Sept.–Apr.
Snow Goose	7000–10 000	Oct.–Apr.
Mallard	8300	All year
Pintail	19 800	Sept.–March
Green-winged Teal	12 800	Aug.–March
American Wigeon	16 000	Sept.–May
Greater Scaup	3000–4000	Oct.–May
Common Goldeneye	12 000–15 000	Oct.–Apr.
Barrow's Goldeneye	up to 3000	Oct.–Apr.
Surf Scoter	4000–5000	Sept.–Apr.
Unidentified ducks	11 900	—

to that in the spring. For instance, most Pacific Black Brant gather in Izembeck Lagoon, Alaska during September and October. The entire Pacific Black Brant population from there apparently crosses the open waters of the North Pacific Ocean for the California coast and Baja, California in one flight (R. Jones, *in* Taylor 1973). Few Pacific brant appear to spend the winter months along the B.C. coast.

Breeding Colonies

Populations of seabirds will be vulnerable to oil spills where the birds are concentrated on nesting islands and surrounding waters during the breeding season, which lasts from May to August. Fourteen species of seabirds nest off the coast of British Columbia, 13 (Table 9) breeding mostly in colonies while the Marbled Murrelet appears to be a tree nester (Harris 1971). Estimates of breeding seabirds are approximate as actual counts were made in only about half of the known colonies. Enumerations of seabirds of the other colonies were based on estimates made by biologists who visited nesting islands and on averages obtained from colonies of known

TABLE 8—Aquatic birds observed during census cruises in four coastal inlets on the west coast of Vancouver Island and the Queen Charlotte Islands in the winter of 1972–73 (Robertson 1974)

	Number of birds			
	Vancouver Island		Queen Charlotte Islands	
Species	Clayoquot Sound, December 11–13, 1972	Quatsimo Sound, February 14–16, 1973	Tasu Sound, January 29–31, 1973	Cartwright and Englefield Sound, February 6–10, 1973
Common Loon	83	4	5	9
Yellow-billed Loon	—	—	—	3
Arctic Loon	167	3	2	9
Red-throated Loon	1	1	2	10
Western Grebe	786	819	—	—
Red-necked Grebe	608	63	39	37
Horned Grebe	480	36	14	45
Pied-billed Grebe	4	1	—	—
Brandt's Cormorant	380	—	—	—
Pelagic Cormorant	468	45	63	93
Double-crested Cormorant	27	—	8	2
Trumpeter Swan	2	—	—	—
Swan sp.	38	54	—	—
Canada Goose	370	205	—	—
Mallard	1 448	1 278	22	84
Gadwall	—	20	—	—
Pintail	355	40	—	—
Green-winged Teal	—	30	—	—
American Wigeon	495	840	—	30
Scaup sp.	501	281	5	85
Common Goldeneye	184	142	—	34
Barrow's Goldeneye	894	9	158	67
Goldeneye sp.	—	64	—	—
Bufflehead	2 483	918	10	51
Oldsquaw	95	—	—	—
Harlequin Duck	3	—	2	21
White-winged Scoter	293	—	2	10
Surf Scoter	2 160	30	99	87
Common Scoter	—	—	7	36
Hooded Merganser	38	1	—	—
Common Merganser	23	52	29	29
Red-breasted Merganser	99	—	5	8
Glaucous-winged Gull	1 093	648	148	106
Mew Gull	804	962	12	1
Common Murre	28	—	—	19
Pigeon Guillemot	10	—	2	—
Marbled Murrelet	336	42	7	16
Ancient Murrelet	2	—	—	—
Unidentified	35	25	5	—
Coot	—	1	—	—
Total	14 793	6 614	646	892
Area (naut. mi^2) surveyed	83.6	37.6	15.7	12.8
Density of birds/naut. mi^2	176.9	175.9	41.1	69.6

size. Many other colonies are probably still undiscovered.

There appear to be three known major and five known minor concentrations of seabird colonies (Figure 4). The three major concentrations from north to south are at the following areas: (1) Langara Island region; (2) southeast coast of Queen Charlotte Islands; (3) Scott Islands.

The Ancient Murrelet (*Synthliboramphus antiquus*) is by far the most numerous species (Table 10) in the Langara Island region (extreme northwest coast of Queen Charlotte Islands). Fork-tailed Petrels (*Oceanodroma furcata*), Ancient Murrelets, and Cassin's Auklets (*Ptychoramphus aleuticus*) are the most numerous breeding seabirds on the east and south coast of Moresby Island, which is the more southern of the two main islands of the Queen Charlotte Islands. A large colony with 5000 pairs of Rhinoceros Auklets (*Cerorhinca monocerata*) is located on Anthony Island at the very southwest end of the Queen Charlotte Islands. Cassin's Auklets, Rhinoceros Auklets, and Tufted Puffins (*Lunda cirrhata*) are the dominant nesting seabirds on the Scott Islands (extreme northwest coast of Vancouver Island).

TABLE 9—Numbers and approximate breeding population estimates of known seabird colonies on the B.C. coast

Species	Number of colonies	Number of breeding pairs
Fork-tailed Petrel	20	60 000
Leach's Petrel	17	25 000
Double-crested Cormorant	6	300
Pelagic Cormorant	47	4 800
Brandt's Cormorant	2	150
Glaucous-winged Gull	78	17 500
Mew Gull	10	60
Common Murre	4	2 000
Pigeon Guillemot	75	7 500
Ancient Murrelet	22	190 000
Cassin's Auklet	27	100 000
Rhinoceros Auklet	11	27 000
Tufted Puffin	17	25 000
Total	336	459 310

Concentrations of 5000 to 10 000 breeding pairs each are found at Hippa Island on the west coast of Graham Island of the Queen Charlotte Islands; on Storm Islands, Tree Islets, and Pine Island at the north end of the Queen Charlotte Strait; on Solander Island near Cape Cook on the northwest coast of Vancouver Island; and in Barkley and Clayoquot Sound region. B. Foster (personal com-

TABLE 10—Estimates of seabirds in three major breeding concentrations (30 000 pairs or more) along the B.C. coast

Species	Number of breeding pairs: Langara region 1971[1]	East and south coast of Moresby Island 1971[2]	Scott Islands 1949–1950[3]
Fork-tailed Petrel	1 000	40 000	—
Leach's Petrel		2 000	—
Pelagic Cormorant	100–200	200	1 200
Glaucous-winged Gull	170	500	2 000–3 000
Pigeon Guillemot	1 000	700	3 000
Ancient Murrelet	80 000–90 000	15 000	—
Marbled Murrelet	200	—	—
Common Murre	—	—	1 500
Cassin's Auklet	—	14 000	50 000–100 000
Rhinoceros Auklet	—	5 000 (Anthony Island)	4 000
Tufted Puffin	100	50	10 000

[1] S. G. Sealy, personal communication.
[2] K. Summers, 1975.
[3] C. J. Guiguet, personal communication; Carl et al. 1951.
[4] K. Vermeer and K. Summers, personal observations in 1974.

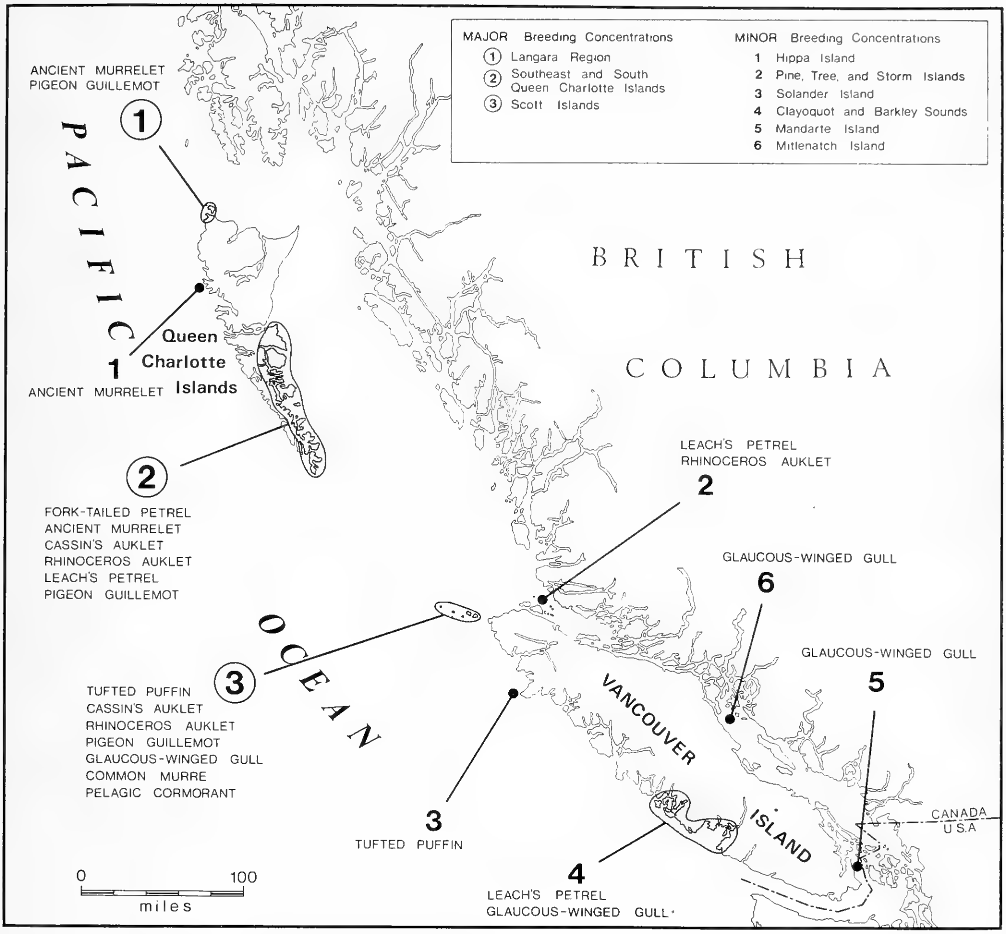


FIGURE 4. Breeding concentrations of seabirds along the B.C. coast.

munication) estimated that there were 10 000 breeding pairs of Ancient Murrelets at Hippa Island in 1971; Drent and Guiguet (1961) reported three separate large colonies of Leach's Petrels (*Oceanodroma leucorhoa*) and one large colony of Rhinoceros Auklets on islands at the entrance of the Queen Charlotte Strait. They also reported an "immense" colony of Tufted Puffins on Solander Island comparable in size to that of Triangle Island in the Scott Islands (approximately 10 000 pairs). The numbers of seabirds nesting at Barkley and Clayoquot Sound have been reported by Campbell and Stirling (1967), Guiguet (1971), and Hatler et al. (1973). Approximately 10-000 pairs of seabirds nest there, about half of which are Leach's Petrels. Another colony, with approximately 3000 pairs of seabirds and known for its diversified seabird life (Drent et al. 1964), is Mandarte Island. Mandarte Island is situated in a busy shipping lane which connects Juan de Fuca Strait with Georgia Strait.

Alcids are the most numerous breeders on the B.C. coast (Table 9). Large-scale fluctuations of alcid populations are known to occur, but their causes are unknown. For instance, Ancient Murrelets occurred in hundreds of thousands in the Langara region in the 1950s, but since that time whole colonies have been abandoned (S. G. Sealy *in* Nelson and Myres 1973). Cassin's Auklet which nested over much of Langara's shoreline as well as on Cox and Lucy Islands (Drent and Guiguet 1961), have largely diminished in numbers in that area (S. G. Sealy *in* Nelson and Myres 1973). Nelson and Myres (1973) suggested that a reduction of euphausid shrimps, which constitute the main food-supply for those two species, may have caused the decline. Large-scale mortalities of alcids have been observed along the west coast, but it is not known whether such die-offs posed a threat to the maintenance of populations. Bailey and Davenport (1971) observed thousands of dead and distressed Common Murres in Bristol Bay, Alaska during April 1970, and they estimated that 68 400 Common Murres died there at that time. Bailey and Davenport suggested that the mortality of murres most likely resulted from starvation precipitated by severe weather. Whether the die-off caused a serious and significant decline of the murre population is unknown.

Although there appear to be many concerns with oil pollution of birds along the B.C. coast, perhaps the major one is with the alcids, as they are the most numerous breeders there and as they are among the most vulnerable to oil pollution (Tables 3 and 4).

Next to the alcids, storm petrels are the most numerous breeding seabirds along the B.C. coast (Table 9). They are less threatened by oil spills than alcids as they spend more time in the air and only dive occasionally. Other Procellariiformes or tubenoses, such as fulmars, shearwaters, and petrels, constitute a small minority in most marine pollution incidents and their deaths are few compared to their total populations (Bourne 1968a). They also avoid diving into oil. Tåning (1951) described the occurrence of a massive "natural" oil slick resulting from the mass deaths of diatoms. The diatoms released multitudes of oil droplets which formed an extensive whitish-gray oil slick on the surface of the sea near Dogger Bank in 1947. Murres became caught and were debilitated in this slick while fulmars were reported to take it well and eat the oil. During the Santa Barbara Channel oil spill in 1969 there was a large influx of Sooty Shearwaters and Pink-footed Shearwaters (*Puffinus creatopus*) into the channel in May, but few or none of the shearwaters were affected by the spill (California Department of Fish and Game 1969).

Vulnerability of Different Feeding Habitats

Alcids and petrels feed mainly on small fishes and euphausid shrimps in the open offshore waters. The food supply of those birds is not much threatened by oil spills because of the tremendous dilution in the oil in the open sea.

Although the B.C. rocky intertidal zone will be vulnerable to oil, few species, such as Black Oystercatchers (*Haematopus bachmani*), Surfbirds (*Aphriza melanocephala*), and Black Turnstones (*Arenaria interpres*) feed extensively in this habitat. Most of these birds are dispersed along a very long rocky west coast; only a massive oil spill would threaten their feeding habitat to any large extent. Gulls probably will be less threatened than other birds by the destruction of their food supply by oil, as they utilize various types of habitat and as their food habits are very versatile.

The feeding habitat of ducks, geese, and shorebirds, which feed in large numbers on tidal sand and mud flats and marshes, may suffer heavily from a spill as a result of the dispersion of oil through the water column in shallow waters and its deposition in the intertidal zone, killing the prey organisms on which those birds feed.

A single spill contaminating Boundary Bay and the Fraser Delta foreshore could result in temporary damage to the birds' feeding grounds and a temporary decline of bird populations as a result. For instance, Harrison and Buck (1967) observed that after the Medway Estuary became polluted with 1700 tons of Nigerian light crude oil and subsequent treatment with detergents, large numbers of molluscs and crustaceans and beds of sea lettuce (*Enteromorpha* sp.) died. The declines of those food organisms and plants were correlated significantly with a drastic decline of shorebirds, geese, and ducks in the first winter after the spill. The affected bird populations, however, appeared to have recovered in the estuary by the second winter (Harrison and Buck 1968).

Of the aquatic birds feeding at Boundary Bay and on the Fraser Delta foreshore, seaducks and Dunlins rely more on the intertidal flats for feeding puposes during the winter than dabbling ducks and other shorebirds, which feed alternatively and extensively in the fresh-water habitat. Therefore Dunlins and seaducks such as Surf Scoters, White-winged Scoters, and Greater Scaup (*Aythya marila*) may be very vulnerable when their food supply, which consists of molluscs, crustaceans, and marine plants (Table 11), will be affected by oil.

TABLE 11—Frequency of food items in esophagi and stomachs of seaducks and Dunlins, collected at Boundary Bay and the Fraser Delta foreshore, January and February 1974 (Number of birds in brackets)

Food Items	Surf Scoter (12)	White-winged Scoter (12)	Greater Scaup (19)	Dunlin (23)
Molluscs				
Snails	3	8	5	9
Bivalves	12	10	2	3
Crustaceans				
Shrimps		2		
Amphipods			2	2
Insects				
Chironomids				3
Vegetation				
Algae			2	5
Plant seeds			1	8
Zostera marina		1		
Lilaecopsis occidentalis			3	

It appears then that although breeding populations of alcids and wintering diving ducks are among the birds most directly affected, ducks (especially seaducks), geese, and shorebirds which feed intertidally, may be hardest hit indirectly by oil on the B.C. coast.

Acknowledgments

Our thanks go to W. J. D. Stephen who suggested assessment of the impact of oil pollution on the Canadian west coast, to I. Robertson who was contracted by the Canadian Wildlife Service to obtain data on the distribution of birds at sea, to K. Summers who assisted with information on migration and breeding colonies, and T. Butler, and G. Miller and his library staff who assisted with the retrieval of literature.

Literature Cited

Aldrich, E. C. 1938. A recent oil pollution and its effects on the water birds of the San Francisco Bay area. Bird-lore 40(1): 110–114.

Alyeska Pipeline Service Company. 1971. Background information on West Coast tanker traffic, October, 1971. Bellevue, Washington. 4 pp.

Anonymous. 1970a. For the record, 2. Marine Pollution Bulletin 1(8): 117.

Anonymous. 1970b. Bird deaths mount in Alaska. Marine Pollution Bulletin 1(5): 66.

Bailey, R. 1966. The seabirds of the southeast coast of Arabia. Ibis 108: 224–264.

Bailey, E. P. and **G. H. Davenport.** 1971. Die-off of Common Murres on the Alaska Peninsula and Unimak Island. Condor 73: 215–219.

Barclay-Smith, P. 1967. Oil pollution—an historical survey. Journal Devon Trust for Nature Conservation; July Supplement, Conservation and the Torrey Canyon. pp. 3–7.

Battelle-Northwest. 1967. Oil spillage study, literature search, and critical evaluation for selection of promising techniques to control and prevent damage. Report to Department of Transportation U.S. Coastguard, by Pacific Northwest Laboratories, Battelle Memorial Institution, Richland, Washington, USA. Chapter 6, p. 57.

Beer, J. V. 1968. The attempted rehabilitation of oiled seabirds. Wildfowl 19: 120–124.

Bergman, G. 1961. Allin ja mustalinnun muuttokannat Keväällä 1960. (The migrating populations of the Long-tailed Duck and the Black Scoter in the spring 1960.) Suomen Riista 14: 69–74.

Blumer, M. 1971. Scientific aspects of the oil problem. Environmental Affairs 1: 54–73.

Bourne, W. R. P. 1963. A review of oceanic studies of the biology of seabirds. International Ornithological Congress 13: 831–854.

Bourne, W. R. P. 1968a. Oil pollution and bird populations. Symposium on the Bio-effects of Oil Pollution on Littoral Communities. 17–19 February 1968. Pembroke, Wales. Field Studies Council. pp. 99–121.

Bourne, W. R. P. 1968b. Observations of an encounter between birds and floating oil. Nature (London) 219: 632.

Bourne, W. P. R., J. D. Parrack, and **G. R. Potts.** 1967. Birds killed in the *Torrey Canyon* disaster. Nature (London) 215: 1123–1125.

Brown, R. G. B., D. I. Gillespie, A. R. Lock, P. A. Pearce, and **G. H. Watson.** 1973. Bird mortality from oil slicks off Eastern Canada, February–April 1970. Canadian Field-Naturalist 87: 225–234.

Burnett, F. L. and **D. Snyder.** 1954. Blue crab as starvation food of oiled American Eiders. Auk 71(3): 315–316.

California Department of Fish and Game. 1969. Second progress report on wildlife affected by the Santa Barbara Channel oil spill. April 1–May 31, 1969. Unpublished Report. 9 pp.

Campbell, R. W., M. G. Shepard, and **R. H. Drent.** 1972. Status of birds in the Vancouver area in 1970. Syesis 5: 137–167.

Campbell, R. W. and **D. Stirling.** 1967. Notes on natural history of Cleland Island, British Columbia, with emphasis on the breeding bird fauna. British Columbia Provincial Museum Report. pp. 24–43.

Carl, G. C., C. J. Guiguet, and **G. A. Hardy.** 1951. Biology of the Scott Island Group, British Columbia. British Columbia Provincial Museum, Report Number 10. pp. 21–63.

Clark, R. B. 1968. Oil pollution and the conservation of seabirds. Proceedings of the International Conference on Oil Pollution of the Sea. October 7–9, 1968, Rome. Warren and Son Ltd., Wykeham Press. pp. 76–112.

Cole, R. H., H. P. Foote, and **J. R. Eliason.** 1973. Oil drift forecasting model. Battelle Pacific Northwest Laboratories, Richland, Washington. 45 pp.

Coulson, J. C., G. R. Potts, I. R. Deans, and **S. M. Fraser.** 1968. Exceptional mortality of shags and other seabirds caused by paralytic shellfish poisoning. British Birds 61: 381–404.

Curry-Lindahl, K. 1960. Serious situation with regard to Swedish populations of the Long-tailed Duck (*Clangula hyemalis*). International Waterfowl Research Newsletter 10: 15–18.

Drent, R. H. and **C. J. Guiguet.** 1961. A catalogue of British Columbia seabird colonies. British Columbia Provincial Museum, Occasional Papers 12: 1–73.

Drent, R. H., G. F. Van Tets, F. Tompa, and **K. Vermeer.** 1964. The breeding birds of Mandarte Island, British Columbia. Canadian Field-Naturalist 79: 208–263.

Eagles, D. 1964. Oil pollution—a near disaster for the Greater Snow Goose. Canadian Audubon 26(2): 37–39.

Einarsen, A. S. 1965. Black Brant, sea goose of the Pacific Coast. University of Washington Press, Seattle, Washington. 142 pp.

Goethe, F. 1968. The effects of oil pollution on marine and coastal birds. Helgolaender Wissenschaftliche Meeresuntersuchungen 17: 370–374.

Grenquist, P. 1956. Oljytuhoista Suomen aluevesillä v. 1948–1955. (Oil damage on Finland's territorial waters in 1948–1955.) Suomen Riista 10: 105–116.

Gross, A. O. 1960. The herring gull–cormorant control project. Proceedings of the International Ornithological Congress 10: 532–536.

Guiguet, C. J. 1971. A list of seabird nesting sites in Barkley Sound, British Columbia. Syesis 4: 253–259.

Guillon, J. C. 1967. Les effets tardifs de l'intoxication par la mazout chez les oiseaux. (The delayed effects of crude oil poisoning in birds.) L'Homme et L'Oiseau 9: 15–16.

Harris, R. D. 1971. Further evidence of tree nesting in the Marbled Murrelet. Canadian Field-Naturalist 85: 67–68.

Harrison, J. and **W. F. A. Buck.** 1967. Peril in perspective. An account of oil pollution in the Medway Estuary. Special Supplement to the Kent Bird Report 16 (1967). Kent Ornithological Society. 24 pp.

Harrison, J. and **W. F. A. Buck.** 1968. The second winter survey following the Medway oil pollution of 1966. The Wildfowler's Association of Great Britain and Ireland, Annual Report and Handbook 1967–1968. pp. 68–71.

Hartung, R. 1963. Ingestion of oil by waterfowl. Papers of the Michigan Academy of Science, Arts and Letters 48: 49–55.

Hartung R. 1965. Some effects of oiling on the reproduction of ducks. Journal of Wildlife Management 29(4): 872–874.

Hartung, R. 1967. Energy metabolism in oil-covered ducks. Journal of Wildlife Management 31(4): 798–804.

Hartung, R. and **G. S. Hunt.** 1966. Toxicity of some oils to waterfowl. Journal of Wildlife Management 30(31): 564–570.

Hatler, D. F., R. W. Campbell, and **A. Dorst.** 1973. Birds of the Pacific Rim National Park, British Columbia. Canadian Wildlife Service Manuscript Report. Edmonton, Alberta. 383 pp.

Hawkes, A. L. 1961. A review of the nature and extent of damage caused by oil pollution at sea. Transactions of the North American Wildlife Conference 26: 343–355.

Hempel, G. 1971. Das Weltmeer als Nahrungsquelle. (The ocean as a source of food.) Wasser, Luft und Betrieb 15(7): 265–267.

Horwood, J. 1959. Death has a rainbow hue. Canadian Audubon 21(3): 69–73.

Hope Jones, P., G. Howells, E. I. S. Rees, and **J. Wilson.** 1970. Effect of *Hamilton Trader* oil on birds in the Irish Sea in May 1969. British Birds 63(3): 97–110.

Joensen, A. H. 1972. Studies on oil pollution and seabirds in Denmark 1968–71. Danish Revue of Game Biology 6(9). 32 pp.

Keith, V. F. and **J. D. Porricelli.** 1973. An analysis of oil outflows due to tanker accidents. Proceedings of Joint Conference on Prevention and Control of Oil Spills, March 13–15, 1973, Washington, D.C. American Petroleum Institute. pp. 3–14.

Lemmetyinen, R. 1966. Jäteöljyn vesilinnuille aiheuttamista tuhoista Itämeren alueella. (Damage to waterfowl in the Baltic by waste oil.) Suomen Riista 19: 63–71.

Leslie, P. H. 1966. The intrinsic rate of increase and the overlap of successive generations in a population of guillemots (*Uria aalge* Pont.). Journal of Animal Ecology 35(2): 291–301.

Martin, P. W. and **M. T. Myres.** 1969. Observations on the distribution and migration of some seabirds off the outer coasts of British Columbia and Washington State, 1946–1949. Syesis 2: 242–256.

McEwan, E. H. and **A. F. C. Koelink.** 1973. The heat production of oiled Mallard and Scaup. Canadian Journal of Zoology 51(1): 27–31.

Milon, P. and **C. E. F. Bougerol.** 1967. Séjour à Rouzic, du 20 au 24 avril. L'Homme et L'Oiseau 9:: 12–13.

Moffitt, J. and **R. T. Orr.** 1938. Recent disastrous effects of oil pollution on birds of the San Francisco Bay region. California Fish and Game 24(3): 239–244.

Murphy, R. C. 1936. Oceanic birds of South America. 2 volumes. American Museum of National History, New York. 1245 pp.

Murty, T. S. and **M. L. Khandekar.** 1973. Simulation of movement of oil slicks in the Strait of Georgia using simple atmosphere and ocean dynamics. Proceedings of Joint Conference on Prevention and Control of Oil Spills, March 13–15, 1973, Washington, D.C. American Petroleum Institute. pp. 541–546.

Nelson, R. W. and **M. T. Myres.** 1973. Changes in the Peregrine population and its seabird prey at Langara Island, British Columbia, 1973. Conference Raptor Conservation Techniques. 27 pp.

Nettleship, D. N. 1972. Breeding success of the Common Puffin (*Fratercula arctica* L.) on different habitats at Great Island, Newfoundland. Ecological Monographs 42(2): 239–268.

Ouweneel, G. L. 1971. De gevolgen van de olieramp in de Biesbos voor in de winter 1970–1971 in het Hollands Diep–Haringvliet pleisterende ganzen. (Consequences of the oil disaster in the Biesbos for geese stopping over during the winter of 1970–1971 in the Holland Diep–Haringvliet area.) Limosa 44: 185–188.

Paish, H. and **Associates.** 1972. The West Coast oil threat in perspective. Volume II. Environmental and Resource Management Consultants, Vancouver, British Columbia. 304 pp.

Ranwell, D. S. and **D. Hewett.** 1964. Oil pollution in Poole Harbour and its effect on birds. Bird Notes 31: 192–197.

Richardson, F. 1956. Seabirds affected by oil from the freighter *Seagate*. Murrelet 37(2): 20–22.

Rittinghaus, H. 1956. Etwas über die "indirekte" Verbreitung der Ölpest in einem Seevogelschutzgebiet. (On the "indirect" spread of oil pollution in a seabird sanctuary.) Ornithologische Mitteilungen 8(3): 43–46.

Robertson, I. 1974. An inventory of seabirds occurring along the west coast of Canada. Canadian Wildlife Service Report, Edmonton, Alberta.

Smail, J., D. G. Ainley, and **H. Strong.** 1972. Notes on birds killed in the 1971 San Francisco oil spill. California Birds 3(2): 25–32.

Smith, P. C. and **J. S. Bleakney.** 1968. Observations on oil pollution and wintering Purple Sandpipers in Nova Scotia. Canadian Field-Naturalist 83(1): 19–20.

Smithsonian Institution for Short-lived Phenomenon. 1972. Event notification reports, numbers 873–874; 1372; 1234–1235.

Soikkeli, M. and **J. Virtanen.** 1972. The *Palva* oil tanker disaster in the Finnish southwestern archipelago. II. Effects of oil pollution on the Eider (*Somateria mollissima*) population in the archipelagos of Kökar and Föglo, southwestern Finland. Aqua Fennica 1972: 122–128.

Southern, H. N., R. Carrick, and **W. G. Potter.** 1965. The natural history of a population of guillemots (*Uria aalge* Pont.). Journal of Animal Ecology 34: 649–665.

Statistics Canada. 1972a. Shipping report, 1970. Part II—International seaborne shipping. Catalogue 54203. 75 pp.

Statistics Canada. 1972b. Shipping report, 1970. Part III—Coastwise shipping. Catalogue 54204. 105 pp.

Statistics Canada. 1972c. Shipping report, 1971. Part II—International seaborne shipping. Catalogue 54203. 63 pp.

Statistics Canada. 1973. Shipping report, 1971. Part III—Coastwise shipping. Catalogue 54204. 91 pp.

Summers, K. 1974. Seabirds breeding along the east and south coasts of Moresby Island, Queen Charlotte Islands, British Columbia. Syesis 7: 1–12.

Swennen, D. C. and **A. L. Spaans.** 1970. De sterfte van zeevogels door olie in februari 1969 in het Waddengebied. (Seabird mortality by oil in the Wadden Sea area in February 1969.) Vogeljaar 18(2): 233–245.

Taylor, E. W. 1973. Marine-associated birds of the British Columbian coast. Canadian Wildlife Service Manuscript Report, Edmonton, Alberta. 82 pp.

Tanis, J. J. D. and **M. F. M Morzer Bruijns.** 1968. The impact of oil pollution on seabirds in Europe. Proceedings of the International Conference on Oil Pollution of the Sea, October 7–9, 1968. Rome, Warren and Son Ltd., Wykeham Press. pp. 67–74.

Taning, A. V. 1951. Olieforurening af habet of massedod af fugle. (Oil pollution of the sea and mass destruction of birds.) Naturens Verden 35(1, 2): 34–43.

Technical Advisory Committee for oil pollution on the Tay. 1968. Oil pollution in the Tay Estuary, 1968 following the *Tank Duchess* incident. Corporation of the City of Dundee, Publications Department, Dundee, Scotland. 26 pp.

Ticehurst, N. F. 1938. Oiled birds resorting to fresh water. British Birds 31(11): 354–355.

Tuck, L. M. 1960. The murres: their distribution, populations and biology—a study of genus *Uria*. Canadian Wildlife Service, Monograph 1. 260 pp.

Vagners, J. and **P. Mar.** 1972. Oil on Puget Sound: An inderdisciplinary study in systems engineering. University of Washington Press, Seattle. 629 pp.

Vereshchagin, N. K. 1946. Gibel' ptits ot nefti v Azerbaidzhane. (Death of birds from oil in Azerbaijan.) Zoologicheskii Zhurnal 25(1): 69–81.

Vermeer, R. and **K. Vermeer.** 1974. Oil pollution of birds: an abstracted bibliography. Canadian Wildlife Service, Pesticide Section, Manuscript Report 29: 1–68.

Wardley Smith J. 1973. Occurrence, cause and avoidance of the spilling of oil by tankers. Proceedings of Joint Conference on Prevention and Control of Oil Spills, March 13–15, 1973, Washington, D.C. American Petroleum Institute. pp. 5–20.

Westphal, A. and **M. K. Rowan. 1970.** Some observations on the effects of oil pollution on the Jackass Penguin. Ostrich (Supplement) 8: 521–526.

Wright, P. 1971. High pollution toll of Shetland seabirds. London Times, June 7, 1971. p. 3.

Received 3 September 1974
Accepted 4 March 1975

The Disappearance of Caribou Reintroduced to Cape Breton Highlands National Park

T. CHARLES DAUPHINÉ, JR.

Canadian Wildlife Service, Eastern Region, 2721 Highway 31, Ottawa, Ontario K1A 0H3

Dauphiné, T. C., Jr. 1975. The disappearance of caribou reintroduced to Cape Breton Highlands National Park. Canadian Field-Naturalist 89(3): 299-310.

Abstract. Fifty-one wild caribou (*Rangifer tarandus caribou*) from Quebec were released in Cape Breton Highlands National Park, Nova Scotia, in 1968 and 1969. The herd was sighted frequently in and near the park for about one year; it then declined and finally disappeared by the summer of 1972. An aerial and ground search in March 1973 revealed that the caribou were not present on range they had occupied previously, and they could not be located in other parts of northern Cape Breton Island which offered suitable habitat. Observations made before the disappearance indicate that the caribou did not disperse, but instead remained near their release site, making short seasonal movements between local habitats. Reproduction occurred. There is no evidence of starvation, poaching, or predation. The herd may have succumbed to neurologic disease caused by the meningeal worm *Parelaphostrongylus tenuis* which parasitizes white-tailed deer of the region; during the decline, three caribou were observed with signs like those of neurologic disease.

The woodland caribou, which originally inhabited much of eastern North America, has been extirpated everywhere south of the St. Lawrence River except the Gaspé Peninsula (Banfield 1961, pp. 73–76). This drastic reduction in range, largely complete by 1900, is attributed to excessive hunting and habitat destruction (Smith 1940; Cringan 1957) and possibly to disease caused by a parasite of invading white-tailed deer (*Odocoileus virginianus*) (Anderson 1972; Anderson and Strelive 1968). In the remote highlands of Cape Breton Island, however, some caribou persisted until the 1920s, when they apparently succumbed to hunting (Benson 1955, 1956). Their habitat remained relatively untouched by forestry, agriculture, and fire (Nichols 1918; Lamb 1954). Much of that original habitat has been preserved since 1936 within the boundaries of Cape Breton Highlands National Park. In the early 1960s the National and Historic Parks Branch, realizing the potential for restoration of caribou in the park, requested the Canadian Wildlife Service to appraise the feasibility of a reintroduction.

Canadian Wildlife Service biologists examined the park, concluded that it was capable of supporting caribou, and recommended obtaining wild, adult stock from neighboring populations which bore closest genetic resemblance to the indigenous caribou of Cape Breton Island (Kelsall no date; Scotter 1966). Two groups of caribou, totaling 51 animals, were captured one year apart in northeastern Quebec, and released in the park (MacDonald 1969). Three males and 15 females were captured at 51°30′ N and 65°10′ W, and released on 23 March 1968. Five males and 28 females were captured near 53°00′ N and 68°00′ W, and released on 24 March 1969.

The Park Warden Service surveyed the introduced herd each winter and also kept a record of sightings reported by the public. Many caribou, including some newborn calves, were observed in and near the park during 1969 and 1970. Thereafter, caribou were seen with diminishing frequency and in smaller groups. They finally disappeared, except for occasional unverified sightings, by the summer of 1972. The situation resembled an ill-fated introduction of nine female and two male Newfoundland caribou to the Liscomb Game Sanctuary on mainland Nova Scotia in 1939 (Tufts 1939); those animals disappeared for unknown reasons a few years after their release (Cameron 1958).

In autumn 1972, the National and Historic Parks Branch requested the Canadian Wildlife Service to direct the Park Warden Service in a search for the caribou and, if the search was successful, to establish a system of monitoring the size of the herd and condition of the habitat. This report describes a search conducted for the caribou in March 1973. It also analyzes information obtained about the caribou after the release on Cape Breton Island in an attempt to determine the probable cause(s) of their disappearance.

The Study Area

The northern peninsula of Cape Breton Island appears well suited to support caribou. The dominant topographical feature, the highland, is a massive, relatively level plateau of Precambrian rock which ranges from 1000 to 1700 feet above sea-level. The sides of the plateau drop off steeply at coastal headlands and into deep, V-shaped valleys occupied by shallow, rapidly flowing streams.

The vegetation of the highlands is boreal and forms a mosaic of climax forest and open "barrens." On the plateau the forest consists predominantly of balsam fir (*Abies balsamea*) in pure stands and mixed with spruce (*Picea mariana* and *P. glauca*) and larch (*Larix laricina*). The forest varies in density from open park-like stands to stunted thickets or "tuckamores." Barrens are formed by sphagnum bogs on wet sites and in dryer places by heaths of ericaceous shrubs, sedges (*Carex* spp.), and lichens. Nearly pure stands of *Cladonia* and *Cetraria* lichens, staple winter foods of caribou, are extensive in the southeastern part of the park (Scotter 1966). With decreasing elevation on the slopes of the plateau, the forest cover becomes continuous and the species composition grades through coniferous-deciduous mixtures to a deciduous Acadian forest community near sea-level. Plant associations of the park have been described and mapped by Atlantic Resource Planners (1972) and Beil et al. (1971).

The cool damp maritime climate of Cape Breton Island has a mean annual temperature of 2.2°C, a mean temperature in January of —2.2°C, and in July of 17.2°C, a mean annual precipitation of 45 inches, and a mean annual snowfall of 100 inches (Canada Department of Transport 1970). There are, however, no published climatological data for the northern highlands, where elevation has a large effect. Kelsall (1965) reported that the average accumulation of snow on the plateau in March of 1965 was over twice what it was at sea-level only 2 miles away. He also found that snow on the highlands, which ranged from an average depth of 27 inches in open barrens to over 60 inches in some forests, had multiple layers of dense hard crust caused by the frequent thaws characteristic of the region's maritime climate.

There have been major changes in the fauna of northern Cape Breton since the time of the indigenous caribou. White-tailed deer first appeared about 1915 (Benson 1955, p. 23) and have been abundant in the park for the last three decades (Clarke 1942; Carter 1955; Benson 1961). The moose (*Alces alces*), which became very scarce or extinct about 1900 (Benson 1955), was successfully reintroduced to the park in 1947 and now occupies most suitable habitat. The caribou's major indigenous predator, the wolf (*Canis lupis*), has been extinct since early in this century (Smith 1940).

Methods

Historical Review

In order to reconstruct the circumstances surrounding the caribou's existence in Cape Breton, I reviewed records pertaining to the habitat appraisal, transplant operation, and subsequent monitoring of the introduced herd. A description of the capture, transport, release, and subsequent monitoring of the introduced herd existed in a series of "Game Reports— Caribou Observations" prepared by members of the Park Warden Service and submitted to the Director, Atlantic Region, National Parks Branch (MacDonald 1969, 1971, 1972a, b; McGuire 1970a, b). Other individuals also submitted reports to the National Parks Branch on the status of the caribou (Simard 1970; Wood 1971). I obtained further information through interviews with personnel of Cape Breton Highlands National Park who had experience with the caribou restoration project and its aftermath.

The Search for Caribou

A search for the missing caribou was conducted in March 1973, using three approaches which are described below. The surveys were conducted by the Warden Service under my direction, and I participated in all surveys of potential caribou habitat.

An aerial survey within the park was undertaken to determine the relative numbers and distribution of deer, moose, and caribou, with emphasis on caribou. The park was subdivided into 37 zones by placing boundaries at changes in topography and in vegetative cover types. This strategy was intended to minimize navigational and visual problems caused by large variations in topography, vegetation density, and weather conditions (visibility) which exist in northern Cape Breton Island. Zone boundaries were located to separate flat plateau, steep slopes, and narrow valley bottoms and to separate treeless areas, thick stands of balsam fir, and mixed coniferous/deciduous forests. As a result, the vegetation and topography of each zone were relatively homogeneous, facilitating the tasks of navigator and observers. Maps of the park's vegetation cover types prepared by Atlantic Resource Planners (1972) were used for reference in establishing zone boundaries. Each zone was surveyed independently and completely, and therefore the entire park was covered (Figure 1). Location of zone boundaries and the detailed method of conducting the survey are described by Wallace (1973).

Outside the park, all potential caribou habitat in northern Cape Breton Island was surveyed from an aircraft. The portion of the peninsula north of the park (approximately 190 square miles) and south of the park to Lake Ainslie and Bras d'Or Lake (approximately 1200 square miles) was covered (Figure 1). The survey aircraft followed every other east-west Universal Transverse Mercator Grid line (spaced 0.62 mile apart), deviating where necessary to circle lakes, bogs, barrens, clear-cuts, and other openings in the forest large enough to reveal caribou or their tracks. The pilot maintained the aircraft at an altitude of 400–500 feet and a ground speed of 50–70 mph. I participated as navigator-observer, and two wardens acted as observers. Logistical details are given by Wallace (1973).

Members of the Warden Service and I searched by snow vehicle and on foot in areas where the caribou had been observed in previous winters. We covered lichen ranges at the head of Ingonish River, Indian Brook, Clyburn Brook, and at Lake of Islands, Branch Pond, Cheticamp Lake, and Round Pond (Figure 1), seeking evidence which would be missed from an aircraft. Snow depth and hardness and the availability of terrestrial and arboreal lichens were examined at these sites.

Examination of Deer for Meningeal Worm

The presence of a large population of white-tailed deer in northern Cape Breton Island presented the possibility that reintroduced caribou were exposed to a lethal neurologic disease caused by a meningeal worm, *Parelaphostrongylus tenuis*. This parasite's normal life cycle in white-tailed deer (the final host) and terrestrial gastropods (the intermediate host) was described by Anderson (1963). Caribou can enter the cycle as an aberrant final host with fatal results (Anderson and Strelive 1968). Smith et al. (1964) found *P. tenuis* in white-tailed deer on mainland Nova Scotia but its presence in northern Cape Breton Island was not reported. Therefore, heads and feces of white-tails were obtained for examination from the park. G. G. Gibson of the Canadian Wildlife Service examined heads of two deer for the adult parasite. Groups of deer feces were collected from deer yards in the park. Using the Baermann technique (Anderson 1963), D. B. Lamperd and I removed larval helminths from the feces and examined the larvae for their resemblance to first-stage larvae of *P. tenuis*, described by Anderson (1963).

Results

Aerial and Ground Surveys

A total of 76 hours was spent searching for caribou from aircraft, 52 within and 24 outside the park boundaries (Figure 1). Ground parties travelled approximately 100 miles on the caribou's former winter range. These surveys did not find any evidence of caribou, past or present.

I had an opportunity during the surveys to appraise the winter habitat available to caribou. Foraging opportunities appeared excellent on the barrens, especially in an area known locally as the "Indian Rising" at the head of Clyburn Brook. Full exposure to wind action there kept the snow shallow and patchy. A mat of

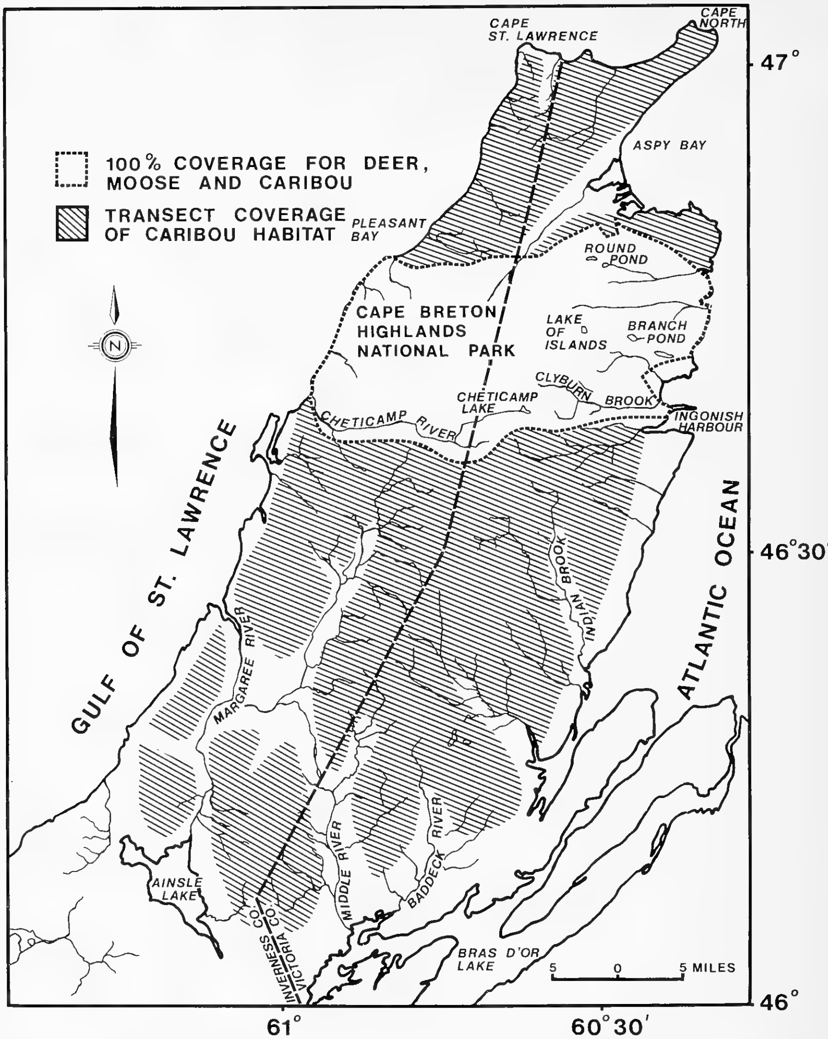


FIGURE 1. Northern Cape Breton Island showing the area searched for caribou in March 1973.

lichens several inches deep was exposed over hundreds of acres. But foraging in shrubby or treed areas was obviously difficult or impossible because of the excessive depth, density, and hardness of the snow. The depth of snow in five sample pits in treed areas ranged from approximately 3 to 6, and averaged 4 feet. There were at least two layers of crust, so hard that they were difficult to penetrate with a shovel. The conditions I observed were similar to those found there by Kelsall (1965) in March 1965. Kelsall (1965, p. 11) concluded from his measurements of snow depth, density, and hardness that "... it seems most unlikely that animals from any caribou population could feed efficiently on the ground by digging through snow of the sort described for most habitat types on the Cape Breton highlands." The open lichen barrens were the only exception, and there was no evidence of caribou on the barrens in March 1973.

The Record of Caribou Observations

(1) *Number of Caribou and Size of Herds*

The number of caribou and the size of herds observed, when plotted against time since the introduction, described the pattern of the decline (Figure 2). I obtained these data from the park's record of observations (McGuire 1970a, b; MacDonald 1971, 1972b). For approximately 1 year after the second introduction, both herd size and number of sightings were high. A decline began in the fall of 1970 and ended approximately 1½ years later in the summer of 1972. More caribou were sighted in the calendar year 1969 than in all subsequent years combined (Figure 2). The decline in number of sightings occurred despite an increasing search effort.

(2) *Herd Composition and Reproduction*

The sex and/or age of the caribou was noted in 26 (35%) of 74 observations. The tally of segregated individuals is 23 "adult" males, 75 "adult" females, and 25 calves. The male:female ratio in the segregated caribou (30:100) is almost twice what it was in the introduced herd (18:100). Females may have been leaving the population more rapidly than males, but it is also possible that males were more visible than females, or that some antlered females were identified as males.

The introduced caribou reproduced successfully; calves seen in 1970 and 1971 (Figure 2) must have resulted from local matings. (Calves observed in 1969, however, could have been born to females which were already pregnant when placed in the park.) Obviously, some caribou remained in the area of the release and made contact during the breeding season.

(3) *Physical Condition*

Wardens noticed physical disabilities in some caribou. Two "thin" bulls were observed in February 1970; their condition was attributed to normal increase in physical activity during the rut in autumn 1969 (McGuire 1970a).

Two other caribou with more pronounced physical abnormalities were observed by McGuire (1970a) in February 1970. He described their condition (excerpt of letter to A. Fisk, 25 April 1972) as follows:

> "A young cow . . . [seen from the aircraft]. She would run from the plane and then her hind legs would buckle. She would then get up and run in another direction."
>
> "A mature bull dragging right hind leg. Fat and in good shape."

MacDonald (1971) observed a "crippled" cow in a herd of seven on 2 April 1971.

At the time it was assumed that these caribou had been crippled by injuries which they sustained when captured and released 1 to 3 years before, and no closer investigation was made. I could not find any record in park files of caribou mortality and the people I interviewed had no knowledge of the death of caribou released in the park.

(4) *Location and Movements*

As the Warden Service recorded the approximate location and date of each caribou

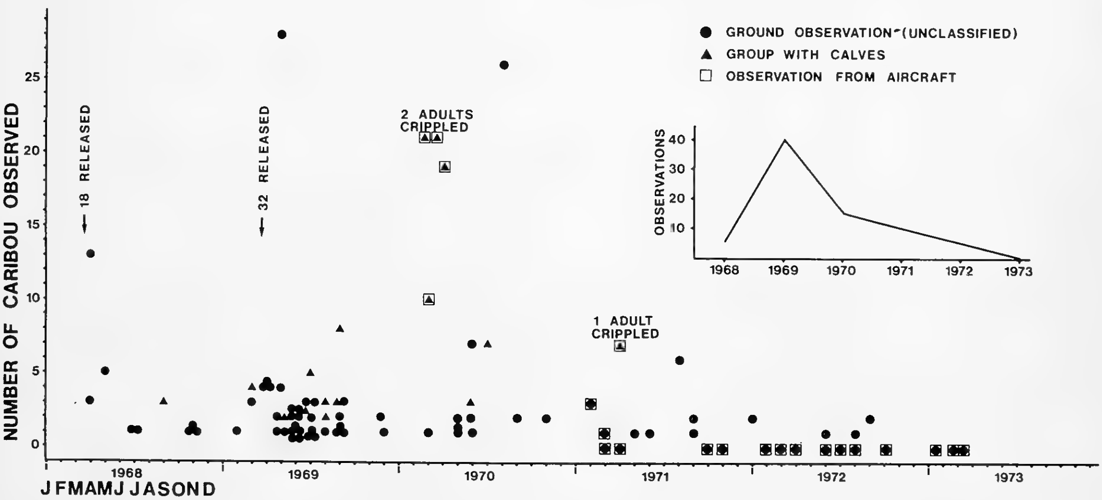


FIGURE 2. Trends in the number and size of caribou groups (including individuals) observed on Cape Breton Island after the reintroductions.

observation, I was able to obtain an indication of the dispersal, seasonal movements, and habitat preferences of the introduced caribou. The locations of 75 observations are shown in Figure 3. Sightings are identified to reveal differences in distribution during the periods with (December–April) and without (May–November) snow cover.

Most observations of caribou occurred locally; 64% were within the park's boundaries, and 84% were within a 15-mile radius of the release site shown in Figure 3.

Twelve observations were located more than 15 miles from the release site, 11 north and 1 south of the park. The southern observation was also the most distant; here, four animals were seen near Margaree on 5 March 1969, approximately 34 miles from the release site.

The seasonal distribution of observations reveals that caribou remained in a relatively small area and in one main habitat type in winter, and that in snow-free months they ranged widely and entered a variety of habitats. Fifteen of 20 winter sightings were located in barrens covering approximately 60 square miles in the southeastern part of the park. Most of the area has a minimum accumulation of snow, as previously noted. In contrast, summer sightings were distributed over a much larger area, i.e., most of the northern peninsula (Figure 3), where there is considerable variation in elevation and habitat. Many summer sightings occurred at or near the coast and in valleys where forest cover was mixed-wood or deciduous.

Some bias arising from the location of observers must be considered in the interpretation of data on caribou distribution. In northern Cape Breton Island, the human population is concentrated on the coast, and there is little travel into the central highlands at any season. This may explain why many summer observations occurred near settled areas on the coast and along the Cabot Trail where it

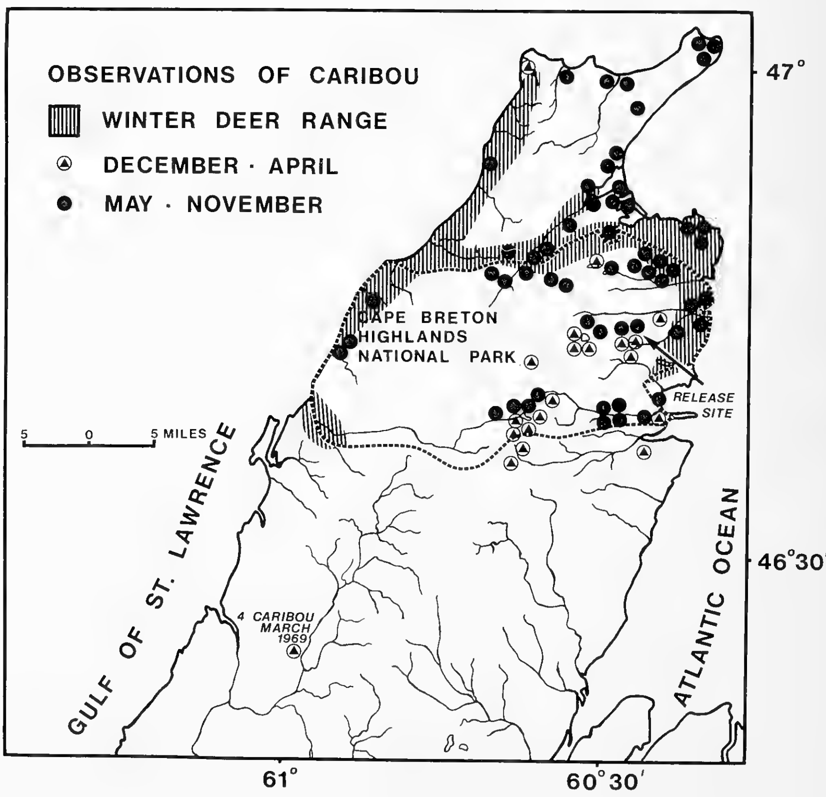


FIGURE 3. Observations of caribou and winter distribution of deer, 1968 to 1973.

crosses the highlands of the north boundary of the park (Figure 3). It is possible that caribou could have also used the central highlands and the headlands northwest of the park in summer; their presence there could have gone undetected because of the lack of observers. In contrast, aerial surveys made in winter were free of that bias because they sampled the entire area. Also, the lack of sightings toward the base of the peninsula must indicate an absence of caribou, because the density of settlement and the occurrence of agriculture and forestry increase directly with distance south from the park.

(5) *Seasonal Herd Size*

The caribou formed larger groups in winter than in summer, according to the record of observations. The average number of caribou in 26 observations made in winter was 5.0, whereas the average size of 50 "groups" observed in summer was 2.7. The observation of a herd of 26 caribou in summer was unusual, since the next largest group observed at that time of year was eight. In summer, 74% of the sightings were of one or two animals; in winter, only 25%.

Distribution of Deer and the Status of Parelaphostrongylus tenuis

According to ungulate surveys made each winter since 1969, white-tailed deer occupy all major valleys and low coastal areas of mixed-wood forests in northern Cape Breton Island (McGuire 1970a; MacDonald 1971, 1972b). Many white-tails also feed in winter on knolls along the western headlands in and north of the park (J. D. MacDonald, F. A. E. Wallace, personal communication). The record of observations indicated that in snow-free months caribou used areas where white-tails had concentrated in winter, but in winter the ranges of the two species were largely discrete (Figure 3).

The deer population of northern Cape Breton is evidently widely infected with the meningeal worm *P. tenuis*. Larvae, indistinguishable from the first-stage larva of that parasite, were recovered from 15 (34%) of 44 deer pellet-groups. G. G. Gibson found *P. tenius* in one of two deer collected from the park in spring 1973. In July 1973, H. J. Smith (personal communication) of the Health and Animals Branch, Agriculture Canada, found that seven of nine deer from Inverness and Victoria Counties in northern Cape Breton were infected with meningeal worm. The infestation rate of both samples combined is 72%, similar to the level of infestation reported by Smith et al. (1964) for mainland Nova Scotia.

Discussion

The results of this investigation indicate that the caribou reintroduced to northern Cape Breton Island no longer exist as a viable population. They have not been observed on their former winter range for 3 consecutive years, as T. J. Wood (personal communication) also failed to find any caribou during aerial surveys in March 1974. Since 1972, only a few sightings of one or two animals have been reported, and none of those observations has been confirmed by park staff. It is possible, of course, that a small number of caribou could remain without detection in a wilderness as large as that in northern Cape Breton Island.

If the caribou had survived and reproduced at rates attained elsewhere in North America, the situation today would be quite different. I applied the following assumptions to make a conservative estimate of the potential increase in the original herd: (1) the sex ratio in the introduced herd (1 male to 7 females) was adequate for servicing all females of breeding age; (2) at least 75% of the transplanted cows were of breeding age; (3) at least 80% of the cows of breeding age produced a calf annually (McEwan 1963; Bergerud 1969; Dauphiné, unpublished data); and (4) the mortality of adult females was at least compensated by addition of younger females into the breeding ranks. It follows, then, starting from the original 43 females, that at least 25 calves could have been born each year. Even if 80% of the calf crop died before reaching 1 year of age (higher than in established caribou populations (Skoog 1968; Bergerud 1969; Parker 1972)), the net annual increase would be five animals. Four calving seasons had passed since the introduction, and the herd should have been increased by a minimum of 20, to number 71 animals. Had the herd survived, it should be larger and more visible now than before.

Unfortunately, the opportunity to identify factor(s) which caused the caribou's disappearance decreases with time and may never be known. It is possible, however, with information available to evaluate many factors which could have caused or contributed to the decline.

Dispersal

The evidence does not support the possibility that all the caribou dispersed from northern Cape Breton Island or that they shifted to dense forests where their presence would not be detected. The caribou were released near the end of a peninsula approximately 60 miles long and 30 miles wide which is well populated on the coast and at the base. Dispersing caribou would be funnelled by the shape of the land mass into areas of increasing human density and less suitable habitat (Figure 3). Yet caribou were observed only once outside the northern half of the peninsula, and then only 34 miles from the release site. In contrast, 24 caribou that dispersed from a release site in central Maine (Baxter State Park) were observed many times at distances up to 90 miles away in the summer and autumn following their release (Dunn 1965). The Maine caribou, released in late autumn, dispersed the following spring as soon as snow no longer restricted travel and the availability of food. Unlike caribou released on Cape Breton, they did not establish and maintain local habitat preferences, movement patterns, or a herd organization which included breeding.

Some caribou may have dispersed from northern Cape Breton shortly after their release, though for reasons already given it is doubtful that a general exodus could have occurred without detection. The wild population in Quebec from which the caribou were captured in 1968 migrates about 100 miles between its winter and summer ranges (I. Juniper, personal communication). Pen-raised progeny of other caribou taken from that population have been released in Laurentides Provincial Park (47°30′ N, 71°30′ W), where they have formed a wild herd even though some individuals strayed up to 60 miles from the release site (Bonefant 1974). Northern Cape Breton seems to offer all habitat requirements for the number of caribou that were released there, and the record shows that many animals remained for at least 1 year. Then the herd consisted partly of animals born in Cape Breton, an association which would likely become less prone to dispersal as time passed.

The idea that the caribou disappeared because they shifted to dense forests where they could not be observed was advanced by J. D. MacDonald (personal communication) after he witnessed severe "icing" of the barrens in the winter of 1971–72. MacDonald is probably right that the caribou were periodically required by snow conditions to make temporary shifts to adjacent forests. After examining snow conditions on the plateau, Kelsall (1965) concluded that ". . . for some periods during most winters . . . ," caribou would be cut off from terrestrial lichens and have to subsist on arboreal lichens and browse. Scotter (1966, p. 8), however, was unimpressed with the abundance of arboreal lichens in the forests of the plateau and concluded that "There would not appear to be enough arboreal lichens present . . . to make them the primary constituents of the diet of a large herd of caribou for a long period of time." Browse also provides an unsuitable permanent substitute; caribou are primarily grazers and nowhere subsist entirely on browse in winter (Cringan 1957). Browse is abundant on Cape Breton only at low elevations where it is already heavily utilized by white-tailed deer and moose in most places. Furthermore, the presence of a large caribou herd at lower elevations near human settlement would not likely have gone unobserved for 3 consecutive winters. I believe that a shift to the forest could be only temporary because of the nature of habitat and snow conditions, and could not explain the continued absence of caribou.

Starvation

An examination of climatological data from northeastern Quebec (Wilson 1971) revealed that caribou released in Cape Breton faced warmer winter temperatures and snow with greater density and hardness than in their original habitat. Could they adjust to a regime of browsing on arboreal lichens and deciduous twigs when unable to dig their accustomed craters to obtain terrestrial lichens? The evidence from sightings suggests that they foraged satisfactorily in their new habitat for at least two winters. I think it improbable that the herd starved after that period of adjustment. They were well-enough nourished to appear normal, even "fat" (McGuire 1970a; MacDonald 1971), and to support pregnancies and nurse calves. That the entire herd starved during heavy crusting of the barrens observed by MacDonald (personal communication) in winter of 1971–72 is not indicated, since the data in Figure 2 reveal that the decline was well under way by then.

Predation

Though lynx (*Lynx canadensis*) and bear (*Euarctos americanus*) inhabit the Cape Breton highlands, predation cannot be held accountable for the disappearance of the herd because caribou are not vulnerable to these predators except when very young (Murie 1944, p. 161; Bergerud 1971, p. 39).

Poaching

Poachers have been active in northern Cape Breton Island since the caribou reintroduction, but there is no verified record of caribou being taken (Warden staff, personal communication). It is unlikely that poaching would have gone undetected if conducted on the large scale necessary to eradicate the herd.

During winter when caribou grouped on the barrens, they would have been susceptible to large losses from poachers. But poachers would have been curtailed during that season by difficult access to, and travel on, the barrens and by the inability to hide signs of their activity in snow. In the snow-free months, it would have been difficult for poachers to contact the entire herd because it was widely dispersed.

Disease

The caribou's disappearance may be linked to the neurologic disease caused by the meningeal worm, *P. tenuis*. The parasite infects a high proportion of white-tailed deer in northern Cape Breton Island, and it follows *a priori* that terrestrial gastropods which carry infective larvae of the worm inhabit the region. In summer caribou were frequently sighted in areas where deer concentrated in winter (Figure 3). Caribou, when they grazed, could have accidently ingested gastropods adhering to the vegetation. Within approximately 10 days after entering the cervid host, larval *P. tenuis* would migrate to its spine, develop into the adult worm, and finally migrate to its brain (Anderson 1972, personal communication). The caribou's appearance and behavior would then show signs of neurologic disease like those described below.

Recent experiences demonstrate that neurologic disease caused by *P. tenuis* is highly lethal to caribou and that it can cause the failure of caribou introductions on deer range. Anderson (1971) describes a case in which 12 reindeer (*R. t. tarandus*) from Norway were placed on an island in Georgian Bay in 1969. White-tailed deer already on the island were infected with meningeal worm. Ten months after the introduction all the reindeer had contracted neurologic disease and seven had died. Calves became infected soon after they were weaned. In another case, 14 caribou placed on white-tailed deer range in Wisconsin succumbed to neurologic disease within 6 months (Trainer 1973). Behrend and Witter (1968) reported that a caribou placed on an island populated with white-tailed deer in Maine developed neurologic disease within 4 months. In each of the above cases, the major clinical signs exhibited by diseased caribou were abnormal and uncoordinated locomotion, bulging eyes, abnormal posture of head and neck, and a general weakness in the hind quarters which gradually progressed to complete paralysis. Afflicted caribou continued to eat and remained in good flesh. Some animals died within 3 months after infection, while others suffered only a slight disability at first and survived for a year or more, remaining normal in appearance to the casual observer.

On Cape Breton Island, caribou were widely dispersed in small groups during the warm season when gastropods are active, and would have been exposed sporadically rather than simultaneously. The observed decline of the herd over a 1- to 2-year period (Figure 2) is consistent with the time required for its gradual infection, impairment, and death from neurologic disease. The scattered carcasses resulting from such a gradual die-off would be quickly reduced by scavengers and difficult to discover in the dense forests, heaths, and bogs which cover most of the region. It is especially significant, in view of the fleeting contact maintained with the caribou, that during their decline three were observed (see Results) exhibiting signs identical to some clinical signs of neurologic disease.

It is unlikely that the introduced caribou brought diseases or parasites from Quebec which were capable of causing extensive mortality. Populations in Quebec have no record of such problems (I. Juniper, personal communication). Each caribou captured was examined before its release by a veterinary pathologist and found to be free of brucellosis and external evidence of other diseases and parasites (E. Broughton, personal communication).

Moose in Cape Breton have not been decimated by neurologic disease, but this does not contradict the possibility that caribou were. Moose, because they are more sedentary and solitary, may have a lower rate of exposure to *P. tenuis* than caribou. Moose may also be more tolerant of the parasite (Anderson and Strelive 1968). Some moose probably do die of the disease in Cape Breton as they do elsewhere in the Maritimes (Smith et al. 1964; Anderson 1972), but go unnoticed in the dense vegetation of the area.

Evidence on which to attribute the disappearance of the caribou to neurologic disease is largely circumstantial. The disease hypothesis can be confirmed only by recovery of adult *P. tenuis* in fresh or otherwise well-preserved caribou specimens. But, the disappearance clearly follows Anderson's (1972, p. 308) prediction that ". . . it will be impossible to reintroduce woodland caribou onto range now occupied by white-tailed deer with a prevalence of meningeal worm."

Acknowledgments

I am grateful to personnel of the National and Historic Parks Branch, particularly J. D. MacDonald, F. A. E. Wallace, and A. Fisk, for information on the caribou and field assistance. D. B. Lamperd and G. G. Gibson, Canadian Wildlife Service, examined white-tailed deer and their feces for meningeal worm. H. J. Smith, Health of Animals Branch, Agriculture Canada, generously provided unpublished data on meningeal worm in deer from Cape Breton Island. G. D. Tessier drew the figures, and D. R. Flook and J. E. Bryant reviewed earlier versions of the manuscript. The project was funded by Parks Canada.

Literature Cited

Anderson, R. C. 1963. The incidence, development, and experimental transmission of *Pneumostrongylus tenuis* Dougherty (Metastrongyloidea: Protostrongylidae) of the meninges of the white-tailed deer (*Odocoileus virginianus borealis*) in Ontario. Canadian Journal of Zoology 41: 775–792.

Anderson, R. C. 1971. Neurologic disease in reindeer (*Rangifer tarandus tarandus*) introduced into Ontario. Canadian Journal of Zoology 49: 159–166.

Anderson, R. C. 1972. The ecological relationships of meningeal worm and native cervids in North America. Journal of Wildlife Diseases 8: 304–310.

Anderson, R. C. and **U. R. Strelive.** 1968. The experimental transmission of *Pneumostrongylus tenuis* to caribou (*Rangifer tarandus terraenovae*). Canadian Journal of Zoology 46: 503–510.

Atlantic Resource Planners Ltd. 1972. A report on the preliminary mapping of the surficial deposits, vegetative cover and ecosystems of Cape Breton Highlands National Park. Report to Atlantic Region, National and Historic Parks Branch, Department of Indian and Northern Affairs. 121 pp.

Banfield, A. W. F. 1961. A revision of the reindeer and caribou, genus *Rangifer*. National Museum of Canada Bulletin 177. 137 pp.

Behrend, D. F. and **J. F. Witter.** 1968. *Pneumostrongylus tenuis* in white-tailed deer in Maine. Journal of Wildlife Management 32(4): 963–966.

Beil, C. E., P. L. Comeau, and **R. T. Smith.** 1971. An ecological investigation and floristic survey of the Sunday Lake – Balwin Lake – Big Southwest Brook Area in Cape Breton Highlands National Park. Report to National and Historic Parks Branch, Department of Indian and Northern Affairs. 139 pp.

Benson, D. A. 1955. Nova Scotia moose studies. M.Sc. thesis, University of Maine. 242 pp.

Benson, D. A. 1956. Ups and downs all the way —the history of big game in Nova Scotia. Sportsman's Province 1(2): 20–21. (Kentville Publishing Company, Kentville, Nova Scotia.)

Benson, D. A. 1961. Notes on the deer herd of Cape Breton Highlands National Park. Report to National and Historic Parks Branch, Department of Indian and Northern Affairs. 5 pp.

Bergerud, A. T. 1969. The population dynamics of Newfoundland caribou. Ph.D. thesis, University of British Columbia. 140 pp.

Bergerud, A. T. 1971. The population dynamics of Newfoundland caribou. Wildlife Monograph 25. 55 pp.

Bonefant, C. 1974. Resurgence of caribou in Quebec. Canadian Geographical Journal 89(1–2): 48–51.

Cameron, A. W. 1958. Mammals of the islands in the Gulf of St. Lawrence. National Museum of Canada Bulletin 154. 165 pp.

Canada Department of Transport, Meteorological Branch. 1970. Atlas of climatic maps, Series 1 to 10.

Carter, B. C. 1955. A report on the deer population in Cape Breton Highlands National Park. Canadian Wildlife Service Report CWSC15. 10 pp.

Clarke, C. H. D. 1942. Investigation of Cape Breton Highlands National Park. Report to National and Historic Parks Branch, Department of Indian and Northern Affairs. 25 pp.

Cringan, A. T. 1957. History, food habits and range requirements of the woodland caribou of continental North America. Transactions of North American Wildlife Conference 22: 485–501.

Dunn, F. D. 1965. Reintroduction of woodland caribou to Mt. Katahdin, Maine. Northeast Fish and Wildlife Conference. 5 pp.

Kelsall, J. P. 1965. Snow reconnaissance of the Cape Breton Highlands. Canadian Wildlife Service Report WE 73. 15 pp.

Kelsall, J. P. No date. Caribou introduction—Cape Breton Highlands National Park. Canadian Wildlife Service Report. 18 pp.

Lamb, I. M. 1954. Lichens of Cape Breton Island, Nova Scotia. National Museum of Canada Bulletin 132: 239–313.

MacDonald, J. D. 1969. Caribou transplant–1968 and 1969. Report to Superintendent, Cape Breton Highlands National Park. 5 pp.

MacDonald, J. D. 1971. Game report—caribou observation (April 1970–April 1971). Report to Superintendent, Cape Breton Highlands National Park. 4 pp.

MacDonald, J. D. 1972a. Game report—1971–72 caribou observations (April 1971–June 1972). Memo to Superintendent, Cape Breton Highlands National Park. 4 pp.

MacDonald, J. D. 1972b. Caribou reconnaissance (January–October, 1972). Report to Atlantic Region, National and Historic Parks Branch, Department of Indian and Northern Affairs. 3 pp.

McEwan, E. H. 1963. Reproduction of barren-ground caribou *Rangifer tarandus groenlandicus* (Linnaeus) with relation to migration. Ph.D. thesis, McGill University. 99 pp.

McGuire, L. A. 1970a. Game report—caribou observations (March 1968–February 1970). Report to Atlantic Region, National and Historic Parks Branch, Department of Indian and Northern Affairs. 5 pp.

McGuire, L. A. 1970b. Game report—caribou observations (February–April 1970). Report to Atlantic Region, National and Historic Parks Branch, Department of Indian and Northern Affairs. 2 pp.

Murie, A. 1944. The wolves of Mount McKinley. United States National Park Service Fauna Series 5. 238 pp.

Nichols, G. E. 1918. The vegetation of northern Cape Breton Island, Nova Scotia. Transactions of the Connecticut Academy of Arts and Sciences 22: 249–467.

Parker, G. R. 1972. Biology of the Kaminuriak population of barren-ground caribou. Part 1: Total numbers, mortality, recruitment, and seasonal distribution. Canadian Wildlife Service Report Series 20. 93 pp.

Scotter, G. W. 1966. Arboreal lichens as a food source for caribou in Cape Breton Highlands National Park, with brief notes on terrestrial vegetation. Canadian Wildlife Service Report 1033. 26 pp.

Simard, B. R. 1970. Report to Mr. George Rochester about my visit to Cape Breton Island National Park in support of a caribou restoration project. Report to National and Historic Parks Branch, Department of Indian and Northern Affairs. 7 pp.

Skoog, R. O. 1968. Ecology of the caribou (*Rangifer tarandus granti*) in Alaska. Ph.D. thesis, University of California. 699 pp.

Smith, H. J., R. McG. Archibald, and **A. H. Corner.** 1964. Elaphostrongylosis in Maritime moose and deer. Canadian Veterinary Journal 5(11): 287–296.

Smith, R. W. 1940. The land mammals of Nova Scotia. American Midland Naturalist 24(1): 213–241.

Trainer, D. O. 1973. Caribou mortality due to meningeal worm *Parelaphostrongylus tenuis*. Journal of Wildlife Diseases 9: 376–378.

Tufts, R. W. 1939. Newfoundland caribou liberated in Nova Scotia. Canadian Field-Naturalist 53(8): 123.

Wallace, F. A. E 1973. Ungulate survey of Cape Breton Highlands National Park, March 6–24, 1973. Report to Atlantic Region, National and Historic Parks Branch, Department of Indian and Northern Affairs. 14 pp.

Wilson, C. W. 1971. The climate of Quebec. Part One, Climatic Atlas. Climatological Studies II, Canadian Meteorological Service.

Wood, T. J. 1971. Caribou survey of Cape Breton Highlands National Park, October 9, 1971. Report to Atlantic Region, National and Historic Parks Branch, Department of Indian and Northern Affairs. 2 pp.

Received 2 January 1975
Accepted 21 February 1975

Notes

Some Previously Unpublished Historical Records of Trumpeter Swans in Ontario

The purpose of this paper is to document historical occurrences of the Trumpeter Swan (*Cygnus buccinator* Richardson) in Ontario; this may be of assistance in describing the former distribution of the species. Although the Trumpeter Swan now breeds only locally in southern Alaska, northern British Columbia, Alberta, Oregon, eastern Idaho, Montana, and Wyoming and south-western Saskatchewan (Godfrey 1966), it formerly had a much wider range (Banko 1960) including part of Ontario and perhaps into western Quebec. A specimen collected near Montreal, Quebec, date unknown, is now in the Redpath Museum, McGill University. The species, first described in 1831 (Richardson and Swainson) apparently occurred commonly along the Hudson Bay coast and inland in the 1700s and 1800s. The type specimen was collected on Hudson Bay (location and date unknown) (Richardson and Swainson 1831). Isham (1949) reported hundreds of swans, many of which were larger than others and therefore presumably trumpeters, around the islands at the mouth of the Hayes River in 1743. In the vicinity of Cumberland House, Saskatchewan, trumpeters were more plentiful than any other species of waterfowl in the 1770s, although they were also observed along the Hudson Bay coast in lesser numbers (Hearne 1958). They were the most common swan observed in the "interior fur country" (Richardson and Swainson 1831). Most of the swan skins imported by the Hudson Bay Company from Hudson Bay (and presumably James Bay) apparently were of Trumpeter Swans (Richardson and Swainson 1831). Between 1853 and 1877, the Hudson Bay Company sold 17 671 swan skins, mostly trumpeters, the annual volume fluctuating from 1312 in 1854 to 122 in 1881 (Coale 1915).

Although the species migrated through Ontario, apparently in large numbers, occurred regularly in the vicinity of Toronto (Hincks 1865), and hence may have bred in the province, material evidence is limited.

Materials and Methods

Specimen evidence from the Royal Ontario Museum (ROM) and National Museum of Canada was examined and the previous identification confirmed. In several instances it was necessary, in the absence of specimen evidence based upon identification by recognized ornithologists, to accept the validity of records. In these instances, the supporting evidence and history of the specimen is present.

Results

Specimen Records

(1) During investigations at the site of "Old House" (Fort Albany), occupied by French and English traders prior to 1721, W. Kenyon, ROM Department of Archaeology (personal communication) found bones and bone fragments which were identified subsequently by D. Baldwin, formerly of the ROM Department of Ornithology as being Trumpeter Swan specimens. These bones are presently in the Royal Ontario Museum collection. Many had apparently been fashioned into ornaments or implements. As virtually all of these birds had probably been traded by local Indians, it is not possible to determine the exact area or date of collection.

(2) W. Hincks, professor of natural history at University College, Toronto, 1854–1871, was aware of the tracheal and sternal characteristics distinguishing the Trumpeter Swan from the Whistling Swan (*Cygnus columbians*), when he registered a specimen shot near Toronto in the Catalogue of Specimens at the University of Toronto (1857, p. 176). The specimen was prepared by Miss Hadgraft in 1857 but has since been lost.

(3) On 21 January 1863, a swan specimen was taken at Toronto and was examined that winter by S. W. Passmore, Toronto taxidermist (Hincks 1865). The bird was initially identified by Hincks as *Cygnus passmori* (a new species) and not *C. buccinator*. Specific locality and date are unknown although the bird was photographed at Toronto prior to collection. The skin of this specimen, which was later identified as that of an immature Trumpeter Swan (L. L. Snyder, unpublished notes, Royal Ontario Museum) was sent to France in 1867 as part of an exhibition. The exhibit, including the swan skin, was never returned to Canada.

(4), (5) On 10 April 1864, two immature male swans were collected near Toronto. Sternal examination indicated that the birds were trumpeters (Hincks 1865). Two immature trumpeter specimens, with incomplete data, currently in the Royal Ontario Museum collection (34.2.26.1 and

34.2.26.2) were thought by J. H. Fleming to be the birds mentioned by Hincks (Snyder, unpublished notes, Royal Ontario Museum).

(6), (7) Hincks (1868) noted that during the winter of 1866–67, an adult female and immature male trumpeter were shot at Toronto. Although it is likely that these birds were indeed trumpeters, it has been suggested by Snyder (unpublished notes, Royal Ontario Museum) that the latter bird may have been a sub-adult; this suggestion was based upon descriptive material submitted by Hincks. Both specimens have since been lost.

(8) About 1878 an adult swan was shot on Lake St. Clair. This individual was donated by J. H. Fleming (Fleming Number 15, 785) to the Royal Ontario Museum and the specimen has been recorded by Coale (1915) as a Trumpeter Swan. The specimen label indicates the collection location as St. Clair. Additional data suggest that the bird was prepared by S. Herring, a Toronto taxidermist, and was subsequently reduced to a study skin.

(9) An adult female swan was killed in 1884 on the St. Clair Flats (Coale 1915) by G. Warin. This specimen is presently in the National Museum of Canada collection (catalogue 1911) and there is no doubt that the bird is a trumpeter.

Additional Evidence

(1) On 7 August 1679 Father Louis Hennepin (1903) reported that swans were very common on Lake St. Clair. It is unclear, however, whether the observation refers to summer or fall sightings. As it is likely that Whistling Swans staged in the vicinity of Lake St. Clair then, as they do now, in spring and fall, it is possible that Hennepin's reference does not indicate evidence that trumpeters bred at Lake St. Clair at that time.

(2) Snyder and Logier (1931) noted that a painting of a Trumpeter Swan, dated 6 April 1847, was probably based upon a specimen taken in southern Ontario, likely in the vicinity of Long Point.

(3) Small (1860) reported that two "Bugle Swans," weighing between 35 and 40 pounds, were taken by hunters at Baptiste Creek, St. Clair Flats, in November 1860. Although the large size of these birds is exaggerated and would suggest that they were probably trumpeters, the present fall distribution of Whistling Swans in southern Ontario indicates that these birds might have been the latter species.

(4) McIlwraith (1886), who may have been aware of the anatomical differences between Whistling and Trumpeter Swans, observed two birds which were killed (date unknown) at Long Point, Lake Erie. Dr. Ganrier (McIlwraith 1886) reportedly shot one at Mitchell's Bay, Lake St. Clair. Neither of these records are adequately documented. Furthermore, McIlwraith apparently separated Trumpeter from Whistling Swans solely on the basis of external anatomy. In addition, two specimens from the Dr. Ganrier (=) Ganrier collection currently at the Royal Ontario Museum originally catalogued as trumpeters, are actually Whistling Swans, thus casting doubt on the validity of his other swan identifications.

Discussion

Historical specimen records indicate that Trumpeter Swans occurred as transients in southern Ontario west of Lake Ontario, until about 1900. Additional evidence suggests that the birds may have occurred commonly in the vicinity of Toronto and Lake St. Clair, especially during fall migration. There is no material evidence from Ontario indicating that the species occurred east of Toronto although H. Savage (personal communication), Department of Ornithology, Royal Ontario Museum, found a trumpeter tibia and carpal bone at Coteau-du-lac, Quebec, a site occupied by Indians from 800 B.C. to 300 A.D., and by the British in the early 1800s. Furthermore, there is specimen evidence from Michigan (Coale 1915) and Illinois (Parmalee 1958) suggesting that the species may have been abundant in those states prior to 1900.

There is no material evidence that trumpeters have bred anywhere in Ontario. From Hennepin's (1903) references to swans on Lake St. Clair it cannot be implied that trumpeters have bred in that area. Therefore, on the basis of these data, it is not possible definitely to include Ontario in the former breeding range of the Trumpeter Swan although the species occurred in southwestern Ontario and in the vicinity of James Bay on migration and probably wintered in the vicinity of Toronto.

Literature Cited

Banko, W. E. 1960. The Trumpeter Swan, its history, habits, and population in the United States. U.S. Fish and Wildlife Service, North American Fauna 63.

Coale, H. K. 1915. The present status of the Trumpeter Swan (*Olor buccinator*). Auk 32: 82–90.

Godfrey, W. E. 1966. The birds of Canada. National Museum of Canada Bulletin 203. 428 pp.

Hearne, S. 1958. A journey from Prince of Wale's Fort in Hudson Bay to the Northern Ocean 1769, 1770, 1771, 1972. *Edited by* R. Glover, Macmillan Co., Toronto. p. 290.

Hennepin, L. 1903. A new discovery of a vast country in America. McClurg and Co., Chicago. p. 109.

Hincks, W. 1865. On *Cygnus passmori*, a supposed new American swan. Journal of Proceedings of the Linnaean Society, London, Zoology 8: 1–8.

Hincks, W. 1868. Further observations on *Cygnus passmori* and *C. buccinator*. Journal of the Proceedings of the Linnaean Society, London, Zoology 9: 298–300.

Isham, J. 1949. James Isham's observations on Hudson Bay, 1743. The Champlain Society, Toronto. p. 127.

McIlwraith, T. 1886. The birds of Ontario. Journal and Proceedings of the Hamilton Association 1: 93.

Parmalee, P. W. 1958. Remains of rare and extinct birds from Illinois Indian sites. Auk 75(2).

Richardson, J. and **W. Swainson.** 1831. Fauna borealis-americana. Part II. Murray, London. pp. 410–480.

Small, H. B. 1860. *In* the Canadian handbook and tourist's guide. p. 157.

Snyder, L. L. and **E. B. S. Logier.** 1931. A faunal investigation of Long Point and vicinity. Transactions of the Royal Canadian Institute 18: 159.

R. M. ALISON

Wildlife Branch, Ministry of Natural Resources
Whitney Block, Queen's Park
Toronto, Ontario M7A 1W3

Received 13 December 1974
Accepted 24 March 1975

Ross' Goose in Quebec

On 30 September 1974 a hunter participating in a controlled hunt of Greater Snow Geese (*Anser caerulescens atlanticus*) at the Cap Tourmente National Wildlife Area, Quebec (47°N, 70°W), shot a very small white goose. Measurements of exposed culmen (39.1 mm), wing length (386 mm), and weight (1650 g), as well as the presence of warty protuberances on the bill, confirmed that the bird was a Ross' Goose, *Anser rossii* (Trauger et al. 1971). Plumage and cloacal examination revealed it was an adult female.

On 12 October 1974, while data was being collected on age-ratios and family groups in a flock of Greater Snows, a lone adult Ross' Goose was spotted by L.S.M.-P., as it swam by itself among the Greater Snows. As the tide was high, the geese were close inshore at the upstream end of the Cap Tourmente National Wildlife Area. The bird was viewed and watched for several minutes through a 25× telescope from an elevated blind at a range of not more than 100 yards. There was no difficulty in recognizing the goose by its much smaller size and characteristically small head and bill.

These are the first authenticated records of Ross' Goose in Quebec and apparently the first time it has been observed in the company of Greater Snow Geese. Dzubin (1965) and Prevett and MacInnes (1972) have documented a recent increase of Ross' Geese in central North America, well to the east of their traditional range. As the numbers breeding on Southampton Island and the west side of Hudson Bay are still very small, the probability of strays being caught up in migratory groups of Greater Snow Geese remains very low.

We are grateful to hunter J. Butt for having donated the specimen now deposited in the National Museum of Natural Sciences in Ottawa.

Literature Cited

Dzubin, A. 1965. A study of migrating Ross's Geese in western Saskatchewan. Condor 67: 511–534.

Prevett, J. P. and **C. D. MacInnes.** 1972. The number of Ross' Geese in central North America. Condor 74(4): 431–438.

Trauger, D., A. Dzubin, and **J. P. Ryder.** 1971. White geese intermediate between Ross' Geese and Lesser Snow Geese. Auk 88(4): 856–875.

AUSTIN REED[1]
L. S. MALTBY-PREVETT[2]

[1] Canadian Wildlife Service
1141 route de l'Eglise
Quebec G1V 3W5
[2] Canadian Wildlife Service
2721 Highway 31
Ottawa, Ontario K1A 0H3

Received 28 October 1974
Accepted 5 February 1975

Second Record of the Blue-spotted Salamander from Labrador

The occurrence of the Blue-spotted Salamander, *Ambystoma laterale*, in Labrador has been previously based on a single specimen taken at Goose Bay (see Figure 1), 25 July 1948, by W. E. Beckel (National Museum of Natural Sciences 2156) and reported by Bleakney (1954). This specimen was listed as *Ambystoma jeffersonianum* prior to the revision of salamanders of this species complex by Uzzell (1964), who re-assigned it to *A. laterale*. It is a male, 98 mm total length and 50 mm snout to anterior margin of the vent, and fits within *A. laterale* variation.

We report here a second Labrador record, this one from the extreme western portion. The specimen was collected 22 September 1974 by John Porter of Wabush, Labrador, about 10 miles south of Wabush, at approximately 52°48′ N, 66°49′ W (see Figure 1). It was taken at the edge of a small bog, and is a juvenile approximately 50 mm total length and 30 mm from snout to anterior margin of the vent. It has been catalogued at NMNS 16241.

This record is of considerable zoogeographic interest. Bleakney (1958), in his review of the zoogeography of amphibians and reptiles of eastern Canada, delimited seven herpetofaunal zones for the area; he correlated them with the approximate limits of certain species and with values for environmental temperature indices (the mean July temperature multiplied by the length of the growing season). Herpetofaunal Section 5 was given a northern "isopleth" running roughly from near the southern end of James Bay east to just north of the north shore of the Gulf of St. Lawrence, as is indicated in Figure 1. The environmental temperature indices just south of this line were calculated as just over 8000 (expressed by Bleakney as 8.0 for convenience). The Goose Bay record was included in a Hamilton Inlet region designated as Section 5A with an index of 8.6. The Wabush record reported here, however, is near an index rating of 6.7. Another new northern extension for *A. laterale*, in western Quebec at Lac Attila (Bider and MacCulloch 1975), is also north of the line for Section 5 and is near an index of 6.6. Evidence is therefore accumulating that the line for Herpetofauna Section 5, if based on the limit of *Ambystoma laterale*, should be moved north nearly to the position of Section 6. Section 6, however, is based largely on the northern limit of *Bufo americanus*, and this must also be moved somewhat north to Richmond Gulf in the west, as pointed out by Cook (1964). It is possible that Section 5A is not distinct and can be included within a revised limit for Section 5.

Thus the cold tolerance of *Ambystoma laterale*, as reflected by the environmental temperature index devised by Bleakney (1958), is lower than previously indicated and the hypothesis that the Hamilton Inlet region may be an isolated northern warm pocket for amphibians (a possible hypsithermal period relict area) is questionable. Two other species thought to be associated with Section 5A, the Spring Peeper, *Hyla crucifer*, and the Leopard Frog, *Rana pipiens*, have now been recorded for Lac Nathalie, 53°29′ N, 77°26′ W (MacCulloch and Bider 1975), also north of the Bleakney limit for Herpetofaunal Section 5.

Our appreciation is expressed to John Porter for the specimen, and to James A. Johnston, Herpetology Section, National Museum of Natural Sciences, for preparing the map.

Literature Cited

Bleakney, J. S. 1954. Range extensions of amphibians in eastern Canada. Canadian Field-Naturalist 68(4): 165–171.

Bleakney, J. S. 1958. A zoogeographical survey of the amphibians and reptiles of eastern Canada. National Museum of Canada Bulletin 155: 1–119.

Cook, F. R. 1964. A northern range extension for *Bufo americanus* with notes on *B. americanus* and *Rana sylvatica*. Canadian Field-Naturalist 78(1): 65–66.

MacCulloch, R. D. and **J. R. Bider**. 1975. New records of amphibians and garter snakes in the James Bay area of Quebec. Canadian Field-Naturalist 89(1): 80–82.

Uzzel, T. M., Jr. 1964. Relations of the diploid and triploid species of the *Ambystoma jeffersonianum* complex (Amphibia, Caudata). Copeia 1964(2): 257–300.

FRANCIS R. COOK[1]
JOHN FOLINSBEE[2]

[1] Herpetology Unit
National Museum of Natural Sciences
Ottawa, Ontario K1A 0M8
[2] Newfoundland Wildlife Service
Wabush, Labrador

Received 10 February 1975
Accepted 6 March 1975

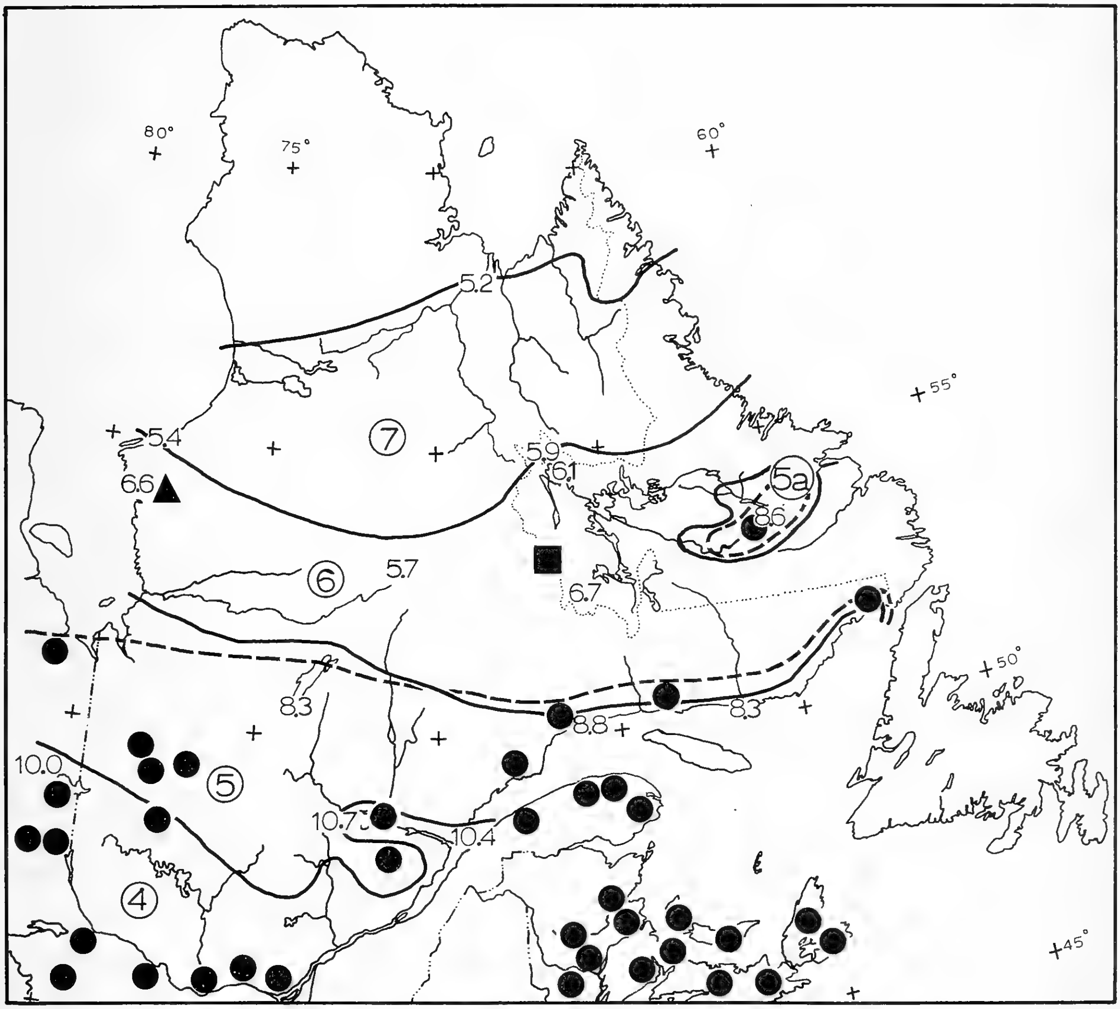


FIGURE 1. The distribution of the Blue-spotted Salamander, *Ambystoma laterale*, in eastern Canada. The solid square shows the location of the new record. The solid triangle is the location where MacCulloch and Bider (1975) report the species. Solid circles are records of *A. laterale* within the accepted continuous range, based on Bleakney (1958) and National Museum of Natural Sciences specimens.

Solid lines and circled numbers denote the herpetofauna sections given by Bleakney (1958). The dashed line is the northern limit for salamanders, after Bleakney (1958). Decimal numbers (e.g. 8.6) are environmental temperature index values from Bleakney (1958).

Pine Siskin on Cornwallis Island, Northwest Territories

On 5 and 6 August 1973 a Pine Siskin, *Spinus pinus* (Wilson), was observed near the laboratory of the Char Lake Project at Resolute Bay, Cornwallis Island, Northwest Territories, 74°41′ N, 94°53′ W. The bird visited a feeding station set up just outside the kitchen window to attract Snow Buntings. It appeared in good condition and visited the station several times in a 24-h period. During the last of its visits I was able to photograph it.

W. E. Godfrey (1966. The birds of Canada. National Museum of Canada Bulletin 203. 428 pp.) stated that the Pine Siskin breeds as far north as Fortymile, Kluane Lake, and Watson Lake in the Yukon, north to Fort Norman in the Mackenzie Valley, Lake Athabasca and Nipawin in Saskatchewan, The Pas and Lake St. Martin in Manitoba, and probably as far north as southern James Bay in Ontario. It has been recorded rarely as far north as Great Whale River and the Knob Lake region in Quebec and breeds at Hamilton Inlet in Labrador and throughout Newfoundland. L. L. Snyder (1957. Arctic birds of Canada. University of Toronto Press, Toronto. 310 pp.) did not include the Pine Siskin in his appendix list of species that are characteristically sub-arctic or that occur occasionally or erratically in the Arctic.

The individual sighted on Cornwallis Island was therefore many hundreds of miles north of the normal range of the species.

I thank W. E. Godfrey for confirming the identification of the bird from my color slides.

ALEXANDER W. CARON

Department of Zoology
University of Toronto
Toronto, Ontario M5S 1A1

Received 18 November 1974
Accepted 20 February 1975

Range Extension of the Western Pine Elfin, *Callophrys eryphon* (Lepidoptera, Lycaenidae), in Ontario

The western pine elfin, *Callophrys eryphon* (Boisduval), occurs throughout central and western North America, its range extending as far east as Nakina, Thunder Bay District, Ontario (J. C. E. Riotte. Butterflies and skippers of northern Ontario. The Mid-Continent Lepidoptera Series, Volume 2, Number 21, February 1971) and Chippewa County, Michigan (M. C. Nielsen. Occurrence of *Callophrys eryphon* (Lycaenidae) in Michigan. Journal of the Lepidopterists' Society 20: 41–42, 1966). The Royal Ontario Museum has one specimen, however, which was collected at Port Hope, Durham County, Ontario, in 1912 (J. C. E. Riotte, personal communication).

Recently a series of seven *Callophrys*, taken by the author on 20 May 1974 in Algonquin Park, Ontario, were examined by J. D. Lafontaine of the Biosystematics Research Institute, Canada Department of Agriculture, and two, one male and one female, were identified as *Callophrys eryphon*. The others were two *C. niphon*, two *C. polios*, and one *C. augustinus*. The specimens were taken while they were sunning themselves on an abandoned logging road in an area which is primarily dry sandy pine barrens with a dense undergrowth of *Kalmia* species.

The exact location is at 46°06′ N, 78°19′ W, in Fitzgerald Township, just inside the northern boundary of Algonquin Park, about a mile south of the road from Deux Rivières to Brent. This is approximately 550 miles southeast of Nakina and 330 miles east of Chippewa County, thus representing a range extension not only for Ontario but for the species.

The female *eryphon* is now in the Canadian National Collection and the male is in my own collection.

I thank J. D. Lafontaine for identifying the specimens and for encouraging me to write this note.

ROSS A. LAYBERRY

530 Byron Avenue
Ottawa, Ontario K2A 0E3

Received 7 January 1975
Accepted 4 March 1975

Seligeria tristichoides, a Moss New to the West

The Seligerias are miniature mosses, highly distinctive but too tiny to be seen by the casual or uninformed collector. The half dozen species of North America are rare and local in distribution but widely scattered in areas offering a suitable substrate. They are especially to be found in the Gaspé, the Great Lakes region, and the Canadian Rocky Mountains on limestone in moist protected places, on the face of shaded cliffs near water, on the undersides of rock overhangs, or sometimes on boulders or mere pebbles at wooded lakeshores or in stream valleys. Frederick J. Hermann, well known as a specialist in the taxonomy of sedges but also an avid and competent bryologist, recently sent me a collection of *Seligeria tristichoides* Kindb. from British Columbia. This species, one of the rarest of the genus, was originally described on the basis of Norwegian material. It is also known from Finland and Sweden, and (according to Nyholm's *Illustrated Moss Flora of Fennoscandia*, 1954) also from the Pyrenees and the Caucasus. It has been found in two localities in eastern North America, at Lake Willoughby, Vermont, and in the Gaspé of Quebec. It has not been reported previously from the west.

The only species listed by Lawton (1971) are *S. campylopoda* Macoun & Kindb., *S. donniana* (Sm.) C. M., and *S. recurvata* (Hedw.) BSG, the same three credited to the flora of British Columbia in Schofield's (1968) checklist. *Seligeria campylopoda* is the only species included in Flower's *Mosses: Utah and the West* (1973). Koch (1950) recorded no Seligerias from California, and Weber (1973) included none in his *Guide to the Mosses of Colorado.* The only species in the Alaskan flora, as presented in Worley and Iwatsuki's (1970) checklist, is *S. polaris* Berggr., a species of arctic range. Steere (1965), however, had already reported *S. campylopoda* from arctic Alaska, from Driftwood and Smith Lakes, and the name was added to the checklist in a supplement by Worley and Iwatsuki (1971).

The specific epithet *tristichoides* suggests a three-ranked arrangement of leaves, as in *S. tristicha* (Brid.) BSG, an Old World species more properly known as *S. trifaria* (Brid.) Lindb. The latter was included in Britton's (1973) revision of the genus and also in Grout's *Moss Flora of North America* (1936) on the basis of Sullivan's *Musci Alleghanienses* no. 142, presumably from Ohio. That material belongs, however, to *S. calcarea* (Hedw.) BSG, and the name can accordingly be omitted from any consideration of American Seligerias. The resemblance of *S. tristichoides* to *S. trifaria* should not be over-emphasized. The leaves are not particularly three-ranked; they are loosely disposed, in seeming disarray, except on sterile stems and innovating branches where they are, at best, obscurely tristichous. Outstanding and recognizable features of *S. tristichoides* include short, stout, slightly curved setae, and peristomate yet systylious capsules which are obconic or hemispheric before dehiscence and even more wide-mouthed when dry and empty. The systylious nature of the capsules—that is, the adherence of the operculum to the tip of the columella after dehiscence—is made the more interesting because of a well-formed peristome. Systyly, a most unusual phenomenon among mosses, is nearly always associated with the absence of a peristome, serving a function in regulating spore dispersal normally controlled by movements of peristome teeth.

Collection data from Dr. Hermann's specimen from British Columbia are as follows: On the face of a calcareous bluff beside Bridal Falls, Popkum, 22 miles west of Hope, *J. J. Hermann 25864*, August 20, 1974 (*in herb.* MICH). The specimen is also represented by duplicates at the Botanisches Museum (Berlin), the National Herbarium of Canada, the Chicago Natural History Museum, the University of Tennessee, and the University of Washington. In North America and elsewhere, the species appears to be limited to damp shaded cliffs and boulders of a calcareous nature. The only previous information on the North American habitat accompanies a specimen collected by myself and Harry Williams at Mont Ste. Anne above Percé, Gaspé Sud, Quebec: on a damp, shaded chimney of a cliff consisting chiefly of limestone pebbles in conglomerate (no. 10850, *in herb.* National Museum of Natural Sciences, Canada). Mönkemeyer (1927) spoke of dolomite and calcareous shales as substrates in Finland and Scandinavia.

Distributional information presented here is based on a search of herbaria at the National Museum of Natural Sciences, Canada, Duke University, the University of Michigan, and the New York Botanical Garden.

Literature Cited

Britton, Elizabeth G. 1913. Seligeriaceae. North American Flora 15: 71–75.

Flowers, S. 1973. Mosses: Utah and the West. Brigham Young University Press, Provo, Utah. xii + 567 pp.

Grout, A. J. 1936. Moss flora of North America. Volume 1. Published by the author, Newfane, Vermont. pp. 49–52.

Koch, L. F. 1950. Mosses of California: an annotated list of species. Leaflets of Western Botany 6: 1–40.

Lawton, Elva. 1971. Moss flora of the Pacific Northwest. Hattori Botanical Laboratory, Nichinan. xiii + 362 pp., plates 1–195.

Mönkemeyer, W. 1927. Die Laubmoose Europas. Akademische Verlagsgesellschaft, Leipzig. x + 960 pp.

Nyholm, Elsa. 1954. Illustrated moss flora of Fennoscandia II. Musci. Fascicle 1. Gleerups, Lund. pp. 34–38.

Schofield, W. B. 1968. A selectively annotated checklist of British Columbia mosses. Syesis 1: 163–175.

Steere, W. C. 1965. The boreal bryophyte flora as affected by Quaternary glaciation. *In* The Quaternary of the United States: a review volume for the VII Congress of the International Association for Quaternary Research. *Edited by* H. E. Wright, Jr. and D. G. Frye. Princeton University Press, Princeton, New Jersey. pp. 485–495.

Weber, W. A. 1973. Guide to the mosses of Colorado. Keys and ecological notes based on field and herbarium studies. Institute of Arctic and Alpine Research, University of Colorado Occasional Paper 6. iii + 48 pp.

Worley, I. A. and **Z. Iwatsuki.** 1970. A checklist of the mosses of Alaska. Bryologist 73: 59–71.

Worley, I. A. and **Z. Iwatsuki.** 1971. Additions to the checklist of Alaskan mosses. Bryologist 74: 376.

HOWARD CRUM

Herbarium
University of Michigan
Ann Arbor, Michigan 48104

Received 4 February 1975
Accepted 18 February 1975

Sight Record of the White Wagtail near Vancouver, British Columbia

On 2 March 1973 a White Wagtail (*Motacilla alba*) was discovered by Genevieve Arnold and Rick Jerema along the banks of the Coquitlam River, British Columbia, just above its confluence with the Fraser River. This locality is about 14 miles east of downtown Vancouver. During the next three weeks the bird was seen at this locality by numerous experienced observers including the authors. It was last observed on 21 March 1973. Attempts at photography were unsuccessful; however, detailed notes on the bird were made in the field by several observers, at least one of whom (Shepard) had had previous field experience with the species in Japan.

A description of the bird, based on field notes taken by the authors on 5 March and by G. Allen Poynter on 4 March, is as follows. The bird was larger than a Water Pipit (*Anthus spinoletta*) but much smaller than an American Robin (*Turdus migratorius*). It was very slender, with a very long tail. The upperparts were medium gray, including the cap, but the front of the cap was nearly black. The forehead and area above the eye were white, with a dark line through the eye. There were whitish patches on the wings, noticeable particularly in flight. The underparts were white, except for a striking black patch on the breast, shaped more or less like a triangle with the apex pointed downward. The tail was black with white sides. The bill was slender and pointed, and was about one-third to one-half the length of the head; both bill and legs were black.

The bird's call was recorded as a double-noted, pipit-like "tchizik," and was given only in flight. When on the ground, the wagtail moved by walking rather than by hopping. It wagged its tail vigorously when sitting still, but not when walking. The flight was deeply undulating. The bird was observed as close as 50 feet away, with equipment ranging from 7 × 35 binoculars to a 20× to 45× zoom spotting scope. The Coquitlam River at the point of the observation is subject to some tidal influence; at low tide the wagtail foraged along the muddy banks of the river, but at high tide it foraged in a nearby pasture with several hundred American Robins and Starlings (*Sturnus vulgaris*). On one occasion, it perched about 70 feet above ground in a group of large black cottonwoods (*Populus trichocarpa*).

The complete field notes on which the description above is based are on file at the British Columbia Provincial Museum in Victoria. R. Wayne Campbell, Assistant Curator of Birds and Mammals at the Museum, tells us that he considers this evidence acceptable for the inclusion of the White Wagtail on the British Columbia list. From the description of the bird, and from geographic considerations, we believe that it probably belonged to the subspecies breeding in northeast Siberia, *Motacilla alba ocularis*.

The White Wagtail has been considered hypothetical in Canada (Godfrey 1966) on the basis of an old, somewhat dubious sight record from Fort Chimo, Quebec, and a bird which travelled on a ship from Ireland to Labrador in 1939 (Martin 1939). There is, however, one previous record for Canada, a single bird seen by R. Wayne Campbell (details to be published elsewhere) on 4 July 1972 at Canoe Lake, in the Richardson Mountains near the Mackenzie Delta. A specimen of *M. a. ocularis* was taken at La Paz, Baja California on 9 January 1882 (Bent 1950, p. 13) and there are two other recent North American sight records of White Wagtails outside Alaska: one, believed to be *ocularis*, of which a photograph has been published (Crowell and Nehls 1974) seen at Eugene, Oregon from 3 February to 26 March 1974; and another, seen in northeastern Sonora, Mexico on 30 April 1974 (Alden and Mills 1974). Until recently considered to be of accidental occurrence in Alaska, the White Wagtail has been recorded there with increasing frequency in the last few years (e.g., see Gibson 1970), especially in the western Seward Peninsula. Breeding was recorded at Wales and Nome, Alaska in 1972 (Gibson and Byrd 1972). As long ago as 1916, Hersey (quoted by Bent 1950, p. 13) stated that "there are reasons for believing that the species is slowly extending its range and becoming established on the [Alaskan] coast." If this range expansion continues, we may expect that the White Wagtail will be recorded at least occasionally, if not regularly, in future along the west coast of North America.

We thank R. Wayne Campbell for assistance with this note.

Literature Cited

Alden, S. and **S. Mills.** 1974. Southwest region. American Birds 28: 836–838.

Bent, A. C. 1950. Life histories of North American wagtails, shrikes, vireos, and their allies. United States National Museum Bulletin 197.

Crowell, J. B. and **H. B. Nehls.** 1974. Northern Pacific Coast region. American Birds 28: 679–684.

Gibson, D. D. 1970. Alaska region. American Birds 24: 706–707.

Gibson, D. D. and **G. V. Byrd.** 1972. Alaska region. American Birds 26: 890–893.

Godfrey, W. E. 1966. The birds of Canada. National Museum of Canada Bulletin 203. 428 pp.

Martin, C. P. 1939. Land birds occasionally conveyed across the Atlantic. Canadian Field-Naturalist 53: 121.

WAYNE C. WEBER[1]
MICHAEL G. SHEPARD[2]

[1] 302–170 East Fourth Street
North Vancouver, British Columbia V7L 1H6
[2] British Columbia Provincial Museum
Vancouver, British Columbia V8W 1A1

Received 24 December 1974
Accepted 10 February 1975

A New Distribution Record for Brassy Minnow in Northwestern Alberta

In 1974 a number of fish collections were made as part of a lake and stream survey program in the Peace River country of Alberta. One of the species of fish collected from Musreau Lake (54°33′ N, 118°37′ W) was identified as brassy minnow, *Hybognathus hankinsoni* Hubbs, a species of fish which has been officially recorded only in south-eastern Alberta (Paetz and Nelson 1970) although one other specimen has been reported from the Athabasca system (Wayne Roberts, personal communication). The natural range of the brassy minnow is described by Scott and Crossman (1973) as occurring from the upper St. Lawrence River and Lake Champlain region of New York, west through southern Ontario and Michigan, west through the Arkansas and Missouri Rivers to Colorado, Wyoming and Montana, north to Alberta, and in British Columbia in the Fraser River and headwaters of the Peace River.

Musreau Lake, located approximately 70 km south of the city of Grande Prairie, has a surface area of 545 ha and a mean depth of 5.6 m. The lake has only one outlet which flows into the Kakwa River, which in turn flows into the Smoky River of the Peace River drainage. The water temperature in Musreau Lake on 12 July 1974 was 15.5°C, the pH was 7.9, and the total alkalinity and hardness were 75 and 80 ppm, respectively. The brassy minnows were collected by G. Brosseau and C. Harrington who seined in a shallow, sandy beach area of the northwestern portion of the lake on 27 July 1974. Other fishes found in the lake were *Salmo gairdneri* (introduced), *Salvelinus malma*, *Catostomus*

catostomus, *Catostomus commersoni*, *Semotilus margarita*, and *Lota lota*.

Approximately 80 specimens of *Hybognathus hankinsoni* were taken at Musreau Lake but only 15 were preserved in formaldehyde and kept for identification. Twelve of these specimens are kept at the Fish and Wildlife laboratory in Peace River and the other three have been sent to the Museum of Zoology, University of Alberta, Edmonton. Measurements made on a representative sample of 10 of the specimens were as follows: total length 47.4 mm to 80.6 mm; fork length 42.4 mm to 70.7 mm; preserved weight 0.9 g to 4.7 g; lateral line scales 37 to 40; scales above lateral line six to seven; and fin rays seven to eight; dorsal fin rays eight; scale circuli 13 to 19. Only a faint yellowish color remained on the sides after 4 months of preservation.

The finding of *Hybognathus hankinsoni* in Musreau Lake is especially interesting because the new location lies between the northern British Columbia and southern Alberta populations and may help support one explanation of how this species reached the upper Peace River system from the Missouri drainage. According to McPhail and Lindsey (1970) it was quite possible that the Prince George area and the Peace River areas were covered by large postglacial lakes which drained southeast through the Rocky Mountains, thereby allowing the dispersal of fish from the Missouri system into northern waters. McPhail and Lindsey (1970) predicted that if this southeast drainage route did once exist then the brassy minnow would be discovered in some additional Alberta or Saskatchewan waters that lie along the supposed dispersal route. The discovery of the brassy minnow in Musreau Lake lends support to the hypothesis that a postglacial southeast drainage route did exist.

My thanks to Martin Paetz, Chief Fishery Biologist, Alberta Department of Lands and Forests, and Wayne Roberts, Museum of Zoology, University of Alberta, for their confirmation of my identification.

Literature Cited

McPhail, J. D. and **C. C. Lindsey.** 1970. Freshwater fishes of northwestern Canada and Alaska. Fisheries Research Board of Canada, Bulletin 173. 381 pp.

Paetz, M. J. and **J. S. Nelson.** 1970. The fishes of Alberta. Government of Alberta, Queen's Printer, Edmonton. 282 pp.

Scott, W. B. and **E. J. Crossman.** 1973. Freshwater fishes of Canada. Fisheries Research Board of Canada, Bulletin 184. 966 pp.

FRANK G. BISHOP

Fish and Wildlife
Alberta Lands and Forests
Box 1348
Peace River, Alberta T0H 2X0

Received 21 January 1975
Accepted 10 February 1975

Sightings of New Zealand Shearwaters in the Northern Gulf of Alaska

From the *R/V Thomas G. Thompson*, in the northern Gulf of Alaska between 16 and 29 September 1974, nine New Zealand Shearwaters (*Puffinus bulleri*) were observed on five different occasions (see Figure 1). On 17 September two New Zealand Shearwaters were sighted at 1100 hours about 73 km at sea (59°18′ N, 141°35′ W) and at 1450 hours three more were observed about 46 km at seat (59°41′ N, 142°16′ W). On 22 September two single New Zealand Shearwaters were sighted at 1345 and 1525 hours, both about 30 km at sea (59°46′ N, 143°51′ W and 59°45′ N, 143°22′ W, respectively). On 24 September at 1210 hours two New Zealand Shearwaters were observed 27 km at sea (59°48′ N, 142°42′ W). Although all Shearwaters were observed within 200 m of the ship; on two occasions they passed directly in front of the bow of the ship. The characteristic blackish inverted "W" on the back and wings, black cap, dark tail coverts, and all white underparts were distinguishing features observed.

The AOU Checklist (1957) lists only three records of New Zealand Shearwaters for North America. Since 1957, however, the species has been observed regularly in fall off the coast of California (see *Audubon Field Notes* and *American Birds* for details). With the advent of regular pelagic bird trips, New Zealand Shearwaters have been reported regularly (in *American Birds*) in that area and off the northern Pacific coast.

Campbell (1971) recently reviewed records of New Zealand Shearwaters off the British Columbia coast and suggested that they are regular fall migrants there. Gruchy et al. (1972) reported siting 200–300 New Zealand Shearwaters at Ocean Station Papa (50°N, 145°W) in 1969. The previous northernmost sighting of the New

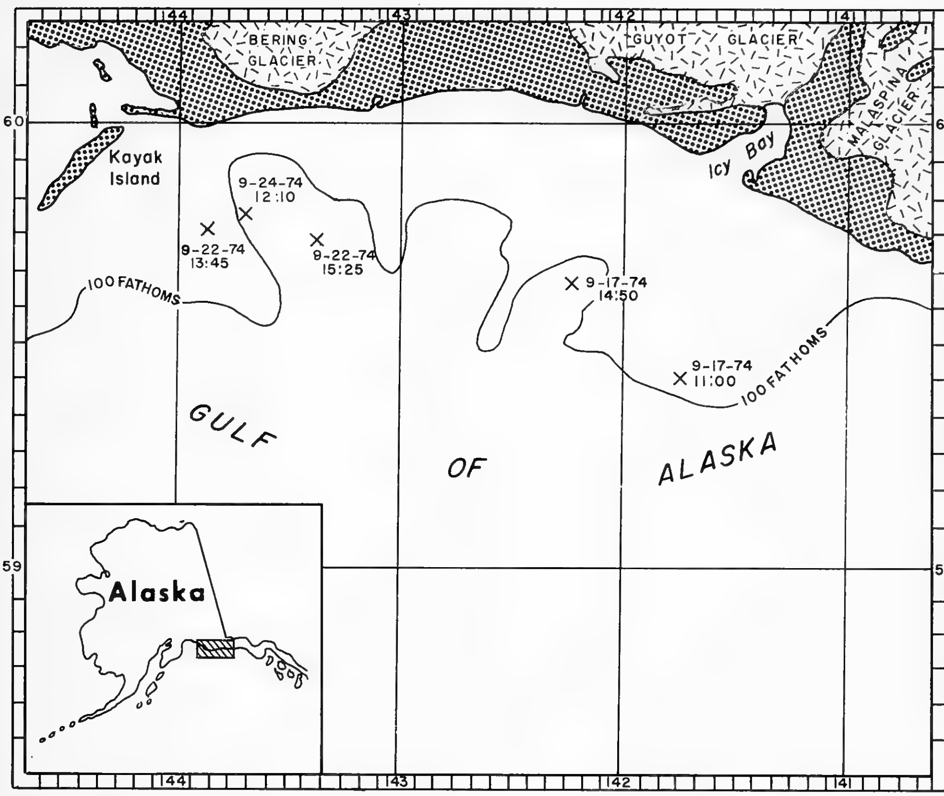


FIGURE 1. Map showing locations where New Zealand Shearwaters were observed in September 1974.

Zealand Shearwater was made off the British Columbia coast at 50°21′ N, 130°15′ W (Nichols 1927). My records are the first sightings off the Alaskan coast.

The cruise of the *R/V Thompson* was conducted by the Office of Marine Geology, U.S. Geological Survey, to acquire geophysical information. The cruise represented the first time that at-sea observations had been obtained in the northeast Gulf in September. The lack of observers may account for the fact that the New Zealand Shearwater had not been reported off the northern Gulf of Alaska coast.

I am grateful to Daniel D. Gibson and R. Wayne Campbell for their helpful criticism of an earlier draft of this note.

Literature Cited

American Ornithologists' Union. 1957. Checklist of North American birds. 5th edition. The Lord Baltimore Press, Inc., Baltimore.

Campbell, R. W. 1971. First Canadian specimen of New Zealand Shearwater. Canadian Field-Naturalist 85: 329–330.

Gruchy, C. G., A. A. R. Dykes, and **R. H. Bowen.** 1972. The Short-tailed Albatross recorded at Ocean Station Papa, North Pacific Ocean, with notes on other birds. Canadian Field-Naturalist 86: 285–287.

Nichols, J. T. 1927. Tubinaires off the northwest coast. Auk 44: 326–327.

KENTON D. WOHL

Alaska Outer Continental Shelf Office
Bureau of Land Management
Anchorage, Alaska 99510

Received 20 December 1974
Accepted 6 March 1975

Wolf as Predator on Mallards in a Bait Trap

Few references can be found to wolves (*Canis lupus*) preying upon waterfowl, and none can be found to them preying upon ducks caught in a trap. Young and Goldman (1944. The wolves of North America. Wildlife Institute, Washington, D.C. 385 pp.) state that waterfowl remains are seldom found in wolf stomachs. They cite one study of 3346 stomachs examined from wolves taken in the continental United States, mainly west of the 100th meridian. Only one of the stomachs examined contained waterfowl remains. Mech (1970. The wolf. Natural History Press, Garden City, New York. 384 pp.) cites one instance of wolves preying upon ducks. During August 1966 J. A. Hagar found the remains of about 40 flightless ducks that had been caught and eaten by wolves in the James Bay region of Canada.

It is possible to reconstruct a wolf – captured duck encounter from observations made at Rocky Pass, 43 km west of Petersburg, Alaska while we were banding ducks. From 18 to 24 February 1973, we placed small traps just above the high-tide line at the heads of bays, and baited them with corn. The circular traps were 2 m in diameter. They stood 60 cm high and were made of welded wire 5 × 10 cm. Each trap had a V-shaped funnel projecting about 25 cm to the inside.

On the morning of 22 February, one trap was found inverted. Duck feathers in the immediate area indicated at least two mallards (*Anas platyrhynchos*) had been caught and subsequently killed. Soft inter-tidal mud allowed us to reconstruct what probably happened. Wolf tracks showed that the animal had walked around the trap. Wolf tracks by the funnel indicated the animal had probably placed its muzzle inside the opening and inverted the trap by lifting. It is unknown whether more than two ducks were in the trap. Mallard duck feathers were scattered about 40 m across the beach to heavy timber. This indicated the wolf carried the ducks into the timber before eating them. Further tracking of the animal was impossible owing to the lack of snow cover. We estimated that five wolves were in our vicinity on four different nights.

The duck-banding project was supported in part by Pittman-Robertson Project W-17-2. We thank D. E. McKnight, Alaska Department of Fish and Game, Juneau, Alaska for editorial assistance with the manuscript.

DANIEL E. TIMM[1]
SIDNEY O. MORGAN[2]
ROBERT E. WOOD[3]

[1] Alaska Department of Fish and Game
333 Raspberry Road
Anchorage, Alaska 99502
[2] United States Fish and Wildlife Service
Juneau, Alaska 99801
[3] Alaska Department of Fish and Game
Ketchikan, Alaska 99901

Received 3 January 1975
Accepted 20 February 1975

A New Distribution Record for the California Myotis *(Myotis californicus)* in British Columbia

A small collection of bats from Castlegar, British Columbia contained three specimens of the California myotis (*Myotis californicus californicus*). The specimens extend the known range of these species in British Columbia eastward by approximately 140 km (Figure 1). The three bats, all females, were collected in the immediate vicinity of Selkirk College on 9 April and 24 October 1968, and on 22 May 1970. The specimens are now in the collection of the National Museum of Natural Sciences (NMC 42837, 42838, and 42839).

Previous records of *M. c. californicus* in British Columbia are from Osoyoos, Vaseux Lake, Hemp Creek, Hedley, Keremeos (Anderson 1946; Cowan and Guiguet 1965), and Okanagan Falls (M. B. Fenton, personal communication). All these localities, except Hemp Creek, are in the dry valleys of the north–south oriented Okanagan drainage system. The new record comes from a

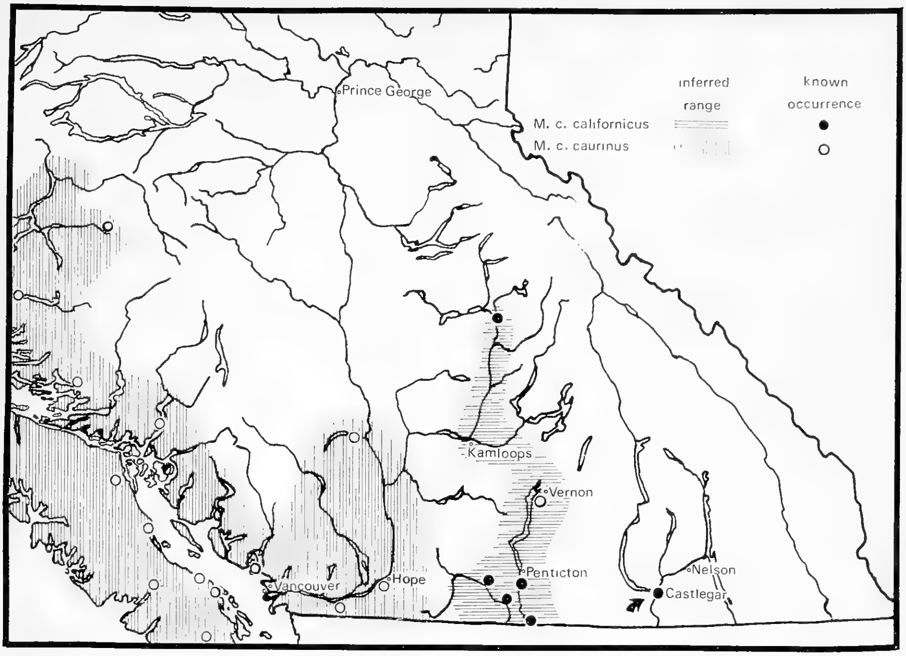


FIGURE 1. Distribution of *Myotis californicus* in British Columbia (after Cowan and Guiguet 1965) with the new distribution record indicated by the arrow. The specimen of the coastal subspecies *M. c. caurinus* from Okanagan Landing, near Vernon, was collected in the fall and was possibly a migrant.

small extension of the dry Montane Forest Region (Rowe 1972) in the similarly-oriented valley of the Columbia River, and is separated from the localities to the west by several high mountain ranges. It appears from these records that the distribution of the species in this area coincides with the major north–south drainage systems. As the Columbia and Okanagan Rivers join just east of Brewster, Montana, the centers of distribution of *M. c. californicus* in British Columbia appear to be finger-like extensions of a continuous range. Barbour and Davis (1969) include nearly the entire state of Washington in the species' range, but unfortunately this is not documented by specimen localities. Both the dark *M. c. caurinus* and the pale *M. c. californicus,* however, have been reported for several localities along the Columbia River and its tributaries by Dalquest (1948). The nearest Washington record is for *M. c. caurinus* from Colville, approximately 88 km south of Castlegar. The fact that both subspecies have been reported from neighboring areas along the same river system suggests the existence of wide variation in color in the population of this area and may be indicative of intergradation between the two subspecies.

Literature Cited

Anderson, R. M. 1946. Catalogue of Canadian recent mammals. National Museum of Canada Bulletin 102, Biological Series 31. 238 pp.

Barbour R. W. and **W. H. Davis** 1969. Bats of America. University Press of Kentucky. 286 pp.

Cowan, I. McT. and **C. J. Guiguet.** 1965. The mammals of British Columbia. British Columbia Provincial Museum, Handbook 11. 414 pp.

Dalquest, W. W. 1948. Mammals of Washington. Museum of Natural History, University of Kansas Publication 2: 1–444.

Rowe, J. S. 1972. Forest regions of Canada. Department of the Environment, Canadian Forestry Service, Publication 1300. 172 pp.

C. G. VAN ZYLL DE JONG[1]
D. C. CAMPBELL[1]
W. J. MERILEES[2]

[1] National Museum of Natural Sciences
Ottawa, Ontario K1A 0M8
[2] Department of Environmental Sciences
Selkirk College
Castlegar, British Columbia

Received 14 February 1975
Accepted 1 April 1975

A Grizzly Bear *(Ursus arctos)* Record near Fort Simpson, Northwest Territories

On 5 September 1974, a subadult male grizzly bear (*Ursus arctos* Linnaeus) was shot at mile 313 of the Mackenzie Highway, about 18 miles northwest of Fort Simpson. E. R. Hall and K. R. Kelson (1959. The mammals of North America. Volume 2. The Ronald Press Company, New York. 1078 pp.) did not include any records of grizzly bear distribution within the Fort Simpson region while V. H. Cahalane (1964. A preliminary study of distribution and numbers of cougar, grizzly, and wolf in North America. New York Zoological Society, New York. 12 pp.) showed the range limits of grizzlies to be relatively near to Fort Simpson. The distribution given by A. W. F. Banfield (1974. The mammals of Canada. University of Toronto Press, Toronto. 438 pp.) was considerably west of Fort Simpson. The local game officer, trappers, and hunters interviewed did not recall prior sightings of grizzly bears in that region. This individual's movement from more typical grizzly bear range to the west may have been caused by agonistic behavior of more dominant individuals. Little is known, however, about the distribution of grizzly bears within the boreal forest region and it may be more widespread than previously thought (A. M. Pearson, personal communication).

The skull from the animal was salvaged. The condylobasal length was 285 mm, the zygomatic breadth was 155 mm, and length and width of the second molar was 3.63×1.92 mm. The estimated live weight of the bear was 350 pounds. Its age, determined by annulations in the cementum of the upper first premolar, was $4\frac{1}{2}$ years. The teeth were unusually worn for such a young bear.

The skull is in the possession of Max Trennert, Game Officer at Fort Simpson, and the hide is in the possession of John Ebelher at Fort Simpson.

GEORGE W. SCOTTER

Canadian Wildlife Service
Edmonton, Alberta T5J 1S6

Received 15 November 1974
Accepted 5 February 1975

New Distribution Data on Two Mosses, *Fissidens exilis* and *Thuidium pygmaeum*, in Quebec

During the fall of 1973 samples of *Fissidens exilis* Hedw. and *Thuidium pygmaeum* BSG were collected from the Morgan Arboretum (Macdonald Campus of McGill University) at the west end of the Island of Montreal at 45°46′ N, 73°57′ W.

Fissidens exilis is new to Canada as no reports of the species for the country have been seen. American specimens of this species have been reported only from Michigan, Maryland, New York, Ohio, and Pennsylvania (Crum 1973). Outside North America, the distribution of *Fissidens exilis* includes the British Isles, central and northern Europe, Scandinavia (Steere 1950), and Japan (Iwatsuki and Noguchi 1973).

The specimens of *Fissidens exilis* were collected in a planted spruce-tamarack association on clay soil. One population was isolated while a second population was associated with *Fissidens taxifolius* Hedw. Because of its minute size (1.0–2.0 mm), *Fissidens exilis* is not an easily found moss. Only under a dissecting microscope will a seemingly bare lump of clay be shown to contain a population of this species. This may explain why it was not until 1947 (Steere 1950) that it was discovered in North America, in the vicinity of Cleveland, Ohio. It is reported as rare in the St. Lawrence drainage system (Crum 1973).

The distinguishing features of this moss include its size, its abundant and persistent protonema, its habit of maturing its spores in the winter, the bluntly-serrate vaginate laminae, and the intramarginal series of long narrow cells of the vaginate laminae.

Thuidium pygmaeum is new to Quebec as it is not listed for the province (Lepage 1943–1949). This moss is widely distributed in eastern North America (Anderson and Zander 1973), although it is not reported as being in Michigan (Crum 1973). Outside of North America, it is only reported from China (Manchuria), Korea and Japan (Honshu and Kyshu) (Watanabe 1972).

Thuidium pygmaeum was collected growing singly on rocks in a typical maple-beech forest association. This species is best distinguished from other North American species of *Thuidium* by its papillose stems and branches.

Identification was confirmed by Dr. Robert Ireland. Representative specimens are deposited at CANM and MTMG.

I thank Dr. Dennis Woodland for his help in preparing this report.

Literature Cited

Anderson, L. E. and **R. H. Zander.** 1973. The mosses of the Southern Blue Ridge Province and their phytogeographic relationship. Journal of the Elisha Mitchell Scientific Society 89(1–2): 15–60.

Crum, H. 1973. Mosses of the Great Lakes Forest. University of Michigan Herbarium, Ann Arbor. 404 pp.

Iwatsuki, Z. and **A. Noguchi.** 1973. Index muscorum Japonicarum. Journal of the Hattori Botanical Laboratory 37: 299–418.

Lepage, E. 1943–1949. Les lichens, les mousses et les hépatiques du Québec. Naturaliste canadien Vol. 70–76.

Steere, W. C. 1950. Notes on *Fissidens.* II. The discovery of *Fissidens exilis* in North America. Bryologist 43(3): 131–136.

Watanabe, R. 1972. A revision of the family Thuidiaceae in Japan and adjacent areas. Journal of the Hattori Botanical Laboratory 36: 171–320.

LAURA MOLNAR

McGill University Herbarium
Department of Plant Pathology
Macdonald Campus of McGill University
Ste. Anne de Bellevue, Quebec H0A 1C0

Received 7 January 1975
Accepted 14 March 1975

Unusual Food Transfer Behavior Performed by American Kestrels

Transfer of food from male to female in relation to courtship feeding has been discussed by T. J. Cade (1960. Ecology of the Peregrine and Gyrfalcon populations in Alaska. University of California Publications in Zoology 63(3): 151–290) for Peregrine Falcons (*Falco peregrinus*), and noted in Gyrfalcons (*Falco rusticolus*) by D. Muir (unpublished data). E. J. Willoughby and T. J. Cade (1964. Breeding behaviour of the American Kestrel (Sparrow Hawk). Living Bird 3: 75–96), as well as D. M. Bird, have also observed this behavior in captive American Kestrels (*Falco sparverius*).

Willoughby and Cade (1964) further describe fully developed courtship feeding in American Kestrels as "the male bringing prey to the female and she begging for it and taking it from him." Although no one seems to have published on this behavior in wild kestrels, the following description is unusual in that it does not adhere to the patterns as recorded above.

On 1 May 1973, in the Lachine area of Montreal, Quebec, we observed a female kestrel hovering and subsequently disappearing from our view over a small field adjacent to some railway tracks. A male kestrel had been flying about and perching in a nearby grove of trees just previous to this sighting. Within minutes, the female reappeared flying toward the grove of trees, carrying an intact meadow vole (*Microtus pennsylvanicus*) in her talons. She alighted near the top of a dead elm tree 60 feet high and transferred the prey to her beak. Within seconds, a male kestrel landed beside her and the prey was transferred to his beak. He promptly flew to a lower branch approximately 25 feet away in the same tree. He did not eat any part of the prey and both birds remained in their respective positions for about a minute. Then the male with prey still in his beak returned to the female's perch, transferred the prey to her beak and then flew to a perch on the other side of the tree. The female immediately tore up and consumed the vole, after which both birds flew off together and perched in a nearby tree.

Copulation was not observed at any time during our observations. The only vocalization heard from the pair was a "whine-chitter" combination, as described by Willoughby and Cade (1964). We could not tell which bird called.

This pair was probably attached to one of several available nest sites at the time of observation. Twenty personal nest records from 1973 and 1974 indicate that kestrels in the Montreal area generally lay eggs in late April to mid-May. One notable exception, however, was a pair of kestrels nesting about 2 miles away from the pair under observation. Since their nest contained only eggs on 22 June 1973, it is highly possible that the latter pair was still in the courtship period.

Willoughby and Cade (1964) report much variation in the pattern of interaction between the sexes during courtship feeding in kestrels. They do briefly mention that a highly motivated female will try to give food to an unresponsive male if he has none. It is not clarified whether she is giving the food for him to eat or to stimulate him to feed her as a courtship activity. Even with our observation of this sequence in the wild, it is difficult to draw any solid conclusions. We know of no previous reports of such behavior by any members of the Falconidae in a wild or captive state.

The authors thank the Department of Education, Province of Quebec for their financial support of our research on birds of prey. A special note of thanks goes to Eric Greene for his excellent field assistance.

DAVID M. BIRD
STEPHEN SPIEGEL

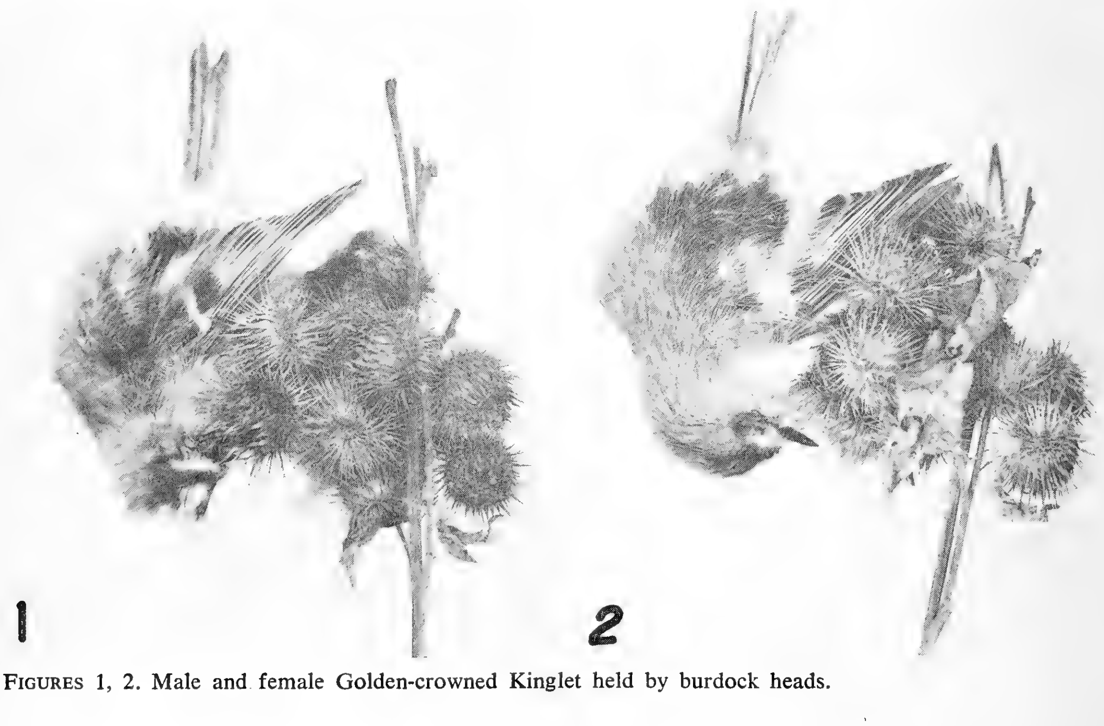
Macdonald Raptor Research Centre
Macdonald College, Quebec

Received 3 January 1975
Accepted 20 February 1975

Burdock as a Threat to Small Birds

During late September 1974, in a beech-maple forest at Waterloo, Ontario, my wife and I found a male and a female Golden-crowned Kinglet (*Regulus satrapa*) entangled in a clump of burdock, *Arctium* sp. (Figures 1 and 2). They had become caught by the hooks of the burdock heads and subsequently died of either starvation, exhaustion, or the cold.

Needham (1909) discovered a similar incident involving Golden-crowned Kinglets in October 1909. As he found that two species of insect larvae were present in considerable abundance,



FIGURES 1, 2. Male and female Golden-crowned Kinglet held by burdock heads.

he assumed that the birds became ensnared in their attempt to secure food. It seems that dried mature burdock presents a hazard for this species during its southward migration from the northern coniferous forests although Bent (1949) claimed that in migration they are found among trees or bushes, or in the undergrowth in deciduous woods.

Bowdish (1906) observed that burdock heads are an unforeseen danger for birds during nest building and searches for food. He reported that the American Museum of Natural History received in 1906, from C. C. Warren, the remains of a hummingbird that had fallen prey to the burdock heads. D. A. MacLulich (personal communication) has seen American Goldfinches (*Spinus trista*) caught on burdock burrs in this fashion. Such an incident is also reported by Bowdish (1906), who states that the birds were after the seeds and had become ensnared upon landing on the burdock head. A more recent sighting of this nature is reported by Brown (1970) who states that on 26 September 1966 a Common Yellowthroat (*Geothlypis trichas*) was caught on burdock by the feet and the primaries of the right wing. He reports other incidences where a Pine Siskin (*Spinus pinus*) and a Black-capped Chickadee (*Parus atricapillus*) have been found caught on burdock.

It would seem that burdock is a greater threat to small bird life than the literature suggests. More careful observations of burdock stands and the ground beneath, particularly during late September–October would perhaps reveal more examples.

Literature Cited

Bent, A. C. 1949. Life histories of North American thrushes, kinglets and their allies. Dover Publications Inc., New York. Reprinted 1960. p. 542.

Bowdish, B. S. 1906. Bird tragedies. Bird Lore 8: 208.

Brown, D. R. 1970. Yellow Throat caught in burdock. Wilson Bulletin 82(4): 464–465.

Needham, J. C. 1909. Kinglets captured by burdocks. Bird Lore 2: 26.

GREGORY HUMPHREYS

Department of Biology
Wilfrid Laurier University
Waterloo, Ontario N2L 3C5

Received 13 December 1975
Accepted 4 April 1975

News and Comment

International Convention on Trade in Endangered Species, Ratified by Canada

Canada has ratified (April 1975) the international convention regulating trade in endangered animals and plants. The convention was adopted by 80 nations in March 1973 to help curb commercial over-exploitation of certain species of wild fauna and flora. The agreement, effective 90 days after the tenth nation has ratified it, imposes import, export, and transit controls on these species. Canada is the eighth nation to ratify the convention.

The restrictions imposed by the convention will affect zoological gardens, pet dealers, private collectors, the fur industry, horticulturalists, tourists, and persons who purchase curios and artifacts made from the by-products of these species. The restrictions placed on a particular animal or plant or its by-product vary according to how it is listed in the convention. Trade in species listed in Appendix I, those which are considered endangered (such as cheetahs and alligators), is allowed only under exceptional circumstances and then both an export and import permit are required; Appendix II species (such as chimpanzees and orchids) need protection so they will not become endangered through excessive trade; and Appendix III species, those which are protected under each participating nation's laws (like the walrus and Snowy Owl in Canada), need an export permit from the originating nation.

Convention controls apply when a listed species is shipped between two nations of which at least one has ratified the agreement. In Canada, these controls will not replace or supersede any domestic legislation, such as the health requirements of the Department of Agriculture. If an imported animal or plant or its by-product lacks the proper convention permits, it will be seized at the point of entry and then either returned to the country of origin at that country's expense or disposed of. Live species which are seized in Canada and not returned will most likely be donated to approved organizations having the proper facilities to care for them.

Canadian convention permits will be issued in accordance with the Export and Import Permits Act. The federal Department of the Environment will issue all convention import permits as well as convention export permits for species which are a federal responsibility. The provinces and territories will issue convention export permits for species which come under their jurisdiction. Further information on the convention is available from the Canadian Wildlife Service.

The National Whale Symposium

The great whales and their smaller relatives will be the subject of a national public conference at Indiana University in Bloomington, Indiana on 9 November through 12 November 1975. The National Whale Symposium will gather together experts from the social and natural sciences, arts, and humanities, and concerned citizens to consider the plight of whales and dolphins. Through such fields as international law, biology, literature, folklore, and music, the Symposium will explore the past and present relationships that man has had with the whales, and will formulate what mutually beneficial relationships might be pursued in the future. The National Audubon Society is joining Indiana University and other national organizations in sponsorship. For information write: The National Whale Symposium, 605 South Fess Street, No. 3, Bloomington, Indiana 47401.

Book Review Editor

The Publications Committee extends its sincere thanks to Dr. Anne Innis Dagg for serving so capably and actively as our Book Review Editor since October 1973. After Dr. J. Wilson Eedy takes over as the Book Review Editor in July 1975, we are confident that this section will continue to be an important component of our journal.

Book Reviews

Zoology

The Mammals of Canada

By A. W. F. Banfield. 1974. University of Toronto Press for the National Museums of Canada. 438 pp. $19.95.

A comprehensive book on Canadian mammals has finally arrived. *The Mammals of Canada,* in preparation for over 50 years, includes the consecutive efforts of four well-known mammalogists from the National Museums of Canada —Drs. R. M. Anderson, A. L. Rand, A. W. Cameron, and A. W. F. Banfield. Banfield completed the project in 1968 and revised the manuscript just prior to publication in 1974. It was designed as a companion volume to the excellent *The Birds of Canada* by W. E. Godfrey.

Although there are good regional works available—*The Mammals of Eastern Canada* (R. L. Peterson), *The Mammals of Alberta* (J. D. Soper), and *The Mammals of British Columbia* (I. McT. Cowan and C. J. Guiguet) —there has never been a single text dealing with all terrestrial and marine mammals of Canada. Therefore, Banfield's long-awaited publication is a welcome contribution to the field of Canadian natural history, and will be of interest to both the professional biologist and the lay reader.

The Introduction deals rather briefly with the characteristics, classification, literature, and distribution of mammals, the history of Canadian mammalogy, the effects of civilization on mammal numbers, and a preview of the contents of the species accounts. A key to the mammal orders and a checklist of the Class Mammalia in Canada precede the accounts. This important new checklist of scientific and common names follows closely the 1973 *Checklist of North American Mammals North of Mexico* by J. K. Jones, Jr., D. C. Carter, and H. H. Genoways. Hopefully its wide adoption will reduce the myriad of mammal names to a standard list. Obsolete names that have been used for decades are not mentioned in the text under the new names, which could lead to confusion. Some readers might wonder what happened to the pine vole, *Lutra,* and many others.

A significant omission is a discussion of the biological zones of Canada. "Embracing half a continent, Canada contains many climatic, physiographic, and vegetative zones. Each . . . has its own particular fauna." A few brief additional comments are offered on 'mammal provinces,' but not even a map is included to show the occurrence of such critical features in mammalian distribution as mountains, grasslands, forests, and tundra (as in the companion volume on birds). I would also like to have seen photographs representing the biomes and transitional zones occurring in Canada. Furthermore, there is no map of Canada with the place-names mentioned in the text (as in the companion volume on birds). Canadian readers, not to mention those from other countries, will be obliged to fan the pages of an atlas to find the distribution of the biological zones and the exact location of places like Ellef-Ringnes Island, Moosonee, and Peribonca.

The species accounts are headed by descriptions of the diagnostic features of each order and family. A family key is provided but *none* at the generic and species levels.

Under the heading "Description" are listed the species' general appearance, color, molt, measurements (metric and English), skeletal and dental characters, and many other relevant facts. Illustrations are referred to and here lie some of the major disappointments of the book. The majority of the colored plates leaves much to be desired when compared to the work of artists skilled in mammal illustration. Many pieces are reminiscent of the pictures formerly appearing on cards found in boxes of tea. Watercolor paintings are rendered in small black-and-white prints with poor results (e.g., water shrew and eastern cottontail). At least ten species (including all four bears) are depicted with some strange affliction in a front limb, for it hangs limply.

The line drawings of mammals and anatomical features likewise display a range of execution from detailed work with shading to others simply done with bold lines. There is an occasional lapse between the author's description and the illustration. For example, in the swift fox account it is stated that, "There are two prominent black spots on each side of the snout below the eyes (Figure 67a)." There is no sign of these markings in the poorly drawn figure. More serious is the fact that no scale is indicated for any of the skull drawings. In the seven drawings of microtine skulls (Figure 42), there is no mention of whether they are natural size or not, or even if they are drawn to scale relative to each other. The shrew skulls (a necessary guide for shrew identification) of Figure 4 are all magnified to the same unknown size, although the skull of Bendire's shrew is twice that of the pigmy shrew.

Six illustrators (several better known for their bird paintings) were employed from as long ago as 1923, which explains the absence of uniform style. Several of the colored plates have appeared previously in another book. The use of single plates depicting many species results in certain mammals appearing twice while 54 of the 196 species are not illustrated at all. The cetacean drawings and occasional other figures are quite adequate, but a book with this title and appeal deserved a much better effort in the art department than the present haphazard approach.

Skulls are illustrated for only 76 of the 196 species, and while probably not all species merit this feature, I must question the inclusion of several and the exclusion of many others. Why, for example, are the skulls of the coypu (introduced to three small areas in Canada) and the big free-tailed bat (one extra-limital record) represented while the skulls of the moose, skunk, muskrat, all four foxes, and all five chipmunks are omitted. These latter skulls are often found by naturalists and should have rated a high priority in being illustrated.

The "Habits" section contains a wealth of interesting facts on activities, diet, populations, predators, etc., and is well done. Here one finds that food passes through the alimentary canal of the American shrew-mole in only 35 minutes, and the gray whale fasts for six to seven months of the year. The author occasionally draws on his own extensive field experience by adding personal anecdotes that relieve the barrage of factual material. I would have favored more of these sidelights, especially missed in the caribou account, a species for which Banfield is well known.

The following section is entitled "Habitat," and while many accounts are adequately documented, others are too brief and generalized. Often one line was thought sufficient to describe a mammal's environmental preferences. For example, "The grey fox prefers forests and marshes and is less at home in farm lands than the red fox." Map 169 correctly indicates that moose may wander far into the tundra, but no mention is made of this fact under "Habitat."

The lack of detail on habitat contrasts with the abundance of material offered in "Habits" and "Reproduction." In the latter, mating behavior, gestation period, litter size, development of young, age at maturity, etc., are covered at great length.

"Economic Status" lists the importance of species to aboriginal and modern hunters, to trappers, to agriculture, and as a vector of disease. Many naturalists will object to the inclusion, in a modern book of natural history, of instructions on poisoning noxious rodents and of comments on recent methods of predator control. An additional "Status" entry is presented for species of mammals that have suffered severe exploitation or persecution, though sometimes this same information appears under the former heading. Estimates of population numbers for certain species are rather dated (1940s); perhaps more recent information is unavailable.

The full range of each species is described under "Distribution," and is illustrated with an inset map (range before interference by modern man), a useful item, since readers may be unaware that many species of Canadian mammals also occur in Eurasia, the United States, and even South America. I found several instances where the ranges shown on the maps did not correspond to the written description. For example, "Grizzlies once occurred on the prairies as far west as the Red River valley, Manitoba (see Map 136) . . ."; however, no prairie distribution is depicted.

"Canadian Distribution" of species appears in large maps of Canada as well as in written descriptions. For marine mammals, a map is supplied showing the range in Canadian waters and throughout the northern hemisphere. An important point that should have been stated in the introduction is that the ranges are based on generalized, suspected distributions and not on actual specimens. I noted many examples of maps showing species' occurrence where they do not exist or have not yet been found. This would have become obvious had the author gone to the extra trouble of including dots where specimens have been taken (as Peterson did for eastern Canada). Even the use of dots for just the peripheral localities would have greatly enhanced the usefulness of the maps for mammalogists, for we must still refer to Peterson's book or *The Mammals of North America.* (E. R. Hall and K. R. Kelson, 1959, now under revision) for the actual distributions of Canadian mammals. An annoying feature of certain maps occurs when a species barely enters Canada. A map of North America is used, reducing the detail of Canadian distribution until it is worthless (e.g. Maps 8, 14, 16, 84).

Accompanying this section is a list of subspecies in Canada; their ranges are also shown on the map. These will likely be of some interest to many readers, although it should be pointed out (as the author does in some cases) that the majority of these subspecies are based on so few specimens as to provide a grossly incomplete picture of the geographic variation present in populations of Canadian mammals.

The final section of each species account is a list (usually containing one to three entries), ". . . of the most important references. . . . Consultation of these papers will lead the reader to the pertinent literature." This latter statement is true for most species, but incredibly inaccurate for others (e.g., only a 1929 reference for the California sea lion; 1868 to 1936 for the beaver). Here was a golden opportunity to provide the first up-to-date list of publications on research conducted in Canada (as well as other pertinent literature). Peterson (1966) did just this for eastern Canadian mammals. Several monographs are surprisingly missing from the short reference list, including papers on the California sea lion (R. S. Peterson and G. A. Bartholomew, 1967), the striped skunk (B. J. Verts, 1967), *Peromyscus* (J. A. King, 1968), and the woodland jumping mouse (R. E. Wrigley, 1972). Some of these would have added considerably to the species accounts.

Following the 196 species accounts is a valuable appendix of dental formulae, and the number of digits and mammae present in each species. Next are a conversion table of English and metric units and a glossary. Though technical terms are not disturbingly frequent, the glossary certainly helps in fully understanding the text. Occasional words slip through undefined (e.g., opisthotonic and anchylosed) and the statement on page 351, "The trenchant character of the bobcat's skull is the confluent foramina lacerum posterius and anterior condyloid on the basicranium below the foramen magnum" will send most amateur naturalists reeling.

An index of common and scientific names appears at the end of the book. No animal tracks are included, a feature often provided in other texts on mammals.

Banfield succeeds in presenting a mass of factual material in an easy-reading style and I noted only 15 spelling errors, not an annoying number for a book of this length. Factual errors are infrequent (e.g., "The pocket gopher family is restricted to the Great Plains region of North America"), but I found occasional statements rather strange (e.g., In the Townsend's mole, "The senses of smell and hearing are probably adequate," and "The arctic shrew is a relatively heavily built short-tailed shrew").

Although *The Mammals of Canada* exhibits some serious shortcomings and disappointments, it does succeed in its prime objective of setting forth much of the natural-history information available on Canadian mammals. It duplicates no other book on the market. Compared to the prices of most large publications appearing in 1974, the cost of $19.95 is not excessive. There is plenty of meat in this mammal text, but at $4 per pound ($20 for the 5-lb book), it is not as good a buy at the market as its companion volume on fowl (*The Birds of Canada*, $3 per pound at $15).

ROBERT E. WRIGLEY

Manitoba Museum of Man and Nature
190 Rupert Avenue
Winnipeg, Manitoba

Birds of the World: A Check List

by James F. Clements. 1974. The Two Continents Publishing Group, Ltd., New York. 524 pp. $15.00.

Voici une liste "complète" des espèces d'oiseaux vivants du monde publiée dans un seul volume. C'est un livre de format pratique (6″ × 9″ × 1.5″; 2.5 livres), très bien relié et d'une solidité qui devrait résister à l'usage le plus soutenu. Les couvertures de carton épais sont protégées par une jaquette attrayante où l'on voit la silhouette d'un goéland devant un soleil couchant. Cette photographie qui pourrait représenter n'importe quelle mer du monde ne manque pas d'ajouter au caractère international de cet ouvrage.

En feuilletant le livre, j'ai favorablement été impressionné par la qualité du papier et l'uniformité du texte imprimé. Il n'y a aucune illustration et seule la carte des grandes régions zoogéographiques du monde imprimée sur le côté intérieur des couvertures et la page de garde correspondante apporte un peu de couleur à l'ouvrage.

La liste systématique occupe la majeure partie du livre. La classification adoptée est celle de Van Tyne et Berger (1959. *Fundamentals of Ornithology*. John Wiley & Sons, N.Y.) quoiqu'il aurait été préférable, à mon avis, de suivre une classification plus récente comme par exemple celle d'Austin (1971. *Families of Birds*. Golden Press, N.Y.) ou celle de Storer (1971. Classification of birds. Dans *Avian Biology*. Edité par D. S. Farner et J. K. King. Vol. I. pp. 1–18). La liste comprend 8904 espèces (non codifiées malheureusement) ce qui en fait la deuxième plus longue jamais publiée. La plus longue est celle d'Edwards (1974. *A Coded List of Birds of the World*. Ernest P. Edwards, Sweet Briar, Va.) qui comprend 8908 espèces. Si le nombre d'espèces est aussi élevé, c'est que l'auteur a choisi d'inclure plusieurs espèces au statut spécifique incertain car il est beaucoup plus facile de retrancher un nom du texte que d'en incorporer un, une fois l'incertitude levée. Clements s'est servi des principaux guides des oiseaux du monde pour dresser sa liste. Malheureusement, il a négligé de consulter certains guides se rapportant aux îles du Pacifique-Sud (e.g., P. L. Bruner. 1972. *Field Guide to the Birds of French Polynesia*. Pacific Scientific Information Center, Hawaii). Ainsi, plusieurs espèces endémiques de ces îles n'apparaissent pas dans sa liste.

Pour chacune des espèces, on trouve une brève description de sa distribution géographique. Quoique ces informations soient en général assez justes, il y a cependant de nombreux cas où les renseignements fournis sont imprécis, incomplets ou erronés. Par exemple, les noms d'îles ou de localités peu connues devraient toujours être accompagnés du nom d'un pays proche et mieux connu. La distribution des espèces introduites avec succès dans de nouvelles régions devrait être modifiée pour tenir compte de ces nouvelles extensions d'aire. Ainsi, par exemple, la perdrix grise, la mouette pygmée et l'étourneau huppé ne se rencontreraient pas en Amérique du Nord si l'on se fie aux informations fournies par l'auteur. Enfin, il y a quelques erreurs. Par exemple, la distribution géographique de l'aigle gris n'est pas holarctique.

Pour les observateurs d'oiseaux, un espace spécial a été prévu afin d'inscrire la date et le lieu de leur première observation de chacune des espèces. A la fin du livre, ils trouveront quatre pages blanches (nombre insuffisant à mon avis) pour inscrire des notes.

Le volume contient aussi quelques hors-textes: une introduction, des directives pour l'utilisation du livre, deux listes de références (une aurait été suffisante surtout que celles présentées sont très mal faites), une liste des ordres et des familles (n'incluant pas les groupes éteints) et un index où les ordres et les familles n'ont malheureusement pas été inclus. En général, j'ai trouvé ces informations supplémentaires insuffisantes. Si l'auteur y avait apporté plus de soin, son oeuvre aurait certainement atteint le rang d'un travail professionnel. Sous sa forme actuelle, je crains que ce livre ne soit surtout populaire qu'auprès des ornithologues amateurs.

Voici quelques suggestions en vue d'une amélioration des éditions futures. L'auteur devrait mentionner les ouvrages récents qu'il a consultés pour apporter des corrections à la classification qu'il s'était originalement proposé de suivre. De plus, il devrait informer le lecteur sur la façon dont il a choisi un nom unique pour les espèces connues sous différents noms (aussi bien scientifiques que vernaculaires) dans différentes parties du monde et comment il a choisi l'ordre de classement des genres et des espèces à l'intérieur de chacune des familles. Enfin, il aurait dû mentionner l'espèce la plus nouvellement découverte qu'il a incluse dans sa liste afin que le lecteur puisse ajouter à sa liste les espèces qui ont été découvertes depuis. Rapidement, j'ai pu constater que plus de dix espèces découvertes depuis 1965 ne figurent pas dans le texte. Il est d'ailleurs inexcusable que l'auteur n'ai pas tenu sa liste à date jusqu'au moment d'aller sous presse.

J'ai noté plusieurs erreurs typographiques, ce qui démontre encore là le peu de soin apporté à la préparation de l'ouvrage. De plus, le bécasseau maritime a été omis de la liste.

En conclusion, malgré mes remarques critiques, je crois qu'il s'agit là d'un ouvrage utile qui vaut bien son prix de vente. Aucune des erreurs que j'ai pu relever n'affecte la valeur de ce "check-list" et je crois que l'on doit féliciter l'auteur pour ce travail qui devrait s'avérer un pas important vers l'uniformisation de la nomenclature mondiale des oiseaux.

JEAN-LUC DESGRANGES

Département de Biologie
Université McGill
Montréal, Québec

A Guide to the Birds of Trinidad and Tobago

By R. ffrench. 1973. Livingston, Pennsylvania. 470 pp., illus. $12.50.

This is a very welcome addition to the literature of neotropic avifaunas. It is refreshing to read a well-written, well-illustrated, and immensely interesting field guide. ffrench has incorporated in the text for each species an enormous amount of information—comparable to many handbooks—and yet over 300 species have been treated in a pocket-size field book. Besides a discussion on range and description, there is a wealth of information on banding status, measurements, nesting and behavior, and it is perhaps in the latter category that a major contribution has been made to field identification to birds in the tropics. For example, knowing that it is the Blue-black Grassquit that jumps high from its perch, exposing white axillaries, will be of great help in keying out this species from many of its congeners. The Striped Cuckoo will be readily identified as that streaked robin-sized bird that flicks out a black bastard wing during dusting. ffrench is to be congratulated on his acute perception of neotropical avifauna and its conversion into written language.

For the breeding bird in Trinidad and Tobago, artist John O'Neil has illustrated each species on 28 plates. He has used great skill in the use of his paints, displaying color and feather detail with great accuracy against a white background. The artwork is further enhanced by the masterful portraits of Don Eckleberry.

The book is fairly free of misspellings and typographical errors. I did note some inaccuracies, however. For example, the author claims that the Thick-billed Plover is "the species well-known in the USA for its distraction display," but he is no doubt referring to the Killdeer. Also, the captions on the figures of the Linneated and Crimson-crested Woodpeckers have been transposed. But these criticisms are minor.

In conclusion, ffrench has written a book that is a must for any student of the neotropics. For $12.50 during an inflationary era, the book is a real bargain.

F. M. BRIGHAM

R.R. 3
Richmond
Ontario K0A 2Z0

Canadian Endangered Species

By Darryl Stewart. 1974. Gage Publishing Ltd., Toronto. 172 pp. $12.95.

After a number of lists, by various specialists and agencies, of our endangered wildlife, Canada at last has its own "Red Book." And it is a large handsome volume, but, upon close inspection, disappointing. Mr. Stewart has worked closely with federal and some provincial government bodies, the World Wildlife Fund, National Museums of Canada, some other museums, and certain universities in producing it. Sir Peter Scott has contributed an eloquent and logical foreword. The introduction, epilogue, and species accounts, all by Stewart himself, are filled with moving pleas and, at times, dramatic statements. But the research leaves much to be desired.

Since numerous endangered subspecies are considered, one would wish Stewart had a better grasp of taxonomy. If some are to be treated, why not endemic (often insular) races of Canadian small mammals? To what race of *Microtus* does he allude on p. 53? Following Banfield (1974), *Sorex vancouverensis* is now considered a form of *S. vagrans*. *Natrix sipedon insularum*, the only *IUCN*-listed endangered Canadian reptile, the Island Water Snake of Lake Erie, is *not* always "uniform pale gray" (p. 103). The Tiger Salamander has *three* subspecies, not two, in Canada (p. 129).

The range maps are tiny and often misleading, as only the threatened races are mapped in some cases (e.g., the Cougar and Peregrine Falcon) yet these maps may appear above the heading for the whole species (also *cf.* the Timber Wolf). Others are not mapped at all (the Greater Sandhill Crane) or have only the endangered race mapped and named (California Bighorn Sheep).

More statistics, if available, should be given: how many cougar attacks on humans are recorded for Vancouver Island (p. 24)? Are there any

"Swan Hills" Grizzlies left (p. 32)? Recent articles in *The Blue Jay* indicate that the Kit Fox and Greater Prairie Chicken *may* survive in Canada. The Cricket Frog, however, is extinct at Point Pelee (p. 124), but the Eastern Hognose Snake (p. 104) has been rediscovered since 1971 at Rondeau (*fide* park staffs). No attention has been paid to potentially-endangered species in Canada, such as Wolverine, Red-shouldered Hawk, and Loggerhead Shrike (*migrans* race), all being investigated for Canadian Wildlife Service, the latter two "blue-listed" in U.S. The spectacular extinct Paddlefish of the Great Lakes is not even mentioned.

Some species may be threatened only in one province but are not discussed (e.g., the Eastern Sand Darter (*Ammoncrypta pellucida*) in Ontario), whereas the list of reptiles and amphibians is misleadingly long because provincial "problems" are counted (Dusky Salamander, Eastern Ribbon Snake) in the main check-list.

Too many statements are misleading or erroneous in the text. The last Eastern Cougar *recorded* in Canada was not at Sorel, Quebec in 1863 (p. 26). Surely the last nesting (egg) record for Bald Eagle in southwestern Ontario was not (p. 72) 1969? There are no teeth in the jaws of soft-shelled turtles, only horny cutting edges (p. 115). On p. 131, the scientific name and maximum size of the Pacific Giant Salamander are both wrong. The Eastern Elk did not occur originally in Alberta (p. 157), and so on.

If sources had been given (none are cited in the text except personal statements, as a rule), many dubious statements could be checked, along with statistics, etc.

More reference material (it does exist) would have improved accounts of such little-known creatures as the Northern Prairie Skink, Tailed Frog, Small-mouthed Salamander, Fowler's Toad, and Dusky Salamander. For a number of species, one feels Mr. Stewart has little or no experience with the live animal. Who could write of the Fowler's Toad without referring to its amazing call? Scales on top of the Massasauga's head (p. 111) are not correctly shown. Scott and Crossman (1973) perhaps should have been consulted more on Canadian fishes (Blue Walleye, Aurora Trout, Blackfin Cisco, for example).

Generally, however, the section on fish is good—and needed! The aid of D. McAllister and C. Gruchy (who is Assistant Curator of *Ichthyology* at N.M.C., not Herpetology as stated in acknowledgments) is valuable. A fine section on whales has been contributed by E. Mitchell of Environment Canada (but it could be in the text, not in small-face at the back). And snakes get necessary attention—they "may be disappearing faster than any other group of vertebrates" (pp. 93–94). After all, approximately half of Ontario's 18 (19) forms are in jeopardy.

Although basically the style is smooth and clear, there are a few errors in grammar and spelling ("pidgeon," "Clarke Irwine," "It's" for the possessive), and some almost spastic abruptness (p. 33). Repetitious clichés, on the Plains bison (p. 44) for example, and inept phrasing like "thrifty band of cougar" (p. 22) also mar style, together with inconsistency (is Blanding's Turtle endangered in Canada, or only in Nova Scotia (p. 116)?).

Format of the bibliography is poor: Mitchell's papers on whales (*in press*), cited on pp. 162–164, are not listed; volume, page(s), and issue are sometimes given, sometimes not. The glossary is even poorer: "BROOD: a batch of eggs"; in places it is inaccurate (as on conifers), fuzzy, ungrammatical, and unalphabetical.

To look on the brighter side; the glossy color photographs are often excellent, by people like Crich, Halliday, Ranford, although occasionally disappointingly blurry (Whooping Crane, Massasauga). Like these and the rest of the book, line drawings by the author are of uneven quality: some sensitive and striking (Bald Eagle, some snakes), others flat and heavily outlined, without detail (Cougar), or incorrect anatomically (Grizzly which should have a concave snout unlike Black Bear).

More crucial, in my opinion, are some apparently underlying ideas. Was only the Great Auk, of the world's extinct species, destroyed by science? See *The Red Book* (under Hihi, for example) to read about other insular birds brought to the brink by museum collecting. Will saving deciduous forest preserve *Trionyx* (p. 115)? Why establish the Pinery Reserve for Blue Racers in Ontario, if it is unlikely any occur there (p. 108)? Why condemn the Newfoundland government and not the Ontario one for exploiting parks? And there is no mention of Ontario and British Columbia nature reserves for rare species, and of Manitoba legislation for endangered reptiles. One wonders about Mr. Stewart's approach to his subjects, although his enthusiasm has produced a book with broad appeal.

CRAIG A. CAMPBELL

119 University Avenue East, #5
Waterloo, Ontario

The Land Mammals of Insular Newfoundland

By Tom H. Northcott. Illustrations by Winston Howell. 1974. Wildlife Division. Department of Tourism, St. John's, Newfoundland. 90 pp.

Recently Canadian mammals have received much attention and with our many islands, the interesting aspects of insular faunas perhaps deserve special study. Not since 1913, to this reviewer's knowledge, has there been a separate work on mammals of Canada's easternmost island. In that year, Outram Bangs, a noted taxonomist, published in the Bulletin of the Museum of Comparative Zoology of Harvard University, an eight-page article, *The land mammals of Newfoundland.* Now we have this inexpensive booklet under the auspices of the Newfoundland government.

Twenty-four species (14, or about 1/10 of Canadian terrestrial species, being native and the rest introductions) are included. This is a distressingly high percentage of "exotics" even with some being "accidental importations." Two species, the polar bear and the arctic fox, are omitted as "infrequent" visitors. Since ranges of the 24 are also mapped for Labrador, might not its additional 21 species of land mammals also have been described?

Economic justifications abound for the importations although a warning does preface Northcott's text: "The fact that Newfoundland does not have as many land mammals as the nearby mainland does not mean that in all instances there is an unoccupied habitat that might just as well be filled." But why (we are not told) were bison brought to the island?

Introductions should be indicated on the checklist (p. 4). And it would be most helpful if sources were stated in the fact-filled text. Few significant references are cited in the ample space at the end of most accounts. Some facts seem doubtful: for example, surely northern *Myotis* bats do not hibernate in buildings (p. 9). Subspecies on the island are noted, but no discussion of insular subspeciation is provided. Habitat is briefly but adequately given; remarks on habits and reproduction are quite interesting and more expansive. Also Northcott is up to date on recent introductions like eastern chipmunk, which is not mentioned by Peterson (1966) or Banfield (1974). Maps do not always agree exactly with those by these two authors (e.g., for *Myotis keenii*, p. 14). Distribution dots might have been better. Keys are satisfactory. Illustrations may be the weakest aspect; tracks and skulls are omitted and except for the cover and a few of the other drawings, they seem poor and lacking in orginality. Compare them with those in Peterson's *Mammals of Eastern Canada.*

The writing is marred by some spelling and/or typographical errors (e.g., "forword"), especially regarding use of the apostrophe. Stylistic flaws are more serious—lack of agreement, run-on sentences. Although at times verging on the abrupt or repetitious (p. 83), the prose is otherwise readable.

All in all, Northcott and Newfoundland's Wildlife Division have produced a useful booklet that fills a need.

C. A. CAMPBELL

119 University Ave., E., Suite 5
Waterloo, Ontario N2J 2W1

Oil Pollution of Birds: An Abstracted Bibliography

By R. Vermeer and K. Vermeer. 1974. Pesticide Section, Canadian Wildlife Service, Manuscript Report 29. 68 pp. Copies available from Dr. K. Vermeer, Room 1110, 10025 Jasper Avenue, Edmonton, Alberta. Free.

The Canadian Wildlife Service is to be commended for sponsoring this useful bibliography by Rebecca and Kees Vermeer. It mainly comprises brief abstracts of 207 papers, arranged in chronological order from 1922 to 1973, dealing with the problem of oil pollution of birds. Most of these consider birds adversely affected by oil spills in Europe or in North America. The number of papers published per year and their degree of sophistication increase as they become more up to date. Those printed in foreign languages are well summarized in English. A list of 232 additional unabstracted entries is appended to the end of the report.

ANNE INNIS DAGG

Otter Press
Box 747
Waterloo, Ontario

Mammals of Ontario

By Anne Innis Dagg. 1974. Otter Press, Box 747, Waterloo, Canada. 159 pp. Hard cover $10; soft cover $6.50 + 50c postage.

In her publication, *Mammals of Ontario,* Anne Dagg has attempted to review the 76 known species of mammals found in Ontario. As a reference text for zoologists, the book has little value. As a field handbook, the publication is a useful addition to any naturalist's library. From a format standpoint, the book is effectively organized. Each species is treated on two pages with information regarding distinguishing characteristics, Ontario distribution, and an "item" on research findings. Line drawings by Roslyn Alexander highlight the treatment of each species.

Although the book claims "to provide an up-to-date glimpse of what mammalogists are currently studying," many of the references given are definitely not current. Similarly, certain species have single references, also somewhat misleading since many aspects of each species known for Ontario have been examined in varying detail. In the book's favor, however, is the fact that the item section is short, well written, and readable.

Probably the handiest feature of *Mammals of Ontario* is that it is solely dedicated to the treatment of Ontario wildlife. Although this will most probably restrict the sales of the book, it is a bonus for residents of Ontario since it reduces confusion of species and allows for easier field identification by amateur naturalists.

Books of this sort may be compared to the very popular *Peterson Field Guide Series.* Dagg's book has several advantages over the Peterson publications. First, as previously mentioned, it treats only Ontario mammals thereby reducing confusion. Secondly, each species is pictorially represented along with a visual distribution review. Perhaps Dagg could have used the Peterson technique of placing arrows on the figures pointing to prominent distinguishing features. Perhaps Otter Press should have reduced the publication size to that of the Peterson books in order to make the book more 'packable'.

PETER CROSKERY

Ministry of Natural Resources
Chapleau, Ontario

A Guide to Alberta Vertebrate Fossils from the Age of Dinosaurs

By Hope Johnson and John E. Storer. 1974. Provincial Museum of Alberta, Edmonton, Publication Number 4. 127 pp. $5.70.

This book constitutes one of the less orthodox attempts at a handbook that would be of general use to amateur palaeontologists in Alberta or, indeed, adjacent parts of Saskatchewan and the USA. Dr. Storer gives some idea of the background of the book when he notes in the foreword that Mrs. Johnson "is a noted nature artist," has had her works widely exhibited, and has been connected with museums and universities both within Alberta and the rest of Canada. Dr. Storer contributed "a few photographs and revised the text" as he felt that Hope Johnson's drawings constitute a notebook, through which she shared her knowledge with her readers.

I am in the fortunate position of knowing both authors well and believe I understand their motives in putting forth this guide. As with any of its sort, it is not exhaustive nor is it intended for specialists. In general, the text is good and relates the information that a discoverer of a fossil might desire when he tries to identify it. The diagrams are similarly interesting to me, for they are not the sort that a textbook contains, but such as might be drawn in the field. Some are diagrammatic, some overlap in information, and some are not extensively labelled, but they all transmit the air of discovery that the unknown produces. Mrs. Johnson has also included one of her attractive prairie landscapes for the colored cover, which depicts the "Badlands in the Oldman Formation, Dinosaur Provincial Park," near Brooks, Alberta.

The book includes chapters on the Legal Land Descriptions used in Alberta and Saskatchewan, descriptions of the geological formations mentioned in the work and their major outcroppings, osteological terminology, and short chapters on some Cretaceous mammals, and on bison and horse teeth which are often mistaken for dinosaur teeth, all of which contribute markedly to the book's usefulness. There are also twelve references offered for further studies and a glossary of scientific terms.

Obviously, in a work of this sort, there will be errors. Satisfyingly enough, there were no typographical errors that I noticed, although some other errors have intruded. On page 6, "Russell 1970, pp. 1105, 1105" does not refer to D. A. Russell, 1972, pp. 375–402, as cited, but to L. S. Russell, 1970 (Correlation of the Upper Cretaceous Montana Group between Southern Alberta and Montana. Canadian Journal of Earth Sciences 7(4): 1099–1108). There are places where the text appears unclear, e.g., on page 10, "The neural canal is enclosed above by the neural arch" or "Vertebrae that take ribs have facets between the centra, and facets on the neural arches or transverse processes, for attachment of rib heads." It would be better to have said that the neural canal is surrounded by the neural arch (as defined on page 127), or that the heads of the ribs articulate with the facets between the centra, and the tubercles on the ribs with those on the arches or transverse processes. On page 31, "The new tooth moved into its predecessor through this opening, and developed beneath it" is similarly imprecise, even when the opening is given as "the small, arched opening in the base of the rooted tooth shown . . ."

Dimensions are usually measured in both Imperial and Metric, which is suitably timely. Diagrams vary from excellent (e.g., Figure 35) to uninspired (e.g., Figure 29). In Figure 43, the humerus is omitted and chevron bones are introduced for the first time but not explained until page 99 or Figure 111. Exception might also be taken to the statement that "The hadrosaur had the most complex and efficient dental equipment of any animal known" (page 75). Comparison with an elephant or horse for a similar apparatus does not suggest that. Meckelian is misspelled "MecKelian" in Figure 85. On page 77 "A.M.N.H." is not explained, and diacritical marks on "*Troödon*" and parentheses within parentheses on page 31 should have been omitted. There are also a few omitted or misplaced hyphens, commas, or other punctuations.

Despite these criticisms, the book is well worthwhile for anyone who needs a non-technical and reasonably priced guide on his shelves, especially if he lives in the Canadian Prairies. It should delight the heart of any young fossil hunter and be useful to many an older person who is either just curious or has inquisitive juniors. It should also be available in many school libraries throughout Canada, where it will be well thumbed by those children interested in natural science. I therefore recommend it to any that are interested in Natural History and especially to amateurs or those unfamiliar with the area and its deposits.

C. S. CHURCHER

Department of Zoology
University of Toronto
Toronto, Ontario

The Vanishing Harvest

By Ken Johnstone. 1972. Montreal Star, Montreal. 87 pp. $1.95.

The Vanishing Harvest by Ken Johnstone is a book concerned with the Canadian fishing crisis which has arisen as a result of (*a*) pollution, and (*b*) ineffective national and international control of declining fisheries. Although pollution is of great concern, by far the more important danger according to Johnstone is that of overfishing. His premise is that with the advancement of modern technology we are capable of determining the location of, and capturing, whole schools of fish. The contributing factor to this crisis is the philosophy of "unlimited supply." Only in recent years have we learned that the area of greatest productivity of the seas does not extend much further than the limits of the continental shelf, nor deeper than the layer of water a photon of light might penetrate. In terms of world surface, this is a very small productive area. Johnstone points out International Conferences of the Sea policies are ineffective as many countries reject a policy of limiting captures on declining stocks.

Because Johnstone is a journalist by trade, many would consider his book an opinion. Although he does not cite a bibliography, which weakens the impact of the work, it does appear to have been well researched. The book proceeds logically and is interesting to read. I would recommend it as an informative inquiry into our fisheries and their problems.

GERARD MADIGAN

495 Delmar, #36
Pointe Claire, Quebec

Botany

Rocky Mountain Wild Flowers

By A. E. Porsild. 1974. National Museum of Canada and Parks Canada, Ottawa. Natural History Series, Number 2. 454 pp. $5.

A book which will delight alpinists in the mountain parks of Alberta and adjoining areas has recently appeared in both English and French versions. The author is A. E. Porsild who was for many years the respected Chief Botanist of the National Museum of Canada. Included are extremely fine paintings of 250 of the "more easily recognized and showy flowers" by the Norwegian artist-botanist Dagny Tande Lid. Each of these species is accompanied by descriptive, ecological, and distributional comments. Supplementary notes are given for 180 other species so that there is coverage of 430 of the 1250 plants known to the author from the National Parks of Alberta.

The plants are described and illustrated in the order followed by most floristic manuals. Both scientific and common names are given for the families and most of the species. Some of the common names are rather general, such as "Milk-vetch" for *Astragalus striatus* and "Cinquefoil" for *Potentilla diversifolia*, and it is odd that no common names accompany such plants as *Agoseris glauca* and *Saussurea densa*. Occasionally the common names given, like "Alder-leaved Service-Berry" for *Amelanchier alnifolia*, are not current locally. This species is widely known as "Saskatoon" or "Saskatoon-berry" in the west. The accompanying French version includes a number of common names which appear to be innovations on the part of the author.

This book is, as its title indicates, about wild flowers. It deliberately omits the numerically large number of introduced plants which occur in the area covered, many of which appear to grow "wild." Many users of the book will unfortunately not have the botanical background and regional experience to know which of the flowers encountered in the field are in fact native to the area, and as a result will often search in vain for an illustration of something that is not included. A further problem, not mentioned in the title, is that not all of the wild flowers of the area are covered, merely "the commoner and more spectacular ones." The validity of this statement, however, can be queried because of the inclusion of a number of species, like *Festuca altaica, Saxifraga flagellaris, Romanzoffia sitchensis, Lewisia pygmaea*, and *Ranunculus gelidus*, which are extremely rare and most of which could not be called "more spectacular."

The Rocky Mountains cover a vast area from Alaska south to Central America and are occupied by a diverse and extensive flora. The title of this book implies a coverage of the entire system and many purchasers will not realize until later that it is only designed to cover the three Rocky Mountain National Parks in Alberta, namely Jasper, Banff, and Waterton Lakes. It is regrettable that the title could not have been geographically more specific. Imprecision of this sort is, of course, a publisher's ploy to sell more books and other examples can be cited, such as *A Field Guide to Rocky Mountain Wildflowers from Northern Arizona and New Mexico to British Columbia*, by J. J. Craighead et al. and *Wild Flowers in the Rockies* by G. A. and W. V. Hardy. The title is also misleading as it implies a coverage of the wild flowers of all elevations and vegetation zones within the Rocky Mountains, whereas in fact, one learns later that the species included are mainly those of the alpine and subalpine zones.

The reader familiar with Alberta plants will be puzzled by remarks in the text which indicate that the following wide-ranging species are restricted to subalpine or alpine areas: *Koeleria cristata, Allium cernuum, Zygadenus elegans, Hedysarum alpinum, Oxytropis splendens, Geranium viscosissimum, Heracleum lanatum, Antennaria rosea*, and *Aster laevis* var. *geyeri*.

The author rightly refers the more serious reader to E. H. Moss' *Flora of Alberta*, the only book which purports to cover all of the vascular plants of Alberta, as a source of more detailed information. He does so, however, with the implication that one will be able to find each species in Moss by the scientific name used in *Rocky Mountain Wild Flowers*. Unfortunately this is not always the case as Porsild has employed a number of names not used by Moss (e.g., *Lilium montanum* (*L. philadelphicum* var. *andinum*), *Pulsatilla ludoviciana* (*Anemone patens* var. *wolfgangiana*), *Heuchera ovalifolia* (*H. cylindrica*), and *Achillea nigrescens* (*A. millefolium* var. *nigrescens*). The listing of names employed by Moss as synonyms would have avoided this problem but synonyms are never given. Such action is acceptable when the nomenclature one is using follows a standard checklist or other source but this is not the case here.

This book deserves to be purchased and enjoyed by anyone interested in the Rocky Mountain wild flowers of Alberta and British Columbia. It is a worthy addition to S. Brown and C. Schaffer's *Alpine Flora of the Canadian Rocky Mountains,* J. W. Henshaw's *Mountain Wild Flowers of Canada*, and G. A. and W. V. Hardy's *Wild Flowers in the Rockies.* The illustrations are among the best to appear on the species covered while the text is both interesting and informative.

CHARLES D. BIRD

Department of Biology
University of Calgary
Calgary, Alberta T2N 1N4

The Alaska-Yukon Wild Flowers Guide

By Helen A. White and Maxine Williams. 1974. Alaska Northwest Publishing Co., Box 4-EEE, Anchorage, Alaska 99509. viii + 218 pp., colored illustrations and line drawings. $7.95 (softbound) + 50c postage and handling.

The title of this book is perhaps somewhat misleading. This is a collection of color photographs of 164 species of flowers which are found in Alaska or the Yukon Territory. These were photographed by 23 individuals, but strangely no mention is made of these, other than a name under the picture. The pictures are good, particularly the close-ups, although the colors did not always reproduce true.

An interesting feature is the addition of small line drawings by Virginia Howie. These bring out features often not readily observed in the photographs. A paragraph which contains a few words of description and habitat and a lot about the distribution also accompanies the photograph.

This small but colorful book will serve as an introduction, primarily for the tourist, to some of the fascinating plants found in Alaska and Yukon, although undoubtedly he will not find them all himself. It will also serve as a backdrop to the stories he will tell of his visit to the far northwestern part of North America.

WILLIAM J. CODY

Biosystematics Research Institute
Central Experimental Farm
Ottawa, Ontario K1A 0C6

Illustrated Key to the Carices in Newfoundland: based on floral structures

By Alexander W. Robertson and Frederick C. Pollett. 1974. Newfoundland Forest Research Centre, St. John's, Newfoundland. Information Report N-X-109. 28 pp. illustrated.

The genus *Carex* is a notoriously difficult one. The authors have attempted to produce a simple dichotomous key, coupled with a schematic key, to the 93 species known to occur in Newfoundland. The key is of the one-character type, which, as Fernald says, "so often fails to turn in the lock." Often it seems that the less easily observed and less decisive characters have been used instead of those which are easy to observe surely and which yield sharp separations. The diagrams on the right-hand pages have often been so conventionalized as to convey very little (or a wrong) impression of the appearance of the sedge. Various errors in the text and drawings will lead the user in some instances to a wrong determination. The beginning student of sedges in Newfoundland would be better off working from Fernald's treatment in the 8th (1950) edition of Gray's Manual.

JOHN H. HUDSON

W. P. Fraser Herbarium
University of Saskatchewan
Saskatoon, Saskatchewan

Peatlands

By Peter D. Moore and D. J. Bellamy. 1974. Springer-Verlag, New York. 224 pp. $12.

Because the subject of peatlands covers a myriad of research interests, seldom do authors attempt to compile a review of these interests. Moore and Bellamy have boldly attempted this challenge, and have been remarkably successful. They cover topics ranging from the use of peatlands as an energy source to its use as an ecological study area. With the expansion of interest in ecology, peatlands have received renewed interests in countries such as Finland, Poland, Ireland, Russia, and more recently Canada. Each country developed its own characteristic approach. This book takes an overview of the many pieces of research done in several countries, and on many aspects of the development of peat or mire systems. One of the most important contributions made by Drs. Moore and Bellamy has been the compilation and integration of the numerous classification systems from individual nations.

This book will be most suitable as a major reference text for senior-level courses in ecology. The references at the end of each chapter will be found by the student to be most useful in extending his knowledge of the material which has been abridged by the authors. The authors, although both botanists, have deliberately reduced the use of genera and species to a modicum; thus the book can be read and understood by almost any person interested in peatlands.

The sections of the geochemical template and the hydrological template explain, by using precise facts, the many variations on a mire complex. This, combined with the evidence available on the productivity of mire as an ecosystem, points out some of the more contemporary aspects of peatland research, and uses it to explain basic concepts held two generations ago. The chapter on peat stratigraphy, based both on the peat's plant fragments as well as upon its pollen, is more or less a standard review of what is known at the present time.

This book closes by discussing what is known of the mire systems throughout the world, the world's resources of peat, and its conservation. What the numbers illustrate is that the statistics on the world's peat resources are in many cases only estimates and that the uses of mires for horticultural, agricultural, or an energy source in some areas have been a serious drain upon the nation's peat reserves, whereas in other countries, Canada in particular, very few sites are being used to exploit the muskeg.

Much research needs to be done in almost every area of peatland studies but a most important contribution that can be made is to bring together what is known in the various countries of the world. This Moore and Bellamy have done. Their book will serve as a major reference text for years to come.

H. R. N. EYDT

Department of Biology
University of Waterloo
Waterloo, Ontario

ENVIRONMENT

Freshwater Pollution, Canadian Style

By Peter A. Larkin. 1974. McGill-Queen's University Press, Montreal. 132 pp. $2.50.

Professor Larkin's book consists of, first, an overview of Canadian regional limnology which effectively stresses the wide differences among our lakes and rivers, and secondly, an extensive account of the nature and ecological significance, now and in future, of virtually all of the water management (not only pollution) problems that we face. Both aspects are well treated. The author makes good use of the lucid, uncluttered descriptions of lake ecosystems conceptualized by D. S. Rawson some time ago. He carries the concept "that no two [lakes] are ever quite the same" through his analysis of ecological effects of pollutants on waters of varied chemistry, physical character, and biota. His conclusion that "it is impossible to make a simple statement that a certain substance is harmful without specifying the nature and the volume of the receiving waters" is music to the ears of limnologists, but likely only noise to some number-hungry water managers of the old sort.

Pollutants are examined in five categories, as follows: organic oxygen-consuming wastes, toxic substances, nutrients, waste heat, and radioisotopes. A realistic viewpoint is prevalent, as the author indicates that organic matter, nutrients, and heat, in the right place and amount, could enhance aquatic productivity to man's advantage. This is wise, albeit risky, advice at a time when attitudes to waste management practices seem to be polarized. But, this idea, together with a holistic approach to resources management, could help pave the way toward the type of planning that could direct some wastewaters to advantageous ends. Comments on toxic substances and radioisotopes are less optimistic, particularly the disturbing fact that new contaminants continue to be injected into the environment at a rate much faster than we can acquire knowledge of possible harmful features. The author's closing statement on toxicants is "that either the level of research should be greatly increased, or their discharge into natural lakes and streams should be prohibited until they are proven harmless." Evidently Professor Larkin has placed the various categories of pollutants in proper perspective. In addition he has demonstrated the relatedness among pollutants; for example, waste heat may aggravate the effects of nutrients (in cultural eutrophication), and both of these would be expected to maximize biomagnification of radioisotopes in local areas. There was one apparent lapse, however, in the statement that "with complete control of discharges, Lake Erie could be back to natural conditions in five to six years"; this overlooks the existing burden of PCBs and mercury and other contaminants which will probably occur at levels several times above "natural" for some time.

There is a wide variety of recommendations scattered through the narrative. These call for careful sustained-yield management of Precambrian Shield fisheries, a caution on the possible spread of parasites of fishes, mandatory rehabilitation of mined areas, less laissez-faire in the availability of pesticides, more preventative (as opposed to punitive) measures in waste management, and several other sound proposals. Research needs also are indicated, including studies on effects of toxic substances (and especially whether we have already other semi-permanent environmental contaminants), on the use of waste heat and sewage in agriculture, on the long-term effects of radioisotopes on human health, on the socio-economic and ecological effects of large-scale water management schemes, on technological treatments to biodegrade oils, pulp mill wastes, and to immobilize sedimented mercury if possible.

The last chapter has little to do with water pollution, in the strict sense of the word, but it provides a good overview of the impacts of land and water use, especially of the variety of perils in big dam construction. It is here that the author makes the best case for holistic approaches to resource management.

The accoutrements to the book include an excellent set of figures for the author's purpose, a good selection of general references on pollution (although not on limnology or oceanography), and a reference list of over 100 scientific papers on Canadian efforts in the water pollution field. The Canada Water Act, all of it, has been included as an appendix. Although this statute is new and apparently not widely understood, I believe the reader might have preferred a listing of pertinent federal and provincial statutes, indicating also the minister(s) responsible for regulations made pursuant to these acts.

In conclusion I believe that the author has been successful in the credible missionary role that was intended by the Canadian Society of Zoologists which sponsored production of the book. The book will be useful in teaching, at the secondary school and early university levels, especially in general courses in environmental studies, in which case the reading list will be of added value. It will be of interest to the general public, having as it does, two guarantees for success. First, it is well written and illustrated, and, secondly, with Sudbury, Lake Erie, James Bay, the Mackenzie River, the Bennett dam, Halifax, and other familiar places featured, no Canadian ought to feel that he or she has been left out.

M. G. JOHNSON

Fisheries & Marine Service
Department of the Environment
Canada Centre for Inland Waters
Burlington, Ontario

The Life of the Far North

By W. A. Fuller and J. C. Holmes. 1972. McGraw Hill, New York. 232 pp. $4.95 hard cover.

Explicit, factual, skillfully interpreted for all ages, timely, beautiful to behold, written with ease and grace, this splendid book breaks new literary ground. Abundant illustrations, mostly in color, are fresh, appropriate, full of implied action, without a trace of the stereotype or the lugubrious. The illustrations are scattered from title page to end page and are keyed to adjoining text, easily debunking the old rule that plates have to be lumped together, remote from relevant text. An appendix on tinted stock deals with topics related to the title such as northern national parks, northern characteristics of mountain national parks, man's experience with permafrost, and threatened species of northern wildlife. Glossary, basic bibliography, and index complete the book. Some pages carrying text enigmatically lack serial numbers and are a minor irritation.

The title will mean different things to different readers, depending on one's view of just where "the far north" begins and ends. It may, however, be an appropriate underlining of our heritage as a land mostly under a northern influence which becomes more intense and pure as one travels towards the polar source. Northern technical terms are explained and illustrated. Words such as boreal, taiga, permafrost, polygons, pingo, and solifluction are part of an arctic heritage and should be known to all who share it.

The first section, "The Northern World" is largely descriptive. It is like a journey, starting in the northern forest, passing through the transition zone to the limit of land and to the polar sea beyond. The route is the Peace River, the vehicle a canoe, the destination is the ice-choked polar sea. The fact that the journey detours across the continent, through Algonquin Park in Ontario to pick up threads of the story does not detract at all from the flow and continuity of the trip. The smallest lichens and sedges, the mighty moose, bison, caribou, and muskox that live there are all viewed in intimate detail. So also are the lesser animals and the predators, both bird and mammal, that reign over the pyramid of numbers: the so-called food chain. And in the background lie the solemn glaciers whose retreat during the last few thousand years has released the land and allowed the rich profusion of arctic life to develop.

The second section outlines the web-of-life relationships, mostly during winter, in the northern forest called "taiga," land of extremes. The problems of food, predation, and reproduction govern the lives and actions of wild creatures. Through the darkening, brooding, silent winter, dimly lit by the aurora, the few animals that hibernate are safe. Those which turn white and blend with the snowy scenery sneak about, looking for food. They live in the presence of predators that must kill and eat regularly. Some live on stored foods and body fat. All are adapted to cope with a certain way of life, yet few are free of danger. The dangers lessen, but do not disappear, with return of the warm or even hot summer weather.

Chapters about ecology follow each other as smoothly and as naturally as the seasons. The third chapter examines the long summer day of the farthest north. The workings of nature outlined earlier, pass as a reverie of comings and goings and intimate glimpses into the lives of arctic creatures large and small. The cameo of a clutch of Snowy Owl eggs in a saucer-shaped nest of frozen mud rimmed with snow, surely evokes images of a harsh northern environment. Yet the egg season, still bitterly cold, must take place before summer warmth arrives so that the young may be self-sufficient before winter returns. The biological explosion of summer is the key to survival. During the rest of the year the food produced in a few short warm weeks is passed around, throughout the web of life.

Too important to remain an isolated cult, too complex for instant comprehension and not yet a hard science, ecology comes closer than any other discipline to defining man in the natural world. The authors of this "ecology" book, assisted by a readability consultant (an innovation in itself), handily dispel the adage that academics do not write for people. More elegant than mere information, yet not quite a coffee-table book, *The Life of the Far North* fills a need for concerned citizens who may be puzzled by so much talk and so little perspective concerning Canada's real national heritage: a vast northern landscape. It should be required reading for every sociologist, economist, industrialist, geographer, planner, or administrator who has anything to do with the northern third of Canada.

R. D. MUIR

Canadian Wildlife Service
Ottawa, Ontario K1A 0H3

Wildlife in an Urbanizing Environment

Edited by John H. Noyes and Donald R. Progulske. 1974. Proceedings of a conference held November 1973 in Springfield, Massachusetts. Cooperative Extension Service, University of Massachusetts, U.S. Department of Agriculture and County Extension Services Cooperating. 184 pp. $3. Available from Room 213, Stockbridge Hall, University of Massachusetts, Amherst, Mass. 01002.

Like all the proceedings which emanate from conferences *Wildlife in an Urbanizing Environment* has its good points and its bad. It is useful in that it provides in one volume an up-to-date compilation of work being done on animals which inhabit cities; it is at the same time rather a hotch-potch of studies and essays often overlapping in theme and of varying degrees of depth, none of which have undergone refereeing by other authorities in the field.

The 33 papers in the volume are grouped into four sections: the philosophy of urban wildlife, public and private roles in urban wildlife management, studies in urban wildlife, and people and urban wildlife. Many of the articles tend to generalize about the necessity and means of encouraging wildlife in cities, but some are of more particular interest to naturalists, especially those on robins, mallards, cardinals, blue jays, squirrels, raccoons, coyotes, stray dogs, amphibians, and reptiles. Other research deals with animals in cemeteries, problems of wildlife diseases and parasites, and bird collisions with aircraft.

This book is attractively prepared, with good photographs. At $3 it is a work well worth buying for anyone interested in urban wildlife.

ANNE INNIS DAGG

Otter Press
Box 747
Waterloo, Ontario

Energy Needs and the Environment

Edited by Robert L. Seale and Raymond A. Sierka. 1973. The University of Arizona Press, Tucson, Arizona. 349 pp. $9.50.

I found this to be a disappointing book in several respects. First, the date of publication suggests that the book contains relatively recent information. But the work is actually a compilation of 19 papers presented at a symposium held at the University of Arizona in 1971 entitled "Energy, the Environment, and Education." The latest reference that I found was dated April 1971. Four-year-old information is not necessarily obsolete, but when the information deals with energy technology and environmental technology, such data may not only be obsolete, but misleading.

A second criticism of the volume is that most of the contributed papers are by engineers employed by energy-related agencies or firms and tend to reflect their rather specific interests that were current in 1971. As a result, most of the papers are technical state-of-the-art studies which will be of interest to a limited audience. With the energy/environment picture changing as rapidly as it is, books may not be the best vehicles for transmitting such information. Perhaps the most appropriate way to transmit this sort of material might have been via the media of technical journals or annual reviews.

Another fault I see in this book is its approach to environmental aspects of energy production. Often the papers concentrate upon the engineering aspects of a specific energy-related research project, giving the environmental concerns related to such a project a relatively perfunctory treatment.

A further complaint is that most of the papers devote little or no attention to the so-called "aesthetic" environmental problems such as strip-mining for fossil fuels and the atmospheric pollution of the regions adjacent to coal-fired electric-generating plants. Also, the biological aspects of thermal pollution of lakes, rivers, and oceans by energy-generating facilities is not well handled. Some technical innovations relating to these problems are discussed, but one does not get a thorough picture of how serious such problems are or are not, nor precisely what is being done in this area by engineers and biologists.

Another void in this collection is any discussion of the potential of energy sources other than fossil fuels or nuclear fuels. Wind power, tidal power, geothermal sources, and solar energy are summarily dismissed in one early paper, not to be discussed again.

In general, the collection of papers presents an incomplete picture of technical U.S.-oriented developments into energy technology and related environmental research. The editors might have produced a more useful volume by cutting out much of the repetitious material which appears in several papers, and by tying the papers together with some worthy editorial comments. A final editorial boost to this book could have been the addition of an index.

One important message that does arise in some of the more thought-provoking papers is that industrial and population growth cannot continue unchecked as it has in the past. Without some highly improbable technical miracle occurring, we shall not have the energy potential to keep up with such growth, nor will we have the ability to retain a livable environment.

MICHAEL P. KINCH

Science-Technology Division
Oregon State University Library
Corvallis, Oregon 97331

Richard Harrington's Yukon

By Richard Harrington. 1974. Alaska Northwest Publishing, Box 4-EEE, Anchorage, Alaska. 103 pp. $7.95 + .50 postage.

The Alaska Northwest Publishing Company has done such a good job of capturing the spirit and beauty of Alaska in its books that it is a pleasure to find it has turned its attention to Canada in publishing *Richard Harrington's Yukon*. Richard Harrington, a well-known Canadian author and photographer, has travelled to all parts of the Yukon in the course of 20 years, taking colored photographs of its people, towns, ruins, mountains, waterways, and wildlife. The best of these pictures are included in this book, which has almost no text aside from descriptive captions. The photographs are grouped into regions: along the Yukon River, the far north, the Ross River area, the Alaska Highway, and the Kluane National Park. Each section gives one an excellent idea of what it would be like actually to be there. And indeed this book may inspire many Canadians to visit this wild and historic part of their nation.

ANNE INNIS DAGG

Otter Press
Box 747
Waterloo, Ontario

Vegetation and Environment in the Central Research Forest, Ottawa Greenbelt

By J. K. Jeglum, M. J. J. Bik, and J. Salm. 1974. Canadian Forestry Service, Department of the Environment. Information Report 0-X-203. 52 pp. (Available from Canadian Forestry Service, Box 490, Sault Ste. Marie, Ontario P6A 5M7.)

The Central Research Forest is a 950-acre tract of open farmland, brushland, and forest, not far outside Ottawa's suburbs. This ecological survey of the forest sets out (1) to describe and document the physical environment, history of occupation and abandonment, and forested vegetation of the Central Research Forest, and (2) to examine in some depth the relationships between the forested vegetation and selected physical factors of the environment.

Studies of the soils, geology, and hydrology preceded the vegetational work. These reveal the major changes in the landscape from the disappearance of the Wisconsin ice cover, through submergence by the Champlain Sea, and subsequent to its withdrawal in response to isostatic uplift. The present landforms and deposits, described and mapped here in considerable detail, are estimated to be between 7500 and 10 000 years old. An elaborate grid of groundwater wells was established to study geomorphology, soil profiles, and groundwater properties.

A reconstruction of the vegetational history begins with postglacial development as interpreted from pollen analysis in the adjacent Mer Bleue peat bog. The species sequence in the pollen record indicates the changes in climate from the Champlain Sea recession until recent times. Although Indians were probably present from early times, no marks of human influence are visible in the record until about 150 years ago when a drastic reduction in pine pollen marks the clearing and logging by white settlers. Subsequent human influences on the landscape include pasturing, ditching, power-line clearance, soil strip-mining, and sugar-bush operations.

Vegetation sampling was limited to two forested blocks of 84 and 224 acres. Using 49 species, an agglomerative classification defines shrub–herb stand types, and species groups. A principal component analysis using a variance–covariance matrix and R-type analysis, based on vegetational variation and several habitat measures, is applied first to tree and sapling data, then to shrub and herb data of the same 49 species treated in the agglomerative classification. The habitat measures include moisture-, light-, and edaphic-relief-related measures. The analysis is presented in tables and the results are discussed. From these, environmental models are developed for Tree – Tall Shrub dominance types, and for Shrub–Herb Understory types. It is concluded that vegetational variation in the Central Research Forest is influenced mainly by light and moisture.

The various approaches used in analyzing ecological relationships lead to useful insights in understanding the present state of the vegetation, and enable the authors to predict future development of the forest. This would assume no further disturbances to the natural course of succession. In fact, the basic information assembled here will form a background for development of the area by the Forest Management Institute of the Canadian Forestry Service, for such uses as forestry research, teaching and demonstration, and interpretive nature study. This paper-bound report is illustrated with photos of characteristic vegetation; three maps tucked into a back pocket show terrain units, land use summary, and forest and vegetation cover types. The plant list in an appendix appears almost complete, although this reviewer detected the omission of one showy species which grows in the Central Research Forest.

This report will interest many students of landscape. It is a valuable demonstration of the amount and quality of information that can be assembled about one parcel of land, and will provide a useful model for other such studies.

ANNE HANES

18 Briarcliffe Drive
Ottawa, Ontario

OTHER BOOKS

To the Arctic by Canoe 1819–1821

The journal and paintings of Robert Hood, Midshipman with Franklin

Edited by C. Stuart Houston. 1974. McGill-Queens. 217 pp. $17.50.

The Canadian Arctic is one of the most beautiful but climatically harsh places in the world. Today travelling there is very much taken for granted with the aid of good maps, radio, aircraft, and other modern conveniences. Even so, to experience its beauty a good deal of planning and forethought must go into any adventure into this land.

In 1819 a dedicated, but by our standards ill-prepared group of Englishmen set out under the instructions of the Lords Commissioner of the Admiralty to attempt, once more, to find the Northwest Passage to the Orient by mapping the land. Hood's journal is an account of this expedition.

To the Arctic by Canoe includes an excellent introduction by C. Stuart Houston, the Editor. His travels by canoe through much of Franklin's country have greatly increased his sensitivity towards the experiences of those early explorers. There are five maps showing the route of the expedition beginning with a map of North America and the Atlantic Ocean which does much to orient the reader. The maps are clearly printed with fine detail and are extremely well labelled.

The body of the work consists of eight chapters, six of which are the narrative of the proceedings of the expedition from Gravesend, England, to Point Lake, Northwest Territories. Two chapters deal with Hood's scientific work on buffalo, climate, aurora borealis, magnetic phenomena, and his account of the Cree Indians. Throughout, the Editor has added notes at the bottom of each page; these are useful in explaining otherwise obscure points.

Prior to the invention of photography, it was essential to have an artist with the expedition. Both Hood and Back were talented and Hood showed great skill in his paintings, twenty of which have been reproduced at the end of the book along with explanatory notes.

The work stimulates much thought, particularly with regard to comparisons between Hood's time and today. The differences are essentially technological, the underlying values of the people involved remaining virtually the same.

Mr. Franklin's respect for nature even extended to the mosquito which he considered had its rightful place in the scheme of things. Wild animals were a commodity to such people, either as sustenance or to be left alone, but not an object of sport. The same values are true today and the reader will identify with many aspects of the expedition as it is presented by Hood in this publication.

SUSAN PURCHASE

18–130 Columbia Street, W.
Waterloo, Ontario

For a Lark: A Remedial Field Guide for Confused Bird Watchers

By John Huberman and Sylvia Tait. 1974. Privately printed in Vancouver. (4765 West 6, Vancouver, B.C. V6T 1C4) 56 pp. $2.95.

Puns based on bird names are familiar to all, and the bird-watcher with his binoculars and field guide is standard joke material for every comedian. Now John Huberman has gone a step farther by writing a series of short poems or couplets about birds in the Ogden Nash style, combining them with bird caricatures by Sylvia Tait to produce this self-styled remedial field guide for confused bird-watchers.

With such a good basic concept and a wealth of bird names available, this has all the potential of a fine book. Unfortunately, it does not live up to its promise. While some of Huberman's poems are both clever and funny there are others that are not worth printing. In some cases the subject material is in poor taste and should have been omitted.

Sylvia Tait's sketches have enough of the cartoonist's touch to match the mood of the book and still bear some resemblance to the bird in the text, which is a neat trick. This is all to the good because even the best of bird-watchers will be confused after reading about the Heroic Heron and the Itchy Dowitcher.

This book should appeal to the reader who likes his poetry short and funny, and if he likes puns on bird names he'll enjoy these. Why Huberman overlooked the Loon, Coot, Red-eyed Vireo, Yellow-bellied Sapsucker, and many others is puzzling. No wonder the book is so short.

W. F. COOPER

317 Highland Road East
Kitchener, Ontario

NEW TITLES

Zoology

Animal architecture. 1974. By Karl von Frisch. Harcourt Brace Jovanovich, New York. 306 pp. $12.95. Translated from the German.

Birds. Brain and behavior. Papers from a conference, Morgantown, W. Va. 1971. Edited by I. J. Goodman and M. W. Schein. Academic Press, New York. 274 pp. $15.

The collector's encyclopedia of shells. 1974. Edited by S. P. Dance. McGraw-Hill, New York. 288 pp. $19.95.

East African mammals. An atlas of evolution in Africa. Vol. II. 1975. By J. Kingdon. Academic Press, New York. Part A, Insectivores and Bats, 404 pp. $35. Part B, Hares and Rodents, 430 pp. $37.50.

The identification of mammalian hair. 1974. By H. Brunner and B. Coman. Inkata Press, Clayton North, Victoria, Australia. 196 pp. $27 Australian.

The insects of the Los Angeles Basin. 1974. By C. L. Hogue. Natural History Museum of Los Angeles County, Los Angeles. 174 pp. Paper, $6.

Mosquitoes of North America (North of Mexico). 1974. By S. J. Carpenter and W. J. LaCasse. University of California Press, Berkeley. 360 pp. $28.50. Reprint of 1955 edition.

The moths of America north of Mexico. Including Greenland. Fascicles 6.2. 1974. By R. W. Hodges. Classey and R.B.D. Publications, London. 142 pp. Paper $57.

Pollution ecology of freshwater invertebrates. 1974. Edited by C. W. Hart, Jr. and S. L. H. Fuller. Academic Press, New York. 390 pp. $24.50.

Le polymorphisme dans le Règne Animal. 1974. Edited by M. Lamotte. Société Zoologique de France, Paris. 562 pp. Paper 75F.

Reptiles and amphibians in the service of man. 1974. By W. T. Neill. Pegasus (Bobbs-Merrill), Indianapolis. 248 pp. Cloth, $6.95; paper, $2.95.

Waterfowl and wetlands. Towards bioeconomic analysis. 1974. By J. Hammack and G. M. Brown, Jr. Resources for the Future, Washington, D.C. (Distributed by Johns Hopkins University Press, Baltimore.) 96 pp. $7.

Botany

Allelopathy. 1974. By E. L. Rice. Academic Press, New York. 353 pp. $25. The book covers biochemical interactions between plants of all levels of complexity, including microorganisms.

An atlas of pollen of the trees and shrubs of eastern Canada and the adjacent United States. Part II, Ulmaceae to Rosaceae. 1974. By R. J. Adams and J. K. Morton. Department of Biology, University of Waterloo, Waterloo, Ontario. 53 pp. $2.50.

The complete book of mushrooms. 1974. By A. Rinaldi and V. Tyndalo. Crown, New York. 332 pp. $14.95. Translated from the Italian.

The distribution of forest trees in California. 1974. By J. R. Griffin and W. B. Critchfield. From Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 114 pp. $1.75. Stock No. 0101–0243.

A flora of the Trinity Alps of Northern California. 1974. By W. J. Ferlatte. University of California Press, Berkeley. 206 pp. $10.95.

Guide to Alaska trees. 1974. By L. A. Viereck and E. L. Little. From Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 98 pp. $1.35. Stock No. 0100–03308.

The Hepaticae and Anthocerotae of North America east of the hundredth meridian. Vol. III. 1974. By R. M. Schuster. Columbia University Press, New York. 880 pp.

Introduction to plant ecology. A guide for beginners in the study of plant communities. 1973. By A. J. Willis. Allen and Unwin, London. 4th edition. (U.S. Distributor Crane, Russak, New York.) 238 pp. Paper, $9.75.

Native shrubs of the Sierra Nevada. 1974. By J. H. Thomas and D. R. Parnell. University of California Press, Berkeley and Los Angeles. 127 pp.

Primary production and production processes, tundra biome. Proceedings of a conference, Dublin, April 1973. 1973. Edited by L. C. Bliss and F. E. Wielgolaski. Available from Department of Botany, University of Alberta, Edmonton, Canada. 256 pp. $4.

Rare or endangered vascular plants of New Jersey. 1973. By D. E. Fairbrothers and M. Y. Hough. Science Notes No. 14, New Jersey State Museum, Trenton, New Jersey. 53 pp.

Rare and local conifers in the United States. 1975. By E. L. Little. From Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 25 pp. 75¢.

Shrubs of Newfoundland. 1974. By A. G. Ryan. Parks Division, Department of Tourism, Newfoundland. 79 pp. Free.

Sierra wildflowers. Mt. Lassen to Kern Canyon. 1974. By T. F. Niehaus. University of California Press, Berkeley and Los Angeles. 223 pp.

A student's atlas of flowering plants. Some dicotyledons of eastern North America. 1974. By C. E. Wood, Jr. Harper and Row, New York. 123 pp. $2.95.

Trees of Puerto Rico and the Virgin Islands. Vol. 2. 1974. By E. L. Little, R. O. Woodbury, and F. H. Wadsworth. From Superintendent of Documents, Government Printing Office, Washington, D.C. 1024 pp. $13.45.

Trees: structure and function. 1974. By M. H. Zimmermann and C. L. Brown. Springer-Verlag, New York. 2nd edition. 336 pp. $12.

World directory of plant pathologists. 1973. Edited by F. E. Fisher. Published at Lake Alfred, Florida. 141 pp.

Environment

A concrete look at nature. Central Park (and other) glimpses. 1974. By E. Kinkead. Quadrangle (New York Times), New York. 242 pp. $8.95.

Encyclopedia of minerals. 1974. By W. L. Roberts, G. R. Rapp Jr., and J. Weber. Van Nostrand Reinhold, New York. 694 pp. $69.50.

Fire and ecosystems. 1974. Edited by T. T. Kozlowski and C. E. Ahlgren. Academic Press, New York. 553 pp. $39.50.

Handbook of common methods in limnology. 1974. By O. T. Lind. Mosby, St. Louis. 154 pp. $5.95.

Introduction à la géographie générale de l'agriculture. 1974. By G. Gilbank. Masson, Paris. 256 pp. 49F.

Living things. An introduction to natural history. 1974. By D. M. Allred. Brigham Young University Press, Provo, Utah. 132 pp. $9.95.

Oil spills and the marine environment. A report to the Energy Policy Project of the Ford Foundation. 1974. By D. F. Boesch, C. H. Hershner, and J. H. Milgram. Ballinger, Cambridge, Mass. 116 pp. Cloth, $7; paper, $2.50.

Perspectives of biophysical ecology. 1975. Edited by D. M. Gates and R. B. Schmerl. Springer-Verlag, New York. 609 pp. $34.80.

***Richard Harrington's Yukon.** 1974. By Richard Harrington. Alaska Northwest Publishing, 4-EEE, Anchorage, Alaska. 103 pp. $7.95 + 50¢ postage.

Survival in toxic environments. 1974. Edited by M. A. Q. Khan and J. P. Bederka. Academic Press, New York. 558 pp. $19.50.

Two nations, one lake. Science in support of Great Lakes Management. Objectives and activities of the International Field Year for the Great Lakes, 1965–1973. 1974. Prepared by J. O. Ludwigson. Canadian National Committee for International Hydrological Decade, Ottawa. 146 pp.

***Vignettes of nature in southern Ontario.** 1974. By W. W. Judd. Carlton Press, 84 Fifth Avenue, New York. $3 + 30¢ postage.

***Wilderness areas of North America.** 1974. By A. and M. Sutton. Funk and Wagnals, New York. 406 pp. $10.

Miscellaneous

***The contrasumers.** A citizen's guide to resource conservation. 1974. By A. J. Fritsch. Praeger, New York. 182 pp. Cloth $7.95; paper, $3.50.

***Natural history photography.** 1975. By D. M. T. Ettlinger. Academic Press, London. 414 pp. $23.25.

Selected Alaska hunting and fishing tales. Vol. III. 1975. Alaska Northwest Publishing, Anchorage, Alaska. 100 pp. $3.95 + 50¢ postage.

* Assigned for review

Information Concerning Content of *The Canadian Field-Naturalist*

Articles

The Canadian Field-Naturalist is a medium for publication of research papers in all fields of natural history. If possible, major articles should be illustrated.

Notes

Short notes on natural history and related topics written by naturalists and scientists are welcome. Range extensions, interesting behavior, pollution data, and other kinds of natural history observations may be offered. It is hoped, however, that naturalists will also support local natural history publications.

Letters

Letters commenting on items appearing in this journal or on any developments or current events affecting natural history and environmental values are welcome. These should be brief, clear, pertinent, and of interest to a wide audience.

News and Comment

Informed naturalists, biologists, and others are invited to present documented narratives and commentaries upon current scientific and political events that affect Canadian natural history and the environment. Contributions should be as short as possible and to the point.

Book Reviews

Normally, only solicited reviews are published. Biologists and naturalists, however, are invited to submit lists of titles (complete with pertinent information regarding authors, publisher, date of publication, illustrations, number of pages and price) for listing under "New Titles."

Special Items

As *The Canadian Field-Naturalist* has a flexible publication policy, items not covered in the traditional sections can be given a special place provided they are judged suitable.

Reviewing Policy of *The Canadian Field-Naturalist*

Manuscripts submitted to *The Canadian Field-Naturalist* are normally sent to an Associate Editor and at least one other reviewer. If their comments concerning the scientific merit and suitability of the manuscript for publication are widely divergent or if an original referee's field of competence does not cover the entire contents of the manuscript, one or two additional referees are asked to review it. Referees are requested to complete their reviews within three weeks or to return the manuscript immediately and suggest an alternate reviewer. Reviews offering a general appraisal of the manuscript followed by specific comments and recommendations for revision are most useful to the Editor and author.

Most manuscripts with a content suitable for *The Canadian Field-Naturalist* must undergo revision — sometimes extensive revision. After resubmission, manuscripts that required major revision are usually returned to the original referees for re-evaluation. Some manuscripts must be rejected if they are scientifically unsound, unimportant (i.e. they do not contribute any worthwhile information), or are otherwise unsuitable for publication. The Editor makes the final decision on whether a manuscript is acceptable for publication and in so doing aims to maintain the scientific quality and overall high standards of the journal.

Instructions to Contributors

Manuscripts

Authors should submit three complete manuscripts with two copies of figures (in addition to the originals) for use by referees. Manuscripts are accepted in either English or French. They should be typewritten on paper measuring $8\frac{1}{2} \times 11$ inches, and if possible, the paper should have numbered lines. Margins should be 1 to $1\frac{1}{2}$ inches wide to allow for copy marking. All text matter, including quotations, footnotes, tables, literature citations and captions for figures should be double-spaced. Only words meant to appear in italics should be underlined. Every sheet of the manuscript should be numbered. In no case should words be abbreviated; this includes references to tables and figures as well as literature citations. Authors are requested, however, to use SI symbols for units of measure.

It is strongly recommended that, before submitting a paper, authors ask qualified persons to appraise it.

An abstract is required for all Articles but is optional for Notes. Authors are requested to use at least one given name. Literature cited should be listed alphabetically according to author and should be placed immediately after the main body of the text, except in Letters to the Editor. If only one or two references are cited, they should be inserted in the text. The tables should be titled and numbered consecutively in arabic numerals, and each should be placed on a separate page after the Literature Cited. Captions for figures should be typed together on one page. The places in the text for tables and figures should be marked in the margin.

Extensive tabular or other supplementary material not essential to the text should be submitted on letter size paper ($8\frac{1}{2}'' \times 11''$) for the Editor to place in the Depository of Unpublished Data, National Science Library, National Research Council of Canada, Ottawa, Canada K1A 0S2. A notation in the published text should state that the material is available, at a nominal charge, from the Depository. Two copies are required for the Depository.

The **CBE Style Manual**, third edition (1972), published for the Council of Biology Editors, Committee on Form and Style, by the American Institute of Biological Sciences, is recommended as a guide to contributors.

Webster's New International Dictionary is the authority for spelling. In a case, however, of difference in the spelling of a common name, and in the use of a variant name, a decision of a learned society is preferred.

The order in which papers are published will be determined by the Editor.

Illustrations

All illustrations should be numbered consecutively in arabic numerals. The author's name, title of the paper, and figure number should be written in the lower left corner of the sheet on which each illustration appears. The caption should **not** appear on the illustration.

Line drawings should be made with India ink on white, good quality drawing paper, blue tracing linen, or good quality blue-lined co-ordinate paper. Co-ordinate lines that are to appear on the reproduction should be ruled in black ink. Descriptive matter should be lettered, not typewritten, and all parts of the drawing should permit easy legibility even if a reduction is made. Photographic reproductions of line drawings are acceptable in lieu of large originals.

Photographs should have a glossy finish and show sharp contrasts. For reproduction as a complete plate they should be mounted with minimal space between prints.

For large drawings and mounted photographs the ratio of height to width should conform to that of the printed journal page (ratio of 45 up to 35 across) or roughly $7\frac{1}{2} \times 5\frac{3}{4}$ inches, but the height should be adjusted to allow for the caption if the caption is to go on the same page.

Special Charges

Authors must share in the cost of publication by paying \$40.00 for each page in excess of six journal pages. When grant or institutional funds are available, we ask authors to help defray a higher proportion of the cost of publishing their manuscripts. At the time the galley proofs are sent to authors, the journal will solicit on a voluntary basis a commitment to pay \$40.00 per page for all published pages. Authors will also be charged for excessive changes in proofs.

Illustrations cost \$5.00 each for any size (up to a full page). Tables cost up to \$40.00 per page, depending upon size. The special charges for illustrations and tables are *in addition* to all charges that are levied for pages in excess of six. Reproduction of color photos is extremely expensive and the full cost must be borne by authors. Price quotations may be obtained from the Business Manager.

Limited journal funds are available to help offset publication charges to authors with minimal financial resources. Requests for financial assistance should be made to the Editor when the manuscript is submitted.

Reprints

An order form for the purchase of reprints will accompany the galley proofs sent to authors.

TABLE OF CONTENTS *(concluded)*

Mailing date of previous issue 28 May 1975

Call for Nominations for OFNC Council

A Nominating Committee has been chosen as required by the Constitution. Its members are C. Gruchy, A. Reddoch, and I. Sutherland. The Committee will be guided on its duties by a proposed by-law which requires that it nominate candidates for the 5 officers and at least 9 of a maximum 18 other members of Council.

Club members also may nominate candidates for officers and for other members of Council. Such nominations require the signatures of the nominator and seconder, and a statement of willingness to serve in the specified position by the nominee. Nominations must be sent to the Nominating Committee, The Ottawa Field-Naturalists' Club, Post Office Box 3264, Postal Station C, Ottawa, Ontario K1Y 4J5, to arrive before 15 November, 1975.

In addition, the Committee will consider any suggestions for nominees which members wish to submit to it by 1 November, 1975. It would be helpful if some relevant background on the proposed nominees were provided with the suggestions.

A. H. REDDOCH
Chairman, Nominating Committee

TABLE OF CONTENTS

Articles

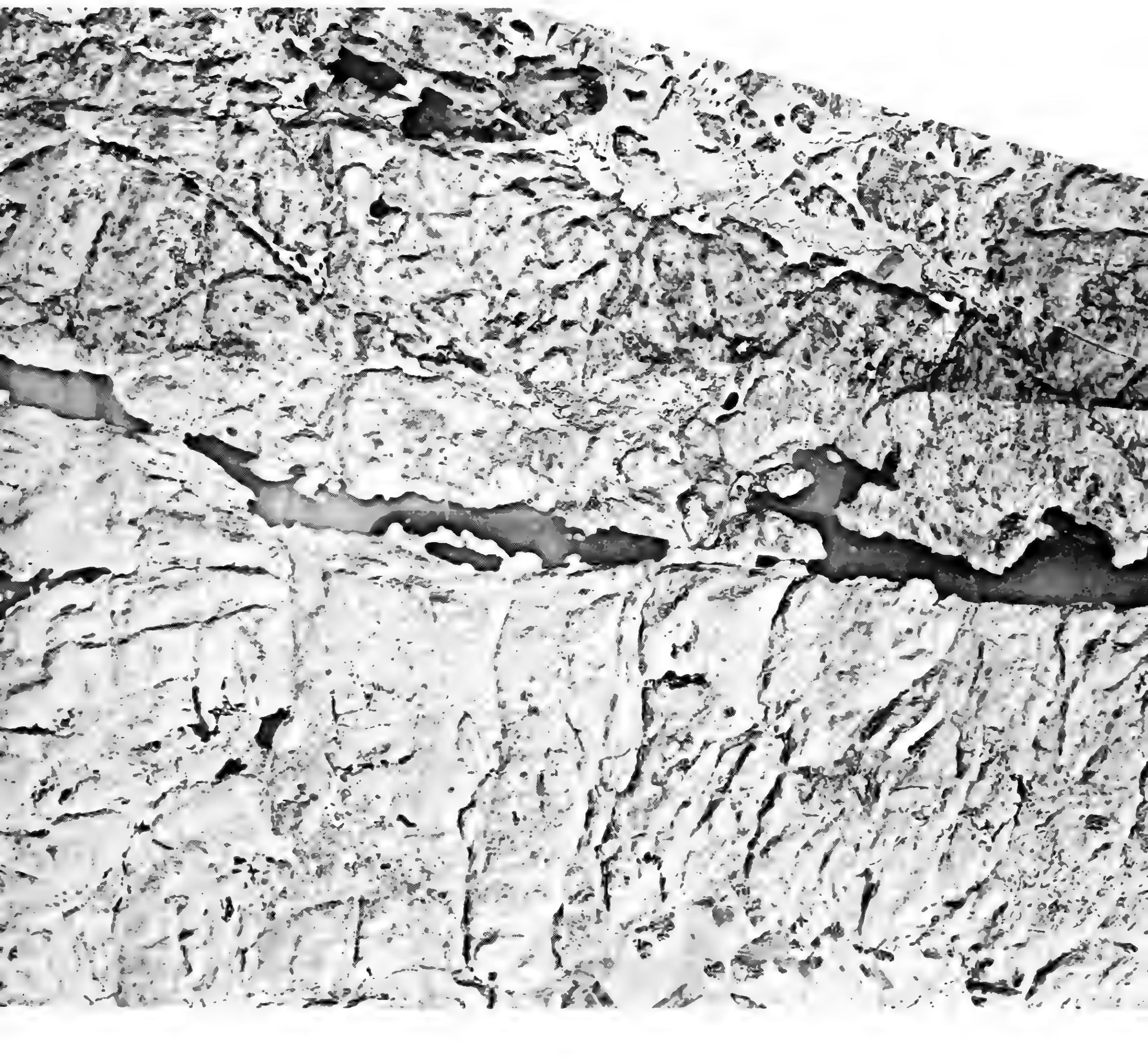
Notes

concluded on inside back cover

THE CANADIAN FIELD-NATURALIST published by **The Ottawa Field-Naturalists' Club**
Box 3264, Postal Station C, Ottawa, Canada K1Y 4J5
Second Class Mail Registration No. 0527 — Return postage guaranteed
ISSN 0008-3550

The CANADIAN FIELD-NATURALIST

Published by THE OTTAWA FIELD-NATURALISTS' CLUB, Ottawa, Canada



Volume 89, Number 4

October-December 1975

Subscriptions and Membership

Subscription rates for individuals are $7.00 per calendar year. Libraries and other institutions may subscribe at the rate of $15.00 per year (volume). The annual membership fee of $7.00 includes club publications. Subscriptions, applications for membership, notices of changes of address, and undeliverable copies should be mailed to: The Ottawa Field-Naturalists' Club, Box 3264, Postal Station C, Ottawa, Canada K1Y 4J5.

Back Numbers

Most back numbers of this journal and its predecessors, *Transactions of The Ottawa Field-Naturalists' Club*, 1879-1886, and *The Ottawa Naturalist*, 1887-1919, may be purchased from the Business Manager.

All material intended for publication should be addressed to the Editor:

Dr. Lorraine C. Smith, Department of Biology, Carleton University, Ottawa, Ontario K1S 5B6

Cover photograph: Air photo (MG 419) of the central portion of Gatineau Park, Quebec is reproduced by permission of the National Air Photo Library, Ottawa, Canada. The chain of lakes from left to right is Lac Philippe, Lac Mousseau (Harrington) and Meach Lake. See series of articles on pages 354-399.

The Canadian Field-Naturalist

VOLUME 89, NUMBER 4 OCTOBER-DECEMBER 1975

Urban Wildlife — is it Wanted and Needed?

Most naturalists and conservationists would agree that urban wildlife is wanted and several of us would also say that it is needed. And yet others would agree with Aldo Leopold's statement "There are some who can live without wild things and some who cannot . . ."

In earlier years Canada's population was largely rural but today it is mostly urban. There is every indication that urbanization will continue and with it changes in the landscape around and in our cities. Constantinos A. Doxiadis, an international city planner, has said that providing a green belt around a city to preserve wildlife for urban people is a myth; nature and wildlife must grow inside cities.

The term "wildlife" is often used in the restricted senses of game animals or all wild animals, but I prefer to use the word to mean all our nondomestic fauna and flora. Although our society is basically dominated by economics, the value of urban wildlife (as opposed to some wilderness wildlife) is not based on the pocketbook but is aesthetic and spiritual. If we acknowledge that there is a need and a desire for urban wildlife, then it is time for biologists to be on teams of urban planners. Furthermore, biologists are needed to advise on the management of urban wildlife. We should push for this to be implemented and should be willing for our governments to pay the cost.

The city is a unique ecosystem and as yet is only partly understood. Research in urban wildlife is relatively new and studies are few in number. To my mind it is important that urban wildlife studies be expanded and the knowledge gained incorporated into future planning.

Do We Want Urban Wildlife?

Those of us who have special interests in wildlife and receive particular pleasure from contact with it have difficulty in believing that some city people do not want wildlife on their doorstep. How many of our population place a low priority or even negative value on nature? How many others like the horticultural approach with flowering exotic trees and closely mown lawns that currently predominates (at considerable expense for installation and maintenance) on much of the urban landscape? How many others don't care at all about urban wildlife or perhaps haven't even considered the matter? Certainly documentation is needed. I believe we should strive for more public awareness about the existence and benefits of urban wildlife and should promote education and interpretation regarding wildlife and its values. Already some city dwellers have been alienated from the natural world. Our technological society is removing us more and more from our roots, from the soil from which we must obtain sustenance to live.

We recognize, of course, that some forms of wildlife are desirable in cities and some are not. Anne Innis Dagg, who pioneered studies of urban wildlife in Canada, has recorded the reactions of city people to birds and mammals encountered on or near their properties. Her summary showed that most people enjoy birds although the exotic birds such as Rock Doves which deface buildings with their droppings and the noisy messy Starlings were not popular with adults. Children, however, liked Rock Doves, Starlings, and House Sparrows best; these species are the ones they most often see at close range. Most people said they liked to see squirrels, chipmunks, and cottontails in the city but other mammals were less desired because of the damage they caused.

If we are to have wildlife in the city we must be prepared to manage that wildlife. Problems will arise and indeed have already arisen. We know that urban animals can carry diseases and parasites that can have a considerable effect on the human population. Urban animals can damage and destroy desirable plants including fruit trees, bushes, and vegetables and can cause landscape damage. Tree roots can block drains and can withdraw so much water from the soil that soil shrinkage results in damage to foundations. Herbaceous plants can grow through concrete and asphalt. Both plants and animals can increase to the extent that they become pests and hence are no longer desirable. Some animals adapt to city environments very readily and exploit the new surroundings they find there. Various structures, such as bridges, signs, poles, etc. have been used as roosting or nesting sites by birds and buildings are utilized by birds, bats, rats, and mice. In many instances good planning would eliminate the structural defects that allow animals access to places they are unwanted e.g., under eaves, in attics and basements, and in refuse. Birds around airports have become hazards to aircraft, although this problem is one of the few that has received considerable attention and research.

Everything considered, however, I suspect that most people do want wildlife in the city. Songbirds, the diurnal small mammals, trees, shrubs and herbaceous plants all add interest and color to residential and downtown areas. Currently there is obviously a keen interest in urban wildlife. In the U.S.A., for example, the National Wildlife Federation launched a campaign regarding backyard wildlife and received requests for over a quarter of a million reprints of an article on the subject by Jack Ward Thomas. Have you noticed the increased number of bird feeders operated in the city? Obviously many people delight in attracting birds. This increase in bird feeders also has considerable economic value—for the manufacturers of feeders and the suppliers of bird seed. Some bird lovers dislike the squirrels that chase the birds away and eat the bird food. At our feeder, however, the red and gray squirrels feed only during certain periods of the day; the rest of the day the birds and chipmunks feed freely.

In order to survive, urban wildlife must have suitable habitats. In Dagg's study, people usually saw birds and mammals near trees and bushes or in parks. By careful planning we can provide environments in the city that are suitable for many desirable wildlife species. With many different habitats, a great diversity of species is indeed possible; for example, in addition to birds, mammals, invertebrates, herbaceous plants, and trees, the city ecosystem can also often include wetlands with their plants, fishes, amphibians, and reptiles. As yet, however, we know relatively little about the various species that can and do live in the cities—about their numbers, and the behavioral, physiological, and genetic changes that have enabled them to adapt to an urban existence.

Do We Need Urban Wildlife?

Many city dwellers feel the need to escape from the city as often as possible. They leave in their atmosphere-polluting automobiles for camps, cottages, and provincial and national parks where they can enjoy the out-of-doors. As the cities expand, more and more rural and wilderness areas will disappear. Wouldn't we be wise to bring nature and wildlife areas into the city where the pleasures they bring can be enjoyed on a daily basis? Man has an inherent metaphysical and spiritual need for nature and he should not retreat from it. Most urban people want open spaces and trees and a contact with nature as part of their daily lives.

Green areas of herbs, shrubs, and trees make definite contributions to human welfare. Not only are they aesthetically pleasing but they also control erosion, regulate hydrology, cool and filter the air (in particular they remove some of the noxious gases and particulate matter), produce oxygen (necessary for animals to live), absorb carbon dioxide (a product of respiration), and reduce noise levels. All species of animals, including man, are dependent on vegetation and its assimilation in food chains. Vegetation also provides animals with food, reproduction sites, and cover from inclement weather and predators.

Although plants in cities can act as indicators of pollution, probably small mammals and birds are most important in this regard. Toxic substances will affect small animals adversely long before the deleterious effects become apparent in man. Decision-makers, thus forewarned, would be able to take appropriate actions to protect the urban populace from toxic pollutants.

Man is affected by his environment and environmental psychology is now a recognized discipline. For their physiological and perhaps sociological well-being, urbanites need urban wildlife, i.e., a contact with nature becomes preventative medicine. According to Valerius Geist an absence of wildlife in the cities deprives children of intellectual development; children are especially curious about the world around them and the city environment can often be boring. Many urbanites have no appreciation of what goes on in the natural world and have thus lost their cultural tie back to the land. For man to be intelligent and make good wildlife-management decisions, decisions on which life itself may depend, he must have an understanding of the principles of ecology.

Urban Wildlife and its Future

If we want and need wildlife in our cities then we must also have the habitats to maintain it. The city environment is not static but is constantly changing and citizens should realize they can influence the possible changes. We must start with what is currently available and preserve this. R. M. Maestro has coined the term "the givens" for those lands, unsuitable for development, that provide habitats where animals and plants can survive and flourish, e.g., cemeteries, golf courses, campuses, edges of rivers and streams, wet areas, fields, woodlots, parks, and neighborhood yards. The greatest variety of animal species is found where water, trees, shrubs, and layered vegetation are present. Wildlife is not, however, absent in the hard-core city center where some species have adapted to life in the concrete jungle. Although we must create and maintain habitats for animals and plants in the city, we must also be very cautious. Problems can and do arise when we bring nature into the city so we must be selective. But as urbanization increases the cities may become the only hope for some wildlife species to survive. Moreover, I must emphasize again that there must be management.

Our cities can be attractive. They reflect our values and our ethics, and they can and should show our concern for the future of man and other living species. The public needs, however, to be better informed about urban ecology. All levels of society will gain through an improved working and living city environment. Therefore, if we want and need properly-managed urban wildlife, we must apply pressure to our politicians to help us achieve this goal.

This editorial is written in the hope of increasing public awareness regarding urban wildlife and to point out the importance of initiating input from a concerned populace to city planners, developers, and other decision-makers.

Suggested Reading

Dagg, A. I. 1970. Wildlife in an urban area. Naturaliste Canadien 97: 201–212.

Dagg, A. I. 1974. Canadian wildlife and man. McClelland Stewart Limited, Toronto. 192 pp.

Dagg, A. I. and **C. A. Campbell.** 1975. Studies in urban nature. Bulletin of the Conservation Council of Ontario 22(1): 10–14.

Euler, D. (*Editor*). 1975. Wildlife in urban Canada. A symposium at the University of Guelph, May 1975. *In press.*

Gill, D. and **P. Bonnett.** 1973. Nature in the urban landscape: a study of city ecosystems. York Press, Baltimore. 209 pp.

Jorgensen, E. 1974. Towards an urban forestry concept. Environment Canada, Forestry Service. 14 pp.

Noyes, J. H. and **D. R. Progulske** (*Editors*).1974. Wildlife in an urbanizing environment. University of Massachusetts Cooperative Extension Service, Amherst. 182 pp.

Thomas, J. W. and **R. M. DeGraff.** 1975. Wildlife habitats in the city. University of Massachusetts Cooperative Extension Service, Amherst. *In press.*

LORRAINE C. SMITH

An Introduction to a Limnological Study of Selected Lakes in Gatineau Park, Quebec

"... some of the things wilderness can do for us. That is the reason we need to put into effect, for its preservation, some other principle than the principles of exploitation or usefulness or even recreation. We simply need that wild country available to us, even if we never do more than drive to its edge and look in. For it can be a means of reassuring ourselves of our sanity as creatures, a part of the geography of hope."

Wallace Stegner

In the lakes of the world the ubiquitous process of succession results in changes in species composition as the organisms themselves change their own environments. In addition man has caused many changes in species composition by altering environments.

A baseline survey of selected lakes in Gatineau Park was initiated with the help of John Whiting in the summer of 1971. A quantitative study was launched in 1971 and 1972 with the support of the National Capital Commission, Environment Canada, and the University of Ottawa. Individuals from these institutions, as well as from the National Museum of Natural Sciences and the Canada Department of Agriculture, were involved with the program.

Gatineau Park covers an area of 88 000 acres and is located in Quebec a few miles northwest of the Ottawa-Hull metropolitan region (see Figure 1). The 35 or more lakes in the park lie in an extension of the Precambrian Shield which extends south into the Ottawa – St. Lawrence Lowlands. The surrounding rocks are composed mainly of granites and gneissis with local areas of crystalline limestone. Five lakes—Pink, Kidder, Meach, Ramsay, and Philippe—were selected for intensive study because they were believed to be representative of most of the lakes occurring in Gatineau Park. Accessibility and use by man were also considered in their choice. Lac Lapêche, the largest of the Gatineau Park lakes, was also investigated by a few of the groups during the summer of 1972.

Gatineau Park is one of the few places in the world where a successional series of lakes, complete with delicate bog areas, can be viewed in its natural setting near a major metropolitan complex. This continuum provides an excellent opportunity for outdoor education and research. Our survey of the lakes in Gatineau Park provides data on a number of factors which, if monitored on a regular basis, will provide valuable information on the changes taking place. There is already evidence that the eutrophication of some lakes in Gatineau Park is proceeding at a rather rapid rate.

Prior to this survey, little was known about the limnology of the lakes in Gatineau Park. The following six papers bring together a modest amount of information. The data on the aquatic plants was gathered as part of this program but has already been published (Aiken, S. and J. M. Gillett. 1974. The distribution of aquatic plants in selected lakes in Gatineau Park, Quebec. Canadian Field-Naturalist 88(4): 437–448). One group of invertebrates, the zooplankton, has recently received a good deal of attention from research initiated by J.-P. Cuerrier (See Cuerrier, J.-P. and M. J. Dadswell. 1968. Limnology and experimental fishery management studies in Gatineau Park during 1968. Canadian Wildlife Service Manuscript Report. 107 pp.; Morry, C. J. 1973. A survey of the limnetic zooplankton of Gatineau Park, Quebec. M.Sc. thesis, Carleton University. 123 pp.; Morry, C. J., J.-P. Cuerrier, and D. J. Faber. 1974. Zooplankton of the Gatineau Park. Naturaliste canadien 100: 551–560).

The National Capital Commission has demonstrated its concern for good management of the lakes in Gatineau Park by supporting the survey. The preservation of these lakes, once the domain of the Algonquin and Iroquois Indians, in an unspoiled state has been given

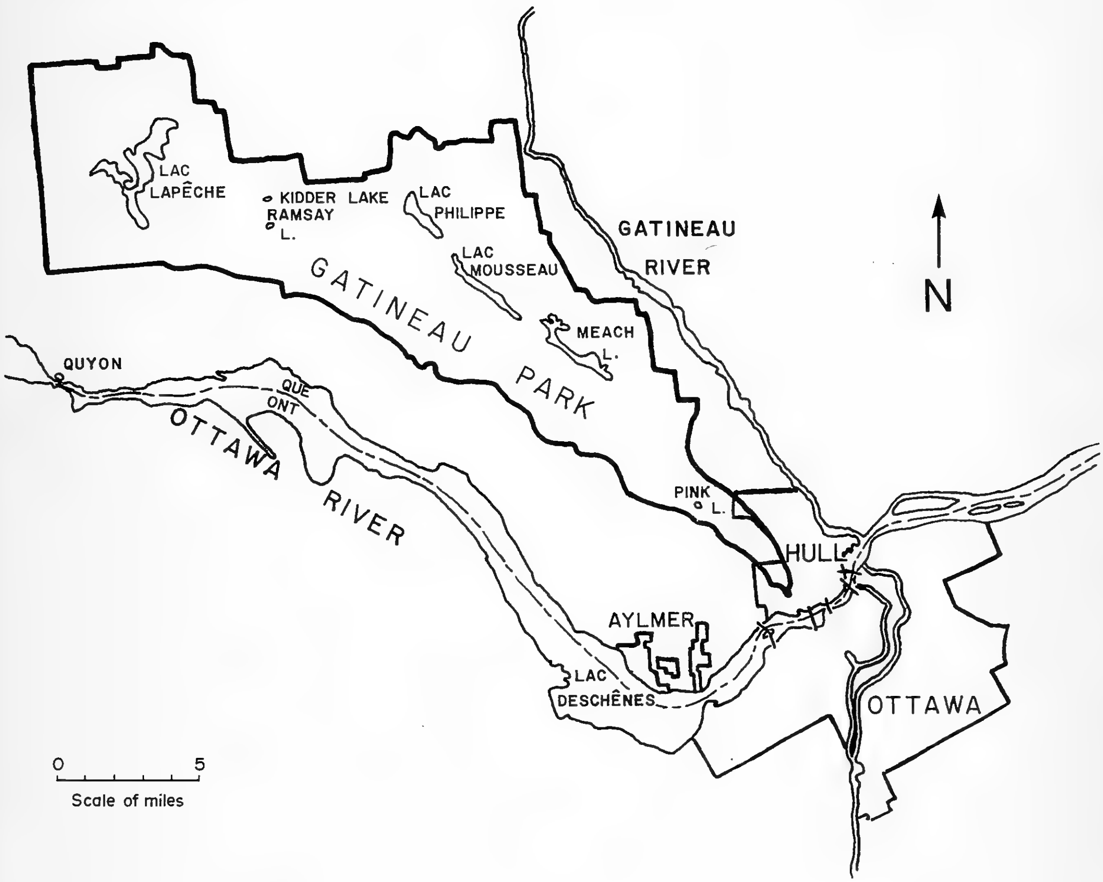


FIGURE 1. Map of Gatineau Park, Quebec indicating the lakes intensively studied.

a high priority by the National Capital Commission. The data provided by the abovementioned authors and in the following six papers should help to establish a baseline from which future changes in the character of these lakes can be assessed.

Acknowledgments

Over the period 1970–1974, 32 people were involved with some aspect of the Gatineau Park Lakes Research Program. We acknowledge the special help and advice of some of these people in making the limnological survey a success. The advice and support of Alan Rémi, Pierre Brulotte, Murry Outhet, B. Eddy, and Allen Ede of the National Capital Commission, as well as of C. McBratney and R. Peters, Inland Waters Section of the Department of Environment, and Jane McDowall, Nicole Voyer, and Marie Tachereau of the University of Ottawa are greatly appreciated. The program was funded by a cooperative agreement between the National Capital Commission and the Inland Waters Branch of Environment Canada.

M. DICKMAN and D. R. OLIVER

The Champlain Sea Episode in the Gatineau River Valley and Ottawa Area

RICHARD ROMANELLI

Department of Geology, University of Ottawa, Ottawa, Ontario K1N 6N5
Present address: #3 220 Mutchmore, Hull, Quebec J8Y 3V1

Romanelli, R. 1975. The Champlain Sea episode in the Gatineau River Valley and Ottawa area. Canadian Field-Naturalist 89(4): 356-360.

Abstract. Champlain Sea beaches at Cantley, Quebec, and Russell, Ontario, were dated at 12 000 ± 160 and 10 000 ± 320 years B.P. (Before Present). The age, location, and elevation (635 feet above sea-level) of the Cantley beach suggest that there was an earlier marine invasion of the Central St. Lawrence Lowlands and a more northerly position of the ice front of the continental ice sheets than previously assumed. Radiocarbon dates from this area show that the Champlain Sea water levels were highest initially and progressively fell, thus suggesting that those of the pre-existing glacial lake Frontenac could have been even higher than the initial marine water plane. The marine waters at the maximum submergence covered much of the area west of the present Gatineau River Valley and created a large embayment tentatively named the Gatineau Gulf.

With very rapid land emergence during the marine episode from 12 000 to about 10 000 years B.P., beaches were formed at successively lower elevations; the beach at Russell, Ontario represents the last stand of marine waters in the general Ottawa area. Since there are no younger marine beaches than the one at Russell, peat and other organic deposits below the elevation of 230 feet (present elevation) are understood to date a post-Champlain Sea fresh-water event, probably initiated at about 10 000 years B.P.

During the final retreat of the Wisconsin ice sheets from the Gatineau area, around 12 000 years B.P. (Before Present), the depression immediately in front of the ice was occupied by an arm of the Atlantic Ocean known as the Champlain Sea. This was the last major geological event to occur in the St. Lawrence Lowlands and hence was responsible for the present drainage and sediment distribution.

During the early part of the Champlain Sea in the area, estuarine conditions prevailed in the Gatineau River Valley. With further recession of the ice and rapid land emergence, beaches were successively formed at lower elevations: 600 feet asl (above sea-level) in the Gatineau River Valley by 11 500 years B.P., and 350 feet asl by 10 800 years B.P. in the Ottawa area.

Continued land emergence led to complete withdrawal of the marine waters from the area and the beginning of fresh-water drainage by around 10 000 years B.P. Many depressions such as abandoned channels of the Ottawa River filled with organic debris and thus formed peat bogs (e.g., the Mer Bleue peat bog located east of Ottawa).

Chronology

The oldest radiocarbon date from the Gatineau River Valley, 12 200 ± 160 years B.P., GSC-1646 (Table 1), indicates that the Champlain Sea was well established in the area at that time. This date is within the range of those obtained for the early phase of the Champlain Sea from the Drummondville and Brockville areas, 12 000 ± 320 years B.P., GSC-396, and 11 800 ± 210 years B.P., GSC-1013, respectively (see Table 1). Although few in number, these dates suggest an earlier invasion of the Lowlands by the Champlain Sea than was previously assumed. The ice-front position in the Ottawa area as shown by Prest (1969), and the broad picture of deglaciation of the St. Lawrence Lowlands as detailed by Prest (1970), needs small readjustments to account for these old marine beaches. A very rapid northward and northwestward recession of the ice front during the Belleville – Fort Ann phase seems necessary to permit the entrance of the marine waters and colonization of the beaches in the St. Lawrence Lowlands. The existence of an ice barrier preventing the marine waters from

TABLE 1—Radiocarbon dates from the Gatineau River Valley, Ottawa area, and other areas related to the early phase of the Champlain Sea

Date, Number	Age, in years B.P., from 1950 datum	Material dated	Locality	Elevation, feet asl	Reference
GSC-1646	12 200 ± 160	marine shells	Cantley, Que.	635	This paper
GSC-842	11 600 ± 150	marine shells	Meach Lake, Que.	557	Lowdon and Blake 1968
L639-B	11 320 ± 200	marine shells	Old Chelsea, Que.	500	Gadd 1964
GSC-982	11 300 ± 180	marine shells	Mahon Lake, Que.	508–526	Lowdon and Blake 1968
GSC-588	10 880 ± 160	marine shells	Ottawa, Ont.	318	Mott 1968
GSC-570	10 800 ± 150	seaweed	Ottawa, Ont.	321	Mott 1968
GSC-587	10 620 ± 200	marine shells	Ottawa, Ont.	340	Mott 1968
Y-216	10 850 ± 330	marine shells	Uplands, Ont.	323	Preston et al. 1955
L-604A	10 700 ± 200	marine shells	Uplands, Ont.	260	Olson and Broecker 1961
Y-215	10 630 ± 330	marine shells	Hull, Que.	392	Preston et al 1955
L-604B	10 550 ± 200	marine shells	Ottawa, Ont.	265	Olson and Broecker 1961
GSC-1553	10 000 ± 320	marine shells	Russell, Ont.	230	Scott 1972
GSC-680	9 910 ± 200	gyttja	Kazabazua, Que.	580	Lowdon and Blake 1968
GSC-546	8 830 ± 190	gyttja	Gladstone Ave., Ottawa, Ont.	200	Lowdon et al. 1967
GSC-547	8 220 ± 150	woody peat	Richmond Rd., Ottawa, Ont.	235	Lowdon et al. 1967
GSC-628	7 870 ± 160	gyttja	Catherine St., Ottawa, Ont.	220	Lowdon et al. 1967
GSC-681	7 650 ± 210	gyttja	Mer Bleue, Ottawa, Ont.	210	Lowdon et al. 1967
GSC-548	6 750 ± 150	peat	Mer Bleue, Ottawa, Ont.	220	Lowdon et al. 1967
GSC-936	12 000 ± 230	marine shells	L'Avenir, Que.	400	Lowdon and Blake 1968
GSC-1013	11 800 ± 210	marine shells	Maitland, Ont.	340	Lowdon and Blake 1968

entering the Lowlands as suggested by Gadd (1964) is no longer necessary.

The assumed ice-front position and distribution of land and water masses during this early phase of the Champlain Sea in the Gatineau River Valley are shown in Figure 1. The high-water plane, 650 feet asl, bordered on nearly vertical cliffs on the eastern side of the valley while it spread much further inland on the western shores, where it created a large embayment west of Wakefield, tentatively named the Gatineau Gulf. The extent of this gulf is shown on a recent map of surficial deposits and landforms in the Gatineau Park (Buckley 1970). Marine sediments are found as far as 12 miles west of the present Gatineau

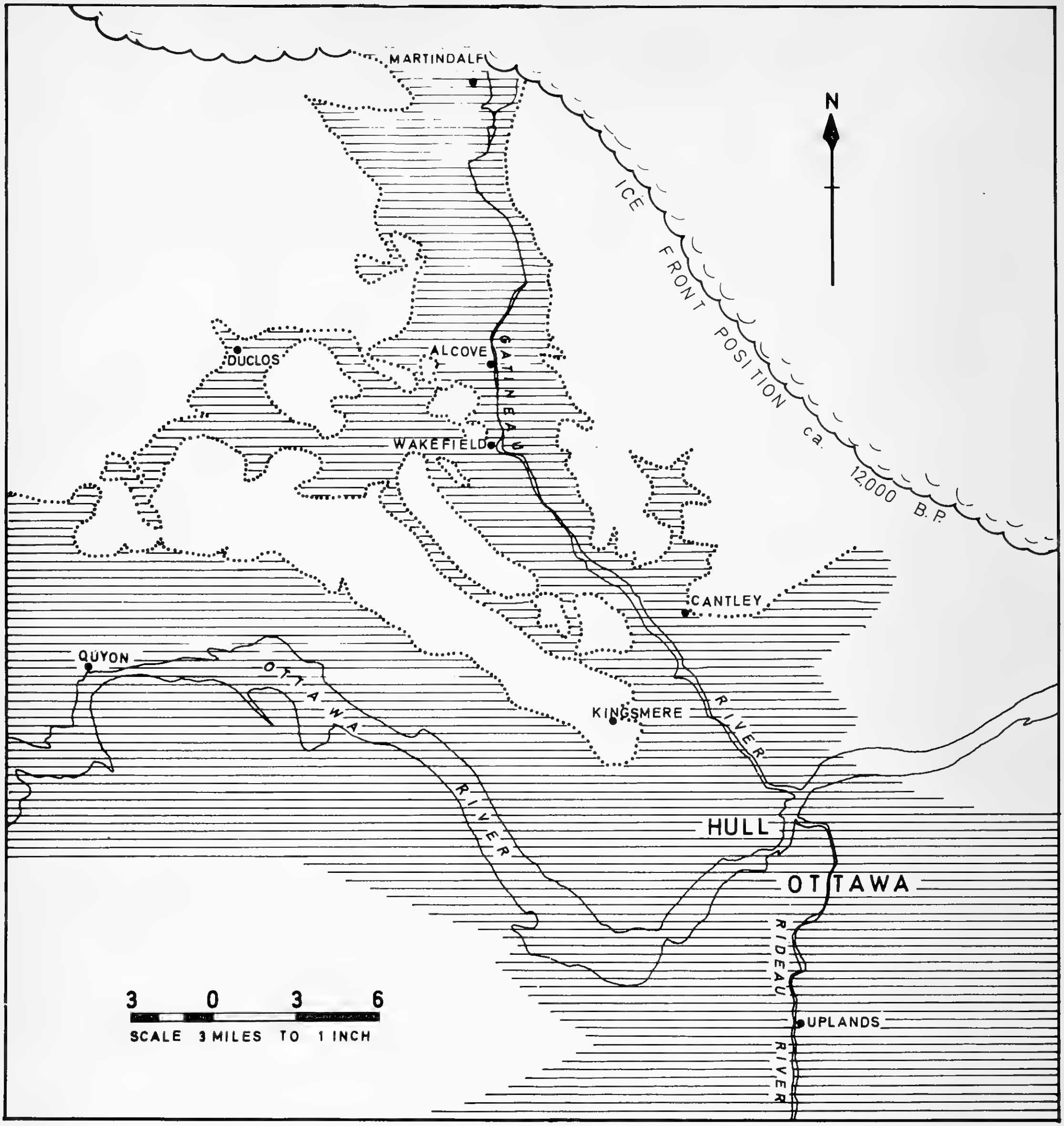


FIGURE 1. Approximate Champlain Sea shoreline at the time of maximum submergence in the Gatineau River Valley, 12 000 years B.P. Ruled area is Champlain Sea, shoreline is dotted.

River at Wakefield. At the southern end of the Gatineau River Valley, the Champlain Sea was restricted to a narrow channel approximately 3 miles wide, while at the northern end in the Martindale area, the sea probably bordered on the ice front. On the eastern shores of the Champlain Sea in the Gatineau Valley, a small embayment existed from Cantley north to Wilsons Corners.

Rapid land emergence caused the withdrawal of the Champlain Sea from higher elevations to lower ones, where beaches formed as is indicated by a cluster of radiocarbon dates at about 11 500 years B.P., and an elevation of approximately 550 to 600 feet asl (see Table 1). The distribution of land and water masses at that time (11 500 years B.P.) is shown in Figure 2. The pattern is roughly similar to

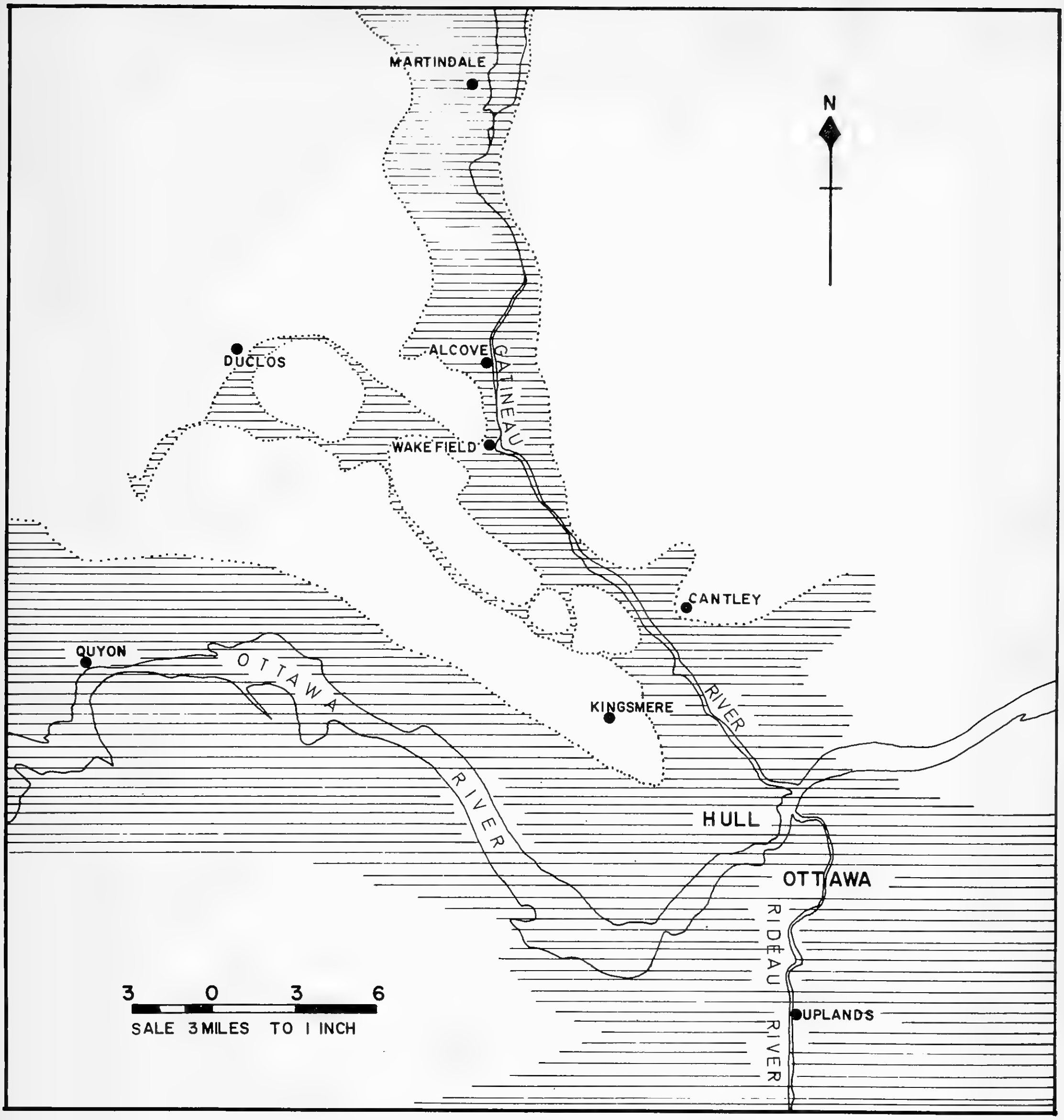


FIGURE 2. Approximate Champlain Sea shoreline 11 500 years B.P. in the Gatineau River Valley.

Figure 1 except for the overall shrinkage of the sea. Embayments on the western and eastern shores have almost disappeared but the water levels of the Champlain Sea at that time are still high enough to flood the whole of the Ottawa area. Beaches in the Ottawa area, as indicated by the radiocarbon dates in Table 1, are younger and lower than those found in the Gatineau River Valley.

The flooding of areas of the Gatineau Valley well to the north of the Ottawa-Hull area either during the time of maximum submergence or after is indicated by the fossil occurrences at Venosta (Antevs 1928), Manitou Lake (Bickel 1970), and Martindale. These localities are all well over 30 miles north of the Ottawa-Hull area. The sparseness of reports of marine fossils from these areas relative to those from southern regions of the Gatineau Valley, suggests unsuitable conditions for the establishment of marine life.

Marine or partly marine conditions continued to prevail in the Ottawa area until about 10 000 years B.P., at which time the water levels stood at about 230 feet asl, as indicated by the radiocarbon date from Russell, Ontario (GSC-1553, Table 1). Since there are no younger marine beaches from lower elevations, perhaps fresh-water drainage was initiated in the Ottawa area at about that time (10 000 B.P.).

A series of radiocarbon dates from the Ottawa area indicates that organic sedimentation in abandoned river channels began about 9 000 years B.P. (GSC-546, Table 1), and that some channels were still being abandoned by 7 000 years B.P. (GSC-548).

Material younger than about 7 000 years B.P. has not yet been dated from the area so a complete chronology of events cannot be constructed.

Literature Cited

Antevs, E. 1928. The last glaciation, with special reference to the ice retreat in northeastern North America. American Geographical Society, Research Series 17. 292 pages.

Bickel, E. D. 1970. Pleistocene non-marine mollusks of the Gatineau Valley. Sterkiana 38.

Buckley, J. T. 1970. Surficial deposits and land forms, Gatineau Park and vicinity. Geological Survey of Canada, Open File 36 (July 1970).

Gadd, N. R. 1964. Moraines in the Appalachian Region of Quebec. Geological Society of America Bulletin 75(12): 1249–1254.

Lowdon, J. A., J. G. Fyles, and **W. Blake, Jr.** 1967. Geological survey of Canada radiocarbon dates VI. Radiocarbon 9: 156–197.

Lowdon, J. A. and **W. Blake, Jr.** 1968. Geological survey of Canada radiocarbon dates IX. Radiocarbon 10(1): 210–245.

Mott, R. J. 1968. A radiocarbon-dated marine algal bed of the Champlain Sea episode near Ottawa, Ontario. Canadian Journal of Earth Sciences 5: 314–323.

Olson, E. A. and **W. S. Broecker.** 1961. Lamont natural radiocarbon dates VII. American Journal of Sciences, Radiocarbon Supplement 3: 146.

Prest, V. K. 1969. Retreat of Wisconsin and Recent ice in North America. Geological Survey of Canada Map 1257A.

Prest, V. K. 1970. Quaternary geology. *In* Geology and economic minerals of Canada. *Edited by* R. J. W. Douglas. Geological Survey of Canada Economic Geology Report I. pp. 675–764.

Preston, R. S., E. Person, and **E. S. Deevey.** 1955. Yale natural radiocarbon measurements II. Science (Washington) 121(3145): 481–488.

Scott, J. S. 1972. Environmental geology prototype study; Ottawa-Hull area (Parts of 31 F, G). *In* Report of Activities, Part A; April 1972 to October 1972. Geological Survey of Canada Paper 72-1. pp. 144–148.

Received 12 October 1972
Accepted 21 May 1974

Phytoplankton of Five Lakes in Gatineau Park, Quebec

M. DICKMAN[1] and M. JOHNSON

Department of Biology, University of Ottawa, Ottawa, Ontario K1N 5N6

[1] Present Address: Department of Biological Sciences, Brock University, St. Catharines, Ontario L2S 3A1

Dickman M. and M. Johnson. 1975. Phytoplankton of five lakes in Gatineau Park, Quebec. Canadian Field-Naturalist 89(4): 361-370.

Abstract. Phytoplankton from Kidder Lake (117 species), Meach Lake (143 species), Lac Philippe (141 species), Pink Lake (101 species), and Ramsay Lake (137 species) were sampled both vertically and horizontally each month throughout the summer of 1971. Phytoplankton reached bloom densities of 500 cells/ml in three of the five lakes, (Philippe, Meach, and Pink). The last had the highest algal standing crop (0.022 cc/litre). Spring and late summer phytoplankton maxima occurred in all five lakes. Pink Lake, the only alkaline carbonate lake in the park, differed markedly in species composition from the other four lakes. Indicator species found in each of the five lakes are described, and the lakes ranked from oligotrophic to moderately eutrophic on the basis of their Araphidinae and Centrales diatom species, and on the basis of maximum algal biomass and diversity. Pink Lake was most eutrophic and Kidder Lake was most oligotrophic.

To the best of our knowledge, no previous study of the phytoplankton of any of the Gatineau Park lakes has been made apart from an unpublished survey by Dickman and Podolsky in 1970. In fact, according to Schindler and Holmgren (1971) "few publications have described the phytoplankton or primary productivity of [Canadian Precambrian] Shield Waters," in spite of the fact that "the Canadian Shield contains the world's largest unbroken lake district." This is not to say that no work has been done. An excellent algal taxonomic study of Quebec and eastern Ontario was made by Bourrelly (1966). Another largely taxonomic study of the southwestern end of the Canadian Shield was conducted by Drouet (1954) and Meyer and Brook (1967, 1968). In addition Christie (1968, 1969) and Michalski (1971) have studied the phytoplankton of several eastern Ontario lakes.

The purpose of this five-lake study was to establish a baseline against which future changes in algal species composition and relative abundance could be judged.

Methods

Vertical Samples

A 0.942-litre (32-oz) sampling bottle was lowered to twice the Secchi depth and raised to the surface. (The Secchi depth is the depth that a white disk of 20-cm diameter can be lowered and be just visible.) The sampling was done at such a rate as was necessary to have the bottle 90% full as it reached the surface. This method permitted the successful sampling of the entire photic zone. Three bottles (total volume 2.826 litres) filled in this manner were placed in a 128-oz jar and labelled. A duplicate sample of three bottles was taken in the same location.

Lugol's solution, an iodine – acetic acid algal preservative (Ruttner 1970), was added to the samples and they were allowed to sit for at least 48 h; this permitted the phytoplankton to settle to the bottom of the container. Then, as much liquid was siphoned off as was possible without disturbing the settled organisms on the bottom. The siphoned liquid was discarded and the remaining fluid and organisms were transferred to a smaller glass jar and allowed to sit for an additional 48 h. The overlying fluid was again carefully siphoned off leaving 150–300 ml, which was measured and placed in a labelled 12-oz jar. These samples are kept in the limnology collection of the University of Ottawa, Biology Department.

The above method, termed the composite sample procedure, was used to assure the collection of small phytoplankton which could otherwise be lost through the pores in a net. It also succeeded in sampling species which were vertically stratified.

Horizontal Samples

The horizontal samples were taken to assure collection of any large algal cells which might have been in patches in the lake and may have been missed when using the composite sampling bottle. The principal disadvantage with this type of sampling is its reliance on a net. There are two disadvantages to a net: (1) many smaller algal species are lost, and (2) the finer the mesh of the net (10-micron pores are the smallest presently available) the less water will pass through the net without clogging it.

A #20 plankton net (78-micron pore size) with a ½-m inner diameter was used. A flow meter was suspended in the opening of the net to gauge the amount of water flowing into it. The flow meter, when calibrated, showed for each turn of the propeller, 20 litres of water flowing through the net.

To collect a plankton sample, the net was lowered over the end of a moving boat and submerged at a depth of about 0.5 m. The calibrations on the flow meter were recorded before and after the tow to determine the length of the tow. A tow of 18–30 m had sufficient algal concentrations for quantitative studies. A second sample replicate was taken following the same procedure.

Phytoplankton Biomass Estimation

A 0.1-ml sample was placed on a slide and all cells which rested within a given number of whipple fields were counted. A conversion factor was calculated for each set of results to express species cell counts or total numbers of cells on a per litre basis. The conversion factor was calculated using the following formula:

$$\frac{As}{Af \times NF} \times \frac{N \times FV}{Ssv} \times \frac{1}{OV}$$

= number per liter, where

Conversion Factor =

As = area of the slide = 484 mm^2,
Nf = number of fields counted on one slide,
N = number of cells counted in fields,
FV = final volume of the sample (in litres) after collection and concentration,
Ssv = volume subsampled (under cover slip),
OV = original volume of sample (in litres).

Biomass estimates were made by multiplying the mean volume of a species by the number of species present in 1 litre of water to give the number of cubic centimetres represented by common and abundant species. These values were summed and plotted in Figure 1. Common species are those that occurred in 20% or more of the samples taken from a particular lake. Cleve-Euler (1951–1955), Irenée-Marie (1938), Huber-Pestalozzi (1942), Patrick and Reimer (1966), Prescott (1962), and Smith (1950) were used to identify the species found in the phytoplankton.

Results

A total of 229 species was found in the phytoplankton of the five lakes. A list of these species, complete with date found, relative abundance, and sample type is available, at nominal charge, from the Depository of Unpublished Data, National Science Library, National Research Council of Canada, Ottawa, Canada K1A 0S2. This list forms the basis for the baseline study; it also includes the relative density of each species throughout the summer sampling period. Species which were either particularly abundant (dominant) or which were unique to one or more of the lakes are discussed under the individual lakes, and wherever possible are illustrated (see Figures 2 to 6). Data for each algal division are summarized in Table 1.

Pink Lake Phytoplankton

Pink Lake has 101 taxa identified from the combined summer samples. In June, the Chrysophytes (yellow-brown algae) made up the largest proportion of each sample. They remained fairly common in July but were accompanied by Cyanophyta (blue-green algae). In August the Cyanophyta were dominant. In addition, bloom densities of a chlorophyta *Lagerheimia* spp. (a green alga) also occurred.

The species composition of Pink Lake was different from those of the four other lakes studied. The Chlorophyte genus *Lagerheimia* (Figure 2) was not found in any of the other four lakes and, according to Prescott (personal communication), its presence indicates eutro-

TABLE 1—Number of taxa in each algal division found in five lakes in Gatineau Park

	Lakes				
	Kidder	Meach	Philippe	Pink	Ramsay
Cyanophyta					
No. of taxa observed	14	22	26	14	21
No. of common taxa	3	10	13	6	9
Chlorophyta					
No. of taxa observed	34	31	32	22	47
No. of common taxa	11	7	6	11	16
Chrysophyta except diatoms					
No. of taxa observed	12	13	8	11	13
No. of common taxa	7	7	4	6	8
Bacillariophyceae (diatoms)					
No. of taxa observed	53	76	74	51	51
No. of common taxa	24	31	29	23	20
Pyrrophyta					
No. of taxa observed	4	1	1	3	5
No. of common taxa	0	1	1	1	3
Totals					
Total no. of taxa observed	117	143	141	101	137
Total no. of common taxa	45	56	53	47	56

phic conditions in waters that are basic because of high calcium carbonate concentration.

Phytoplankton abundance, expressed as cubic centimetres of algal cell volume per litre of water, was higher in Pink Lake than in any of the other four lakes studied (Figure 1). Turbidity, which is an index of the total suspended solids in the water, rose from 0.7 units in mid-July to 2.7 units in August (Figure 1). The transparency of the water as indicated by Secchi depth fell from 4 to 2.1 m during the same period (Dickman and Peters, unpublished). To our knowledge, blooms of this severity have not been recorded for Pink Lake in the past. Consequently, a nutrient budget for Pink Lake has been undertaken to determine the quantity of nutrients entering and leaving the lake. It is hoped that this information may permit management decision about the control of nutrient influxes to the lake.

A spring bloom occurred in Pink Lake sometime between the two turbidity samples, taken on 13 and 20 June (Figure 1). Unfortunately the phytoplankton samples of 12 June and 7 July did not coincide with peak bloom densities as reported by swimmers. The phytoplankton samples of 12 June were dominated by numerous species of the genus *Dinobryon*. *Dinobryon sertularia* and *D. sociale* (Figure 2) are common in hard-water lakes and sometimes, as in the June samples, comprise the most conspicuous element in the phytoplankton (Prescott 1966, p. 379). *Achnanthes lapponnica* var. *fennica* was also common in June as was *Tabellaria fenestrata* (Figure 2). By July, *Microcystis* and *Aphanocapsa* showed up in increasing numbers. In August *Lagerheimia quadriseta* and *L. citriformis* became dominant along with *Asterionella formossa* (Figure 2). During August, bloom densities of over 1 000 000 cells per litre were recorded for *Lagerheimia* species in Pink Lake.

Ramsay Lake Phytoplankton

A suprising number of phytoplankton taxa were recorded in this small bog lake. It ranked with Meach Lake in having the identical number of common species although it had fewer taxa in total than Meach (137 versus 143). This surprisingly high phytoplankton diversity in Ramsay was apparently due to the large number of desmids found in the acid waters of this bog lake. There were 47 Chlorophyte taxa, which include the desmids, present in Ramsay Lake while only 31 Chlorophyte taxa were recorded from Meach Lake and 32 from

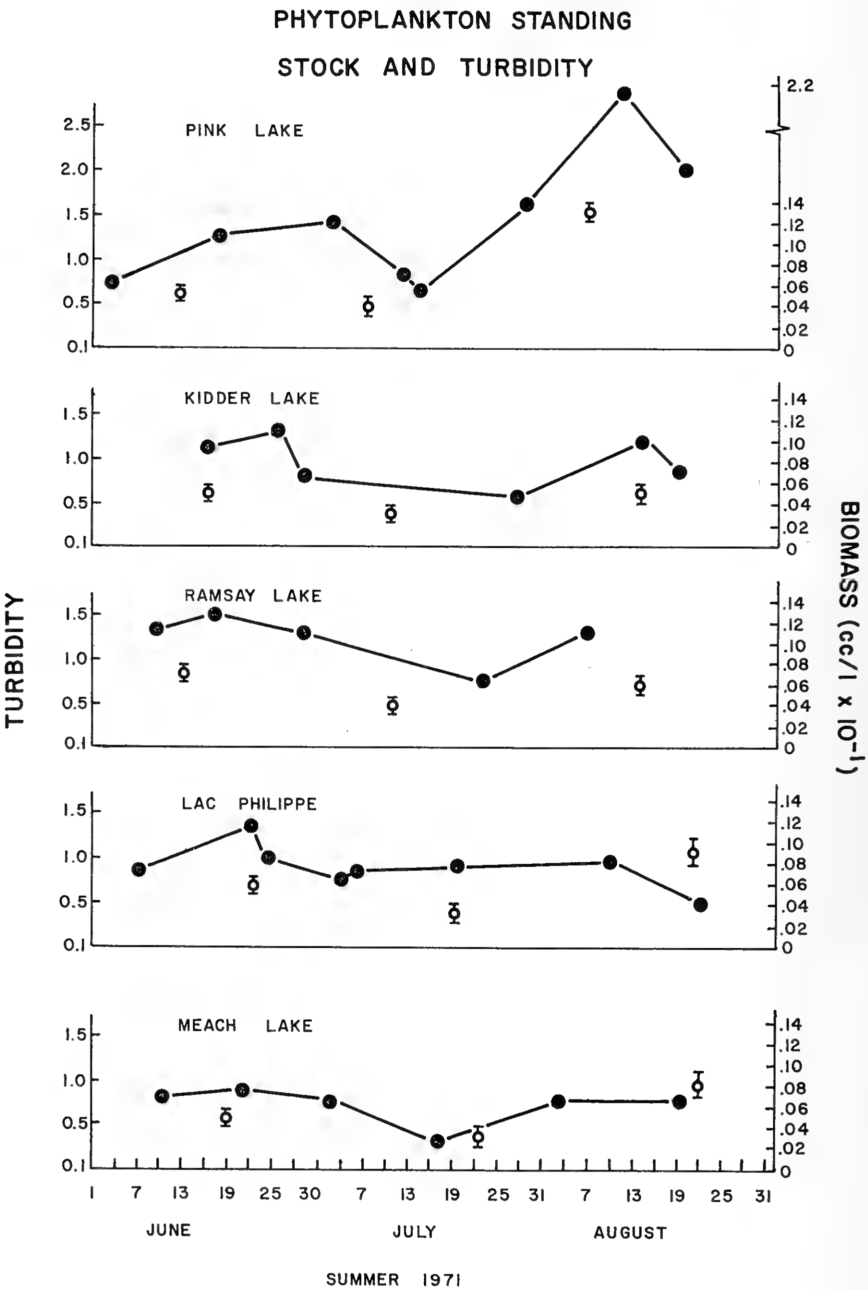


FIGURE 1. Phytoplankton biomass and turbidity in five lakes in Gatineau Park. The biomass values for the three sampling periods are represented by a symbol: the top bar = maximum, lower bar = minimum, and circle = mean; n = 3.

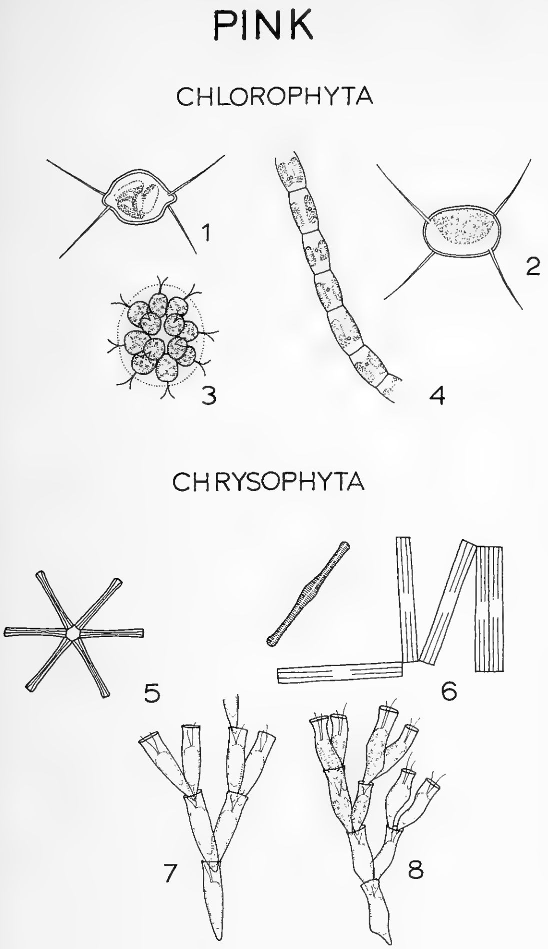


FIGURE 2. (1) *Lagerheimia citriformis* var. *paucispina*; (2) *Lagerheimia quadriseta*; (3) *Pandorina morum;* (4) *Ulothrix subtilissima*; (5) *Asterionella formossa*; (6) *Tabellaria fenestrata*; (7) *Dinobryon sociale;* (8) *Dinobryon sertularia*.

Lac Philippe. Pink Lake with its alkaline waters, had no common desmid species and only 22 Chlorophyte taxa.

The Chrysophyta dominated the water at Ramsay Lake in June with Cyanophyta being the second most abundant group. In July the Cyanophytes were still prominent and Chlorophytes were found in wide variety. During August, Cyanophytes were densest with the green and yellow-brown algae having a large variety of taxa but smaller numbers.

Ramsay Lake has a smaller algal density (0.0062 cc cells/litre water) than either Lac Philippe (0.0065) or Pink Lake (0.0072). The above values are mean densities calculated by summing the monthly densities (Figure 1) and dividing by 3. Ramsay shared with Meach Lake the following abundant species: *Dinobryon sociale* in June; and *Chrysosphaerella* cf. *longispina* colonies in August.

The high humic content of Ramsay Lake was reflected in its considerable turbidity (Figure 1) and low Secchi transparency (Dickman and Peters, unpublished). The brown waters of this lake may inhibit algal growth through direct chemical inhibition as a result of the phenolic and humic substances dissolved in the water, by the absorption of necessary growth substances (nutrients) on humates, and by reduction in light penetration (Ruttner 1970).

Dactylococcopsis sp. (Figure 6) was found above trace levels only in Meach and Ramsay Lakes. *Ankistrodesmus* cf. *falcatus* (Figure 3) was only in Ramsay as was *A.* cf. *subulatus*. Both are indicators of acid waters. The two bog lakes, Ramsay and Kidder, shared a number of species such as *Scenedesmus bijuga* and *Dinobryon vanhoeffenii* and several species of the diatom genus *Eunotia* (Figure 3). Many of these shared species were acid-loving or acid-tolerant forms, such as *Eunotia curva* var. *capitata* (Figure 3).

Kidder Lake Phytoplankton

During June and July, *Cyclotella bodanica* was abundant in Kidder Lake while in June, July, and August *Navicula radiosa, Navicula laevissima*, and *Tabellaria flocculosa* (Figure 4) became abundant. In all, 117 species were found in the phytoplankton of Kidder Lake. Only 38% of these ever became common and only 4% of these became abundant (Table 1). Except for Pink Lake which had 101 species, Kidder Lake had the lowest number of taxa. It also had the fewest common taxa (45 vs. 56 in Pink). June samples were largely comprised of chrysophytes such as *Dinobryon* cf. *bavaricum* (Figure 4). In July both chrysophytes and cyanophytes were common. By August the cyanophytes appeared in highest cell density.

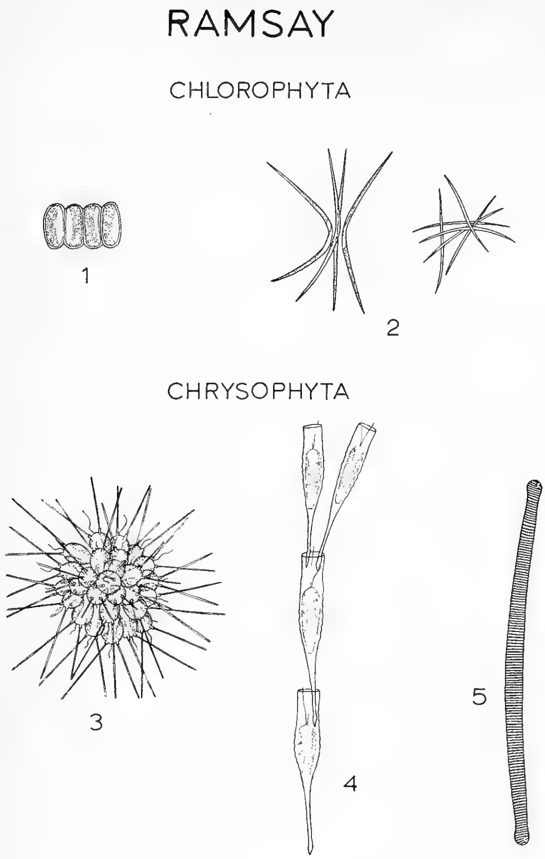


FIGURE 3. (1) *Scenedesmus bijuga*; (2) *Ankistrodesmus falcatus*; (3) *Chrysosphaerella longispina*; (4) *Dinobryon vanhoeffenii*; (5) *Eunotica curvata* var. *capitata*.

A number of genera such as *Crucigenia* (Figure 6) and *Geminella* occurred only in Kidder and Ramsay Lakes. Even more striking, six of the seven *Eunotia* species found in the five lakes occurred only in Ramsay and Kidder, indicating the similarity of these two bog lakes.

The phylum Pyrrophyta, which includes the dinoflagellates, displayed a rather interesting transition. With the exception of *Ceratium hirundinella* (Figure 4) which was present in all five lakes, no other pyrrophyte taxa were present in either Meach Lake or Lac Philippe; Pink had three taxa, Kidder four, and Ramsay five. The presence of large numbers of desmids and acidophilic diatoms such as *Eunotia serra* var. *diadema* and *Eunotia diodon* (Figure 4) help confirm the bog status of Kidder Lake.

Kidder had the lowest algal density of the five lakes studied (0.0039 cc/litre (Figure 1). In August, phytoplankton density reached a maximum of 400 cells/ml. A single colony of Cyanophyceae such as *Gomphosphaeria* often exceeds this value. This indicates the questionable value of expressing cell density as the number of cells per litre. For this reason total cell volume instead of cell number was used (Figure 1) as a more reliable estimate of standing crop.

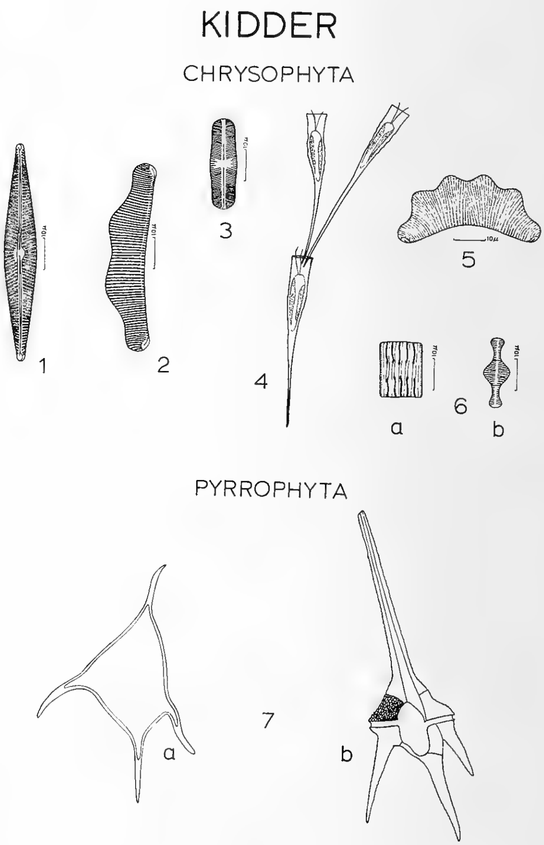


FIGURE 4. (1) *Navicula radiosa*; (2) *Eunotia diodon*; (3) *Navicula laevissina*; (4) *Dinobryon bavaricum*; (5) *Eunotia serra* var. *diadema*; (6) *Tabellaris flacculosa* (*a*) girdle view, (*b*) valve view; (7) *Ceratium hirundinella* (*a*) cyst (*b*) adult.

Lac Philippe Phytoplankton

Approximately 140 taxa were identified over the summer sampling period. The Cyanophyta had the largest number of cells throughout this period. Several taxa of the Chrysophyta were also present in fairly large numbers over the summer. *Dimorphococcus* sp., a genus belonging to the Chlorophyta, was found in August. It was not identified in any other lake but was relatively common in Lac Philippe.

Species composition and abundance were fairly similar to Meach Lake. Several species abundant in August, *Synedra acus* and *Amphipleura pellucida* (Figure 5), are indicators of hard water (Prescott 1962). Their presence in Lac Philippe was restricted to the late summer. This may be an indication that calcium chloride additions to the Meach-Philippe lakeside road as a dust retardent may be influencing the chemical composition of these waters. In addition, the presence of a few periphyton, salt-loving (halophilic) algal species such as *Synedra fulgens*, *Diploneis smithii*, and *Pinnularia aestuarii* (Patrick and Reimer 1966, Figure 5) prompted speculation that $CaCl_2$ summer dust control and NaCl winter ice control may have elevated the Cl^- ion concentration in these lakes enough to select for halophilic forms (Dickman and Krelina 1975). Chloride levels in the ground water survey near these lakes were also slightly elevated, possibly for the same reason (Beatty 1970. Gatineau Park ground water survey. Hydrology Consultants Ltd. Available from National Capital Commission as consultants report. 22 pp.).

Fragilaria crotonensis (Figure 5) a chrysophyte common in Lac Philippe during August, is listed as being widely distributed in mesotrophic waters (Prescott 1962). In addition, a number of oligotrophic indicator species were found in less abundance such as *Pinnularia divergens* (Figure 5). The presence of fewer oligotrophic indicator species in Lac Philippe than in Meach Lake may mean that Lac Philippe is becoming eutrophic at a greater rate than Meach. This hypothesis is also supported by the higher algal densities in Lac Philippe (Figure 1).

Vollenweider (1968) states that lakes hav-

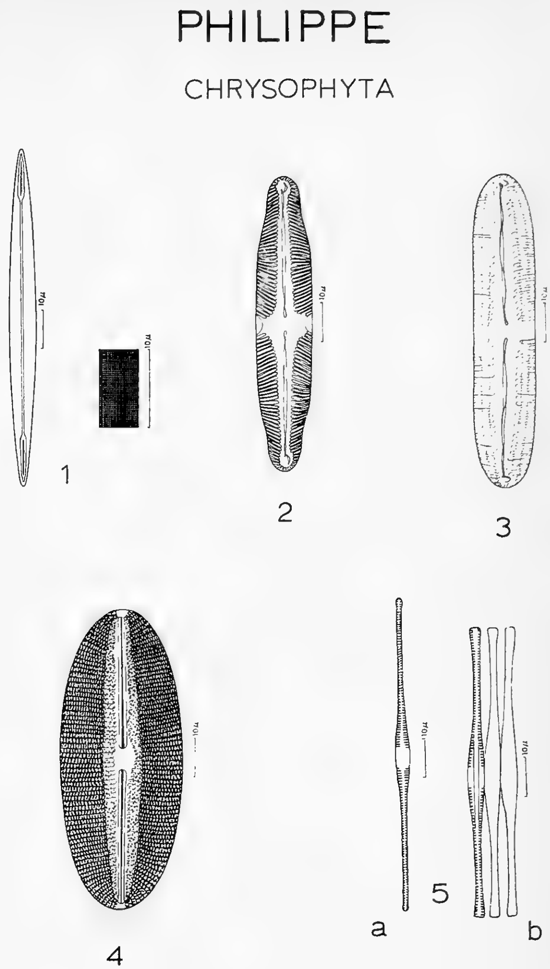


FIGURE 5. (1) *Amphipleura pellucida*; (2) *Pinnularia divergens*; (3) *Pinnularia aestuarii*; (4) *Diploneis smithii*; (5) *Fragilaria crotonensis* (*a*) valve view (*b*) girdle view.

ing a mean phytoplankton biomass exceeding 0.01 cc/litre (roughly 10 000 mg/m^3) are generally regarded as being eutrophic. Only Pink Lake exceeded this level while Lac Philippe and Ramsay Lake were intermediate (0.007 and 0.006 respectively). Meach (0.005 and Kidder (0.004) Lakes were lowest. These observations correlate fairly well with those based on hypolimnetic oxygen minima (Dickman and Peters, unpublished).

Meach Lake Phytoplankton

More phytoplankton taxa were reported for Meach Lake (143) than for any of the other lakes studied in Gatineau Park. In brief, it can be argued that three major factors were responsible for this high diversity. (1) Meach Lake is at the base of a connecting chain of lakes and therefore receives spores and cells of other plants and animals from many other lakes via its inlet. (2) Meach Lake is in transition from an oligotrophic to a eutrophic lake. Thus, it has species characteristic of both lake-types. (3) Meach Lake also has a variety of habitat types from sandy beaches to water-weed filled bogs from which a variety of phytoplankton may eminate.

Throughout the summer, the Cyanophyta had the largest number of cells. Various members of the Chrysophyta were also fairly common during the summer.

In general many phytoplankton species were common to both Meach Lake and Lac Philippe (e.g., *Synura uvella* and *Crucigenia rectangularis* (Figure 6), *Amphipleura pellucida* (Figure 5), *Cymatopleura solea, Fragilaria brevistriata* (Figure 6), *F. capucina* (Figure 6), *Nitzschia littoralis*, and *Navicula divergens*, to name only a few). This is to be expected when two lakes are closely linked together in the same watershed. What is surprising is the relationship between algal number and the position of the lake in the watershed. Generally the higher the lake is in the watershed the lower its algal density relative to those lakes below it (Ruttner 1970). Lac Philippe, however, had substantially higher algal densities than Meach Lake although Lac Philippe drains into Meach Lake. Without a detailed nutrient budget it is difficult to do anything but speculate that the presence of a large swimming area and overnight camping area on Lac Philippe has substantially augmented its nutrient levels, thereby contributing to its higher algal densities and lower hypolimnetic oxygen levels in late summer. The recent addition of a sewage collecting system which pumps the sewage into a distant lagoon hopefully will help reduce the apparently rapid rate of eutrophication in Lac Philippe.

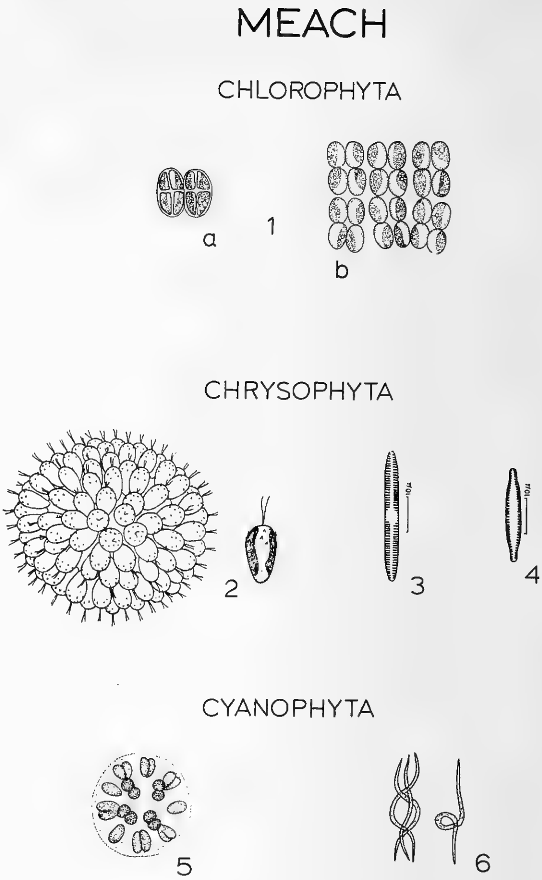


FIGURE 6. (1) (*a*) and (*b*) *Crucigenia rectangularis*; (2) *Synura uvella*; (3) *Fragilaria capucina*; (4) *Fragilaria brevistriata*; (5) *Gomphosphaeria aponina*; (6) *Dactylococcopsis fascicularis*.

Conclusions

It is impossible to add a significant amount of any substance to a lake without this substance's eventually reaching a level in the water which is capable of restricting or augmenting the growth of one or more species (Brinkhurst 1969). These sensitive species are often termed indicator organisms. The mere presence of a pollution-tolerant species or the absence of a single intolerant one, however, does not imply a causal relationship between it and the (inferred) pollutant (Patrick 1949; Palmer 1969; Dickman 1969). For this reason all the species found in a lake's plankton must be considered as a community. This paper deals only with those species which dominated the phytoplankton of each lake or which were unique to a particular lake.

It is likely that numerous patterns might emerge following a more detailed analysis of the extensive data from this study. To date the only attempt to evaluate gross community characteristics was based upon the interesting studies of John Stockner. Stockner (1971) used the ratio of the two planktonic diatom groups, Araphidineae (A) and Centrales (C), in assessing the trophic status of 27 lakes of which 16 were located in Ontario. According to his scheme, lakes with an A/C ratio of 1.0 or less are oligotrophic while those falling between 1.0 and 2.0 are mesotrophic. Those having A/C ratios above 2.0 are eutrophic.

Our data (available from the Depository of Unpublished Data) were used to calculate the A/C ratio for each of the five Gatineau Park lakes. Kidder Lake had the lowest ratio (0.86) while Pink Lake had the highest (1.5). Ramsay Lake (1.4) being a shallow bog lake cannot be classified using this method according to Stockner (p. 273), because benthic diatoms are swept into the water in such lakes rendering the A/C ratio meaningless. Both Lac Philippe (1.2) and Meach Lake (1.2) would be classified as equally mesotrophic according to Stockner's scheme although it is apparent from the indicator species mentioned previously that Lac Philippe is more eutrophic than Meach Lake. To our knowledge this is the first time the A to C ratio has been applied to phytoplankton samples in classifying lakes, as both Stockner (1971) and Michalski (1971) have applied it only to the sediments. With the exception of Ramsay Lake the relative ranking of these lakes in order of their trophic status appears plausible. Pink Lake apears to be truly eutrophic, however, when judged in terms of its high algal standing crop and relatively low diversity. Thus Stockner's (1971) index has merit as a *relative* index as long as absolute limits for eutrophy or oligotrophy are avoided. No single index has yet proved adequate in characterizing the trophic levels of all lakes.

Acknowledgments

We thank Coleen Dawson, Susan Aiken, Luba Podolsky, and John Whiting for their assistance in collecting samples. Alita Karstad prepared Figure 2 (1, 2, 3, 4, 7, 8), while Figure 3, Figure 4 (4, 7), and Figure 6 (1, 2, 6) were supplied by G. W. Prescott, author of *Algae of Western Great Lakes* (Wm C. Brown Co. 1962). The remaining figures are published from *Diatoms of the United States* (Academy of Natural Sciences of Philadelphia, 1966), with permission of the authors R. Patrick and C. Reimer. We thank R. Lee and E. Krelina of the Phycology Section, National Museum of Natural Sciences for assistance in the diatom identification, and W. Illman of the Department of Biology, Carleton University for helpful guidance in both identification and sampling techniques. The study was supported by grants from the National Capital Commission and the National Research Council of Canada.

Literature Cited

Bourrelly, P. 1966. Quelques algues d'eau douce du Canada. Internationale Revue der Gesamten Hydrobiologia 51: 45–126.

Brinkhurst, R. O. 1969. The fauna of pollution. *In* The Great Lakes as an environment. *Edited by* D. V. Anderson. Report PR 39, Great Lakes Institute, University of Toronto. pp. 11–20.

Christie, A. E. 1968. Nutrient-phytoplankton relationships in eight southern Ontario lakes. Ontario Water Resources Commission, Division of Research, Publication 32. 37 pp.

Christie, A. E. 1969. In vitro responses of soft water algae to fertilization. Ontario Water Resources Commission, Division of Research, Paper 2024. 16 pp.

Cleve-Euler, A. 1951. Die Diatomeen von Schweden und Finland. Kunglia Svenska Vetenskapakadamiens Avhandlingar I. Ser. 4. 961 pp.

Dickman, M. 1969. A quantitative method for assessing the toxic effects of some water soluble substances based on changes in periphyton community structure. Water Research 3: 963–972.

Dickman, M. and **E. Krelina** 1975. Baseline periphyton survey of five lakes in Gatineau Park, Quebec. Canadian Field-Naturalist. This issue.

Drouet, R. 1954. A preliminary study of the algae of northwestern Minnesota. Proceedings of the Minnesota Academy of Science 22: 116–138.

Huber-Pestalozzi, G. 1941–1942. Das Phytoplankton der Susswassers, Systematile und Biologie. *In*

Die Biennengewasser Einyelderstellungen aus der Limnologie und ihren Nachbargekieten. Volume 16, Part 2,(1) Chrysophyceae, Farblose Flagallaten; Heterokonatae. (2) Diatomeae. *Edited by* A. Thienemann. Schweizerbart, Stuttgart. pp. 250–329.

Irenée-Marie, F. 1938. Flore desmidiale de la région de Montréal. Des Frères de l'Instruction Chrétienne. Laprairie, Québec.

Meyer, R. L. and **A. J. Brook.** 1967. Freshwater algae from the Itasca State Park, Minnesota. I. Chlorophyta. Nova Hedwigia Zeitschrift fuer Kryptogamenkunde 16: 251–266.

Meyer, R. L. and **A. J. Brook.** 1968. Freshwater algae from the Itasca State Park, Minnesota. II. Chrysophyceae and Santhophyceae. Nova Hedwigia Zeitschrift fuer Kryptogamenkunde 17: 105–122.

Michalski, M. 1971. Report on water quality in Weslemkoon Lake. Ontario Water Resources Commission Reports. 37 pp.

Palmer, C. M. 1969. A composite rating of algae tolerating organic pollution. Journal of Phycology 5(1): 78–82.

Patrick, R. 1949. A proposed biological measure of stream conditions based on a survey of the Conestoga Basin, Lancaster County, Pennsylvania. Proceedings of the Academy of Natural Science of Philadelphia 101: 277–341.

Patrick, R. and **C. W. Reimer.** 1966. The diatoms of the United States. Academy of Natural Science of Philadelphia, Monograph 13. 688 pp.

Prescott, G. W. 1962. Algae of the Western Great Lakes area. Wm. C. Brown Co., Dubuque, Iowa. 977 pp.

Ruttner, F. 1970. Fundamentals of limnology. University of Toronto Press. 295 pp.

Schindler, D. W. and **S. K. Holmgren.** 1971. Primary production and phytoplankton in the Experimental Lakes Area, northwestern Ontario and other low-carbonate waters, and a liquid scintillation method for determining ^{14}C activity in photosynthesis. Journal of the Fisheries Research Board of Canada 28: 189–201.

Smith, G. M. 1950. Freshwater algae of the United States. McGraw-Hill Book Co., Inc., New York.

Stockner, J. G. 1971. Preliminary characterization of lakes in the Experimental Lakes Area, northwest Ontario, using diatom occurrences in sediments. Journal of the Fisheries Research Board of Canada 28: 265–275.

Vollenweider, R. 1968. Technical Report of the Organization of Economic Development. Paris DAS/CST/6827. pp. 1–182.

Received 13 September 1972
Accepted 24 November 1974

Periphyton of Five Lakes in Gatineau Park, Quebec

M. DICKMAN[1] and E. KRELINA

Department of Biology, University of Ottawa, Ottawa, Ontario K1N 6N5

[1] Present Address: Department of Biological Sciences, Brock University, St. Catharines, Ontario L2S 3A1

Dickman, M. and E. Krelina. 1975. Periphyton of five lakes in Gatineau Park, Quebec. Canadian Field-Naturalist 89(4): 371-377.

Abstract. In this baseline survey of the periphyton from five Gatineau Park lakes we identified 368 species. The habitats are described and the relative abundance of each of these species during June, July, and August 1971 are reported. As this is the first inventory of periphyton species in these lakes—Kidder Lake, Meach Lake, Lac Philippe, Pink Lake, and Ramsay Lake—in Gatineau Park, it will facilitate comparisons with future studies.

There is a renewed interest in the role of periphyton as principal primary producers in rivers, streams, ponds, and the littoral zones of shallow lakes (Brown and Austin 1971). Literature on periphyton is only slightly less extensive than literature on phytoplankton. Many important papers on periphyton have been summarized in a survey of methods by A. Sladèckova (1962).

Attempts to relate composition and structure of communities of benthic algae to controlling ecological factors, both natural and man-induced, are often complicated by overlapping patterns of long-term cyclic changes (Sherman and Phinney 1971). For this reason a baseline survey of the attached algae of five typical Gatineau Park lakes was undertaken so that future changes in periphyton species composition might be detected and, in time, related to the ecological factors which caused the changes.

Methods

Five lakes in Gatineau Park were visited once each month in June, July, and August 1971. Algae growing along the shore in roughly half a foot of water were removed from three substrate types: (a) higher aquatic plants (epiphytic algae), (b) mud and silt (epipelic algae), and (c) rocks (epilithic algae). Each sample was preserved in 5% Lugol solution and stored in 24-ml vials (6 drams).

In the laboratory, each vial was subsampled and a wet-mount slide was made from 0.5 ml of this subsample. Each slide was observed under a phase contrast microscope. Cleve-Euler (1951–1955), Patrick and Reimer (1966), and Huber-Pestalozzi (1942) were used in diatom identifications. Because our Bacillariophyceae literature was incomplete there are some synonyms in the list of species. Prescott (1962), Smith (1950), and Irenée-Marie (1938) were used for the identification of other periphyton species.

Diatom subsamples were put through a standard cleaning and mounting procedure. Nitric acid was used to oxidize the internal organic matter and the cleared cells mounted on microscope slides in Hyrax mounting medium. All slides are on file with the Phycology Section of the National Museum of National Sciences, Canada, CANA Accession numbers 11565–11906.

Results

Table 1 summarizes our data from the baseline periphyton survey. A total of 368 species of periphyton was collected in summer samples taken from five Gatineau Park lakes. A list of the species in each lake, including the date each species was found and its abundance, is available, at a nominal charge, from the Depository of Unpublished Data, National Science Library, National Research Council of Canada, Ottawa, Canada K1A 0S2.

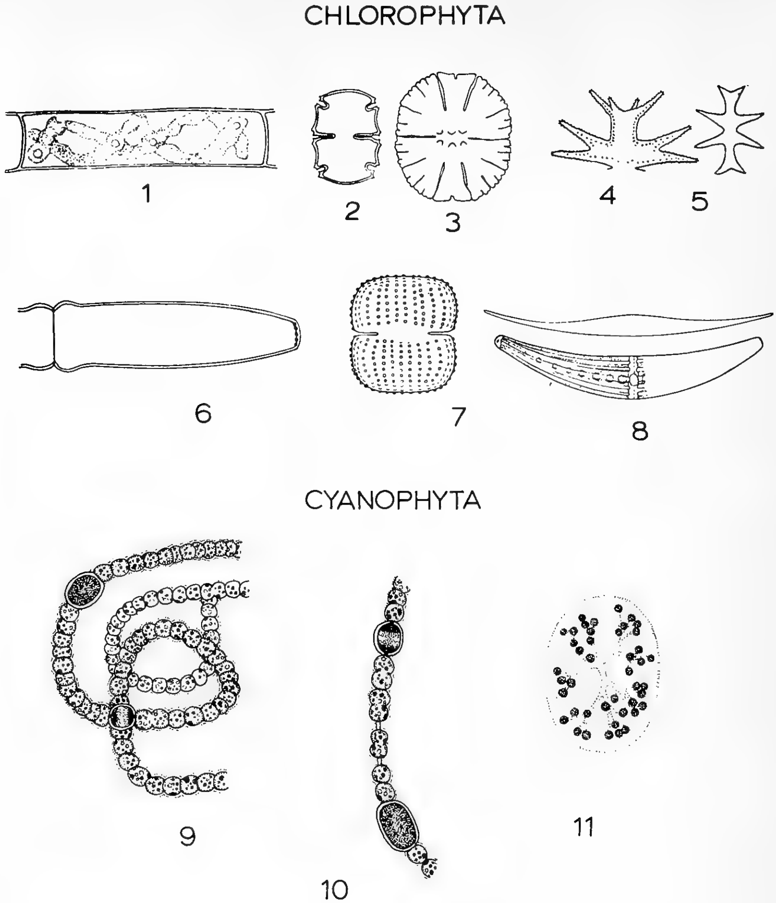


FIGURE 1. (1) *Spirogyra subsalsa*; (2–5) *Micrasterias*; (6) *Pleurotaenium*; (7) *Cosmarium*; (8) *Closterium*; (9–10) *Anabena circinalis*; (11) *Gomphosphaeria lacustris*.

Periphyton of Pink Lake

This study established a baseline for Pink Lake of 16 species of Cyanophyta (blue-green algae), 24 Chlorophyta (green algae), 86 Chrsyophyta (largely diatom species), and 8 species from the other algal divisions. Periphyton analysis indicated that of the five lakes studied in Gatineau Park, Pink Lake was unique in having indicator species of alkaline hard waters. For example, *Navicula exigua* (Figure 3), a diatom indicator of moderate hardness (Patrick and Reimer 1966), was found only in Pink Lake. *Eunotia arcus* (Figure 3), one of the few members of the genus which grows in association with high concentrations of calcium carbonate (Patrick and Reimer 1966), was restricted to Pink Lake as well. Another diatom, *Amphipleura pellucida*, which was unique to Pink Lake, is generally restricted to fairly hard waters (Patrick and Reimer 1966).

Periphyton density in Pink Lake was low. Long strands of filamentous green algae or mats of blue-green algae in the littoral zone were never observed in the two years that we have been studying the lake. *Spirogyra subsalsa* (Figure 1) was present in low densities while *Bulbochaeta* and *Oedogonium* were only slightly more abundant. Pink Lake has proved to be unique in a number of ways all of which ultimately are related to its meromictic status as the only lake in the Gatineau Park with a permanent, deep, non-mixing bottom layer (Dickman and Peters, unpublished).

Ramsay Lake Periphyton

Ramsay Lake was the closest to a true bog of the five lakes studied. There were 86 diatom species. A large proportion of these, such as *Eunotia exigua*, *E. parallela*, *Frustulia rhomboides*, and *Stauroneis nobilis* (Figure 3), to mention only a few, were bog-loving or acidophilic forms (Patrick and Reimer 1966). It is significant that *Stauroneis nobilis* (Figure 3), a dystrophic indicator species (Patrick and Reimer 1966), was found only in Ramsay Lake, indicating that the lake has progressed fairly far along the route toward bog formation. Desmid species (Figure 1) such as *Cosmarium* spp. and *Micrasteris pinnatifida* (Irenée-Marie 1938) further confirm the bog status of this lake.

Of the 13 *Eunotia* species found in this study, all but two were restricted to the two bog lakes in this study, Ramsay and Kidder Lakes (nine of the species in Kidder Lake and eight in Ramsay Lake), six were common to both lakes.

Periphyton of Kidder Lake

In addition to establishing a baseline of 78 diatom species, 20 blue-green algal species, 25 Chlorophyta (green algal) species, and various other subordinate classes (Table 1) this study established the presence of a number of indicator species in Kidder Lake. The indicator species were of two major types: (1) species which prefer cold waters with low total dissolved solids (e.g., *Pinnularia nodosa, Pinnularia dactylus*, and *Synedra tabulata* (Patrick and Reimer 1966; Figure 2)); (2) species indicating slightly acid conditions, such as *Eunotia diodon* and *Eunotia robusta* (Figure 3; Patrick and Reimer 1966).

Indicators of dystrophic bog conditions, such as *Stauroneis nobilis* (Figure 1; Patrick and Reimer 1966), were not found in Kidder Lake but they did occur in Ramsay Lake. Thus Kidder Lake appears to be in an earlier (less dystrophic) stage of bog formation than Ramsay Lake (Dickman and Oliver, unpublished).

TABLE 1—The relative abundance of the periphyton species collected from five lakes in Gatineau Park

	Lakes				
	Kidder	Meach	Philippe	Pink	Ramsay
Cyanophyta					
No. of taxa observed	16	15	20	23	24
No. of common taxa*	5	3	6	4	4
Chlorophyta					
No. of taxa observed	24	29	25	26	28
No. of common taxa	5	8	7	4	7
Chrysophyta, except diatoms					
No. of taxa observed	5	5	2	4	4
No. of common taxa	2	1	0	0	0
Bacillariophyceae (diatoms)					
No. of taxa observed	81	86	78	117	102
No. of common taxa	17	16	23	28	24
Pyrrophyta					
No. of taxa observed	1	3	6	2	0
No. of common taxa	0	0	0	0	0
All other algal classes					
No. of taxa observed	7	6	9	6	8
No. of common taxa	2	0	3	2	3
Totals					
No. of taxa observed	134	144	140	178	166
No. of common taxa	30	31	45	38	38
			Total = 368 species		

* Common taxa were those occurring in more than 20% of the samples analyzed.

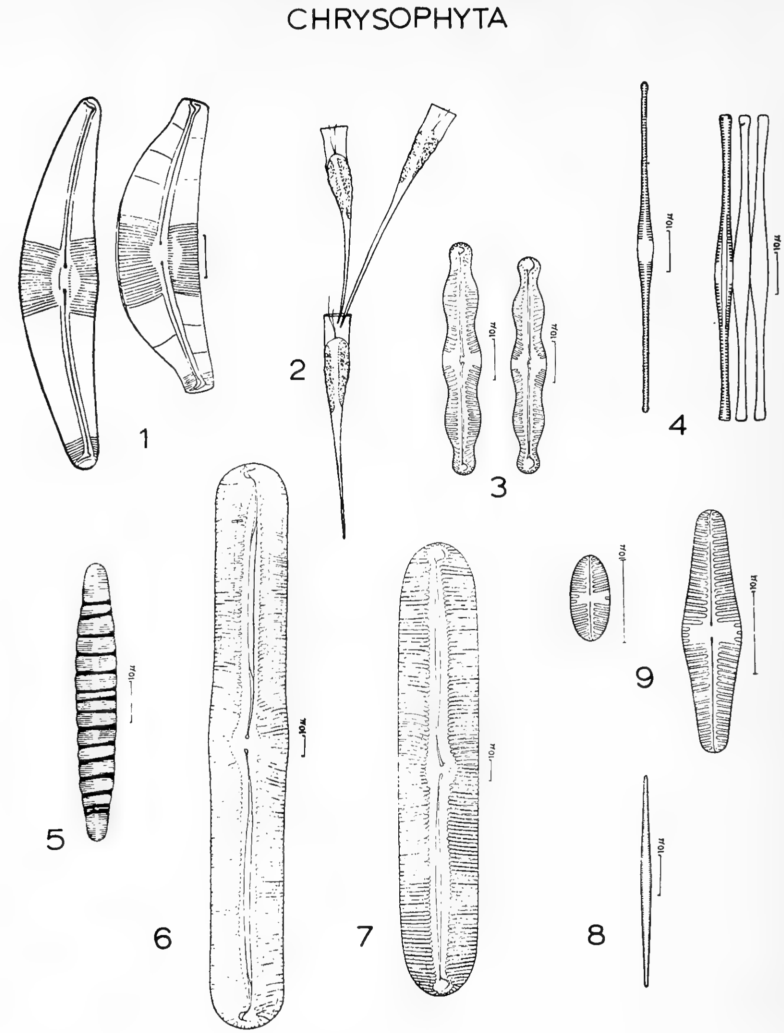


FIGURE 2. (1) *Cymbella stuxbergii*; (2) *Dinobryon bavaricum*; (3) *Pinnularia nodosa*; (4) *Fragilaria crotonensis*; (5) *Diatoma hiemale*; (6) *Pinnularia nobilis*; (7) *Pinnularia dactylus*; (8) *Synedra tabulata*; (9) *Achnanthes lanceolata*.

Periphyton of Meach Lake

Meach Lake contained the highest diversity of periphyton species with 117 diatom species, 23 Cyanophyta, 26 Chlorophyta, and 12 species from other classes giving a total of 178 periphyton species (Table 1). This high diversity is attributed to three major factors:

(1) Meach Lake receives a continuous supply of algal cells from Lac Mousseau and Lac Philippe because it is at the base of the watershed.

(2) Meach Lake, like Lac Philippe, appears to be in transition between oligotrophy and eutrophy and both types of indicator species are present. For example, *Tabellaria fenestrata, Navicula vulpina* (Figure 3), and *Fragilaria crotonensis* (Figure 2) are all indicators of mesotrophic to eutrophic conditions (Patrick and Reimer 1966) while *Pinnularia divergens* and *Diatoma hiemale* (Figure 2), two more or less oligotrophic species (Patrick and Reimer 1966), are also found in Meach

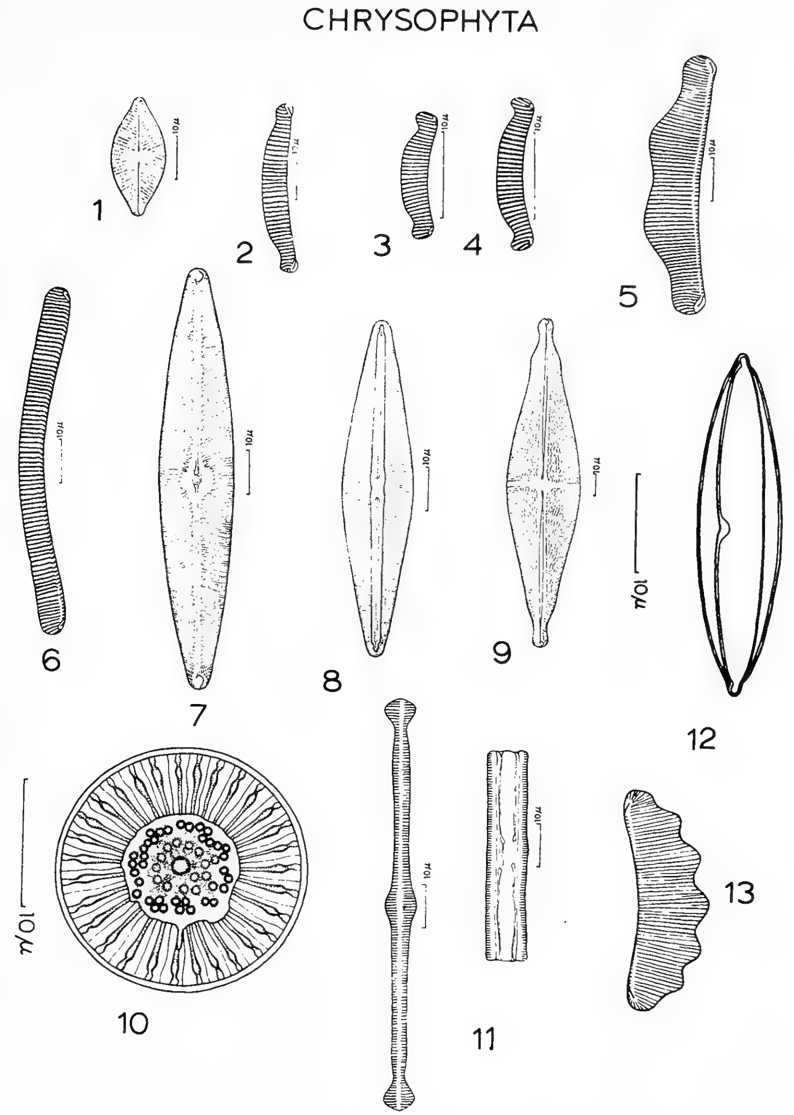


FIGURE 3. (1) *Navicula exigua*; (2) *Eunotia arcus*; (3–4) *Eunotia exigua*; (5) *Eunotia diodon*; (6) *Eunotia parallela*; (7) *Navicula vulpina*; (8) *Frustulia rhomboides*; (9) *Stauroneis nobilis*; (10) *Cyclotella kuetziugiana*; (11) *Tabellaria fenestrata*; (12) *Tropidoneis* sp. aff. *lepidoptera*; (13) *Eunotia robusta*.

Lake and are possible indicators of the lake's past oligotrophic conditions when trout and ciscoes were its dominant fish species (Rubec 1975). Thus both oligotrophic and eutrophic species temporarily co-exist in Meach Lake increasing its total algal diversity.

(3) The third reason for the lake's high periphyton diversity is its large variety of habitats such as the extensive area of higher aquatic plant species at the north end of the lake (Aiken and Gillett 1974), the silt-laden bays, the sandy beaches, and the rock out-

croppings. This habitat diversity maximizes the kinds of locations available for periphyton colonization.

Periphyton of Lac Philippe

The desmid (Figure 1) oligotrophic indicator species such as *Cosmarium margaritatum, Pleurotaenium subcornulatum*, and *Closterium* spp. as well as some diatoms such as *Diatoma hiemale* (Figure 2) indicate that at one time the waters of Lac Philippe, like those of Meach Lake, were also quite oligotrophic. A large number of mesotrophic and eutrophic indicator species such as *Fragilaria crotonensis, Tabellaria fenestrata, Anabaena circinalis,* and *Gomphosphaeria lacustris* (Patrick and Reimer 1966; Prescott 1966; Figures 1, 2, and 3) appear to have established themselves in the lake since that time.

The presence of algal species tolerant to brackish water, such as *Synedra fulgens, Diploneis smithii, Pinnularia aestuarii,* and *Tropidoneis* sp. (Patrick and Reimer 1966) in both Meach Lake and Lac Philippe was initially quite paradoxical. But upon learning that 10–15 tons per mile of sodium chloride was applied to the road running along the southern shore of Lac Philippe and Meach Lake over the last few years during winter, and a similar quantity of $CaCl_2$ applied during summer as a dust retardant, we recognized the possibility that such applications might transform the areas receiving runoff from the road into a brackish-water habitat. Chloride levels at these sites were higher than at any of the other lakes in Gatineau Park (1-13 ppm, Dickman and Peters, unpublished). Hydrology Consultants Ltd. reported that some wells in the Breton Beach, Lac Philippe area had chloride concentrations above 100 ppm (Beatty, B. W. 1970. Gatineau Park groundwater survey. Hydrology Consultants Ltd. Available from National Capital Commission as consultant's report. 22 pp.). Thus the presence of these brackish-tolerant species in the middle of summer in Meach Lake and Lac Philippe, although startling, now appears to have a plausible explanation. *Tropidoneis* sp. aff. *lepidoptera* was a dominant species for one station in Pink Lake along its southeastern shore. It was also found in both Philippe and Meach Lakes. Long considered a marine species (Hohn and Hellerman 1963) its presence in Pink Lake confirms its ability to survive in waters with negligible salinity. Whether such species are remnants (relicts) of the Champlain Sea era is purely speculative at this stage.

The genus *Fragilaria* in Lac Philippe and Meach Lake is particularly diverse. Six of the seven species found in Gatineau Park were present in these two lakes. *Fragilaria brevistriata, F. capucina, F. crotonensis*, and *F. pinnata* were found only in these two lakes. Ecological data are, however, incomplete for this genus. There are six more species found only in these lakes: *Diploneis ovalis* var. *oblongella, Melosira islandica, Navicula vulpina, N. rhynchocephala, Nitzschia littoralis,* and *Synedra vaucheriae* (Table 1), indicating again the basic similarity in the two lakes.

Conclusions

This study indicates the rich variety of lake types all within a few miles of one another in Gatineau Park. Desmids (green algal forms commonly associated with acid or softwater) abounded in the two bog lakes, Kidder Lake and Ramsay Lake, while hardwater-loving species were common in Pink Lake. Brackish-water as well as alpine, arctic, and marine forms were encountered in Meach Lake and Lac Philippe. The cold-water alpine species *Cymbella stuxbergii, Diatoma hiemale,* and *Pinnularia divergens* were felt to be indicators of past oligotrophic conditions which prevailed during the time when lake trout and ciscoes were plentiful in these lakes. At present, Meach Lake and Lac Philippe appear to be in transition between oligotrophy and eutrophy (mesotrophy), with Lac Philippe the more eutrophic of the two.

The problem of distinguishing between euplankton, tychoplankton, and attached algae in 'periphyton' samples makes any comment about periphyton substrate diversity quite suspect. Suffice it to say that analysis of epipelic, epiphytic, and epilithic samples from each of the five lakes resulted in a comprehensive table of the species composition for each of these three habitats (data are available from the

Depository of Unpublished Data).

More species were identified from Meach Lake (178) than from any of the other four lakes. Lac Philippe was next (156), with the two bog lakes, Ramsay (139) and Kidder (137), being slightly higher than the meromictic Pink Lake (134).

It is our belief that careful surveillance of the changes in the periphyton species composition in these Gatineau Park lakes will reveal how rapidly they are undergoing eutrophication. A baseline survey such as this one will now make comparisons through time possible.

Acknowledgments

We thank Coleen Dawson, Susan Aiken, Luba Podolsky, and John Whiting for their assistance in collecting samples. Aleta Karstad prepared Figure 1 (9, 10, 11), Figure 2 (2), and Figure 3 (10, 12) while Figure 2 (1 to 8 inclusive) was supplied by G. W. Prescott, author of *Algae of the Western Great Lakes* (Wm. C. Brown Co., 1962). The remaining figures are those of R. Patrick and C. Reimer's *The Diatoms of the United States* (Academy of Natural Sciences of Philadelphia, 1966). The study was supported by grants from the National Capital Commission and from the National Research Council of Canada.

Literature Cited

Aiken, S. and **J. Gillett.** 1974. The distribution of aquatic plants in selected lakes in Gatineau Park, Quebec. Canadian Field-Naturalist 88: 437–448.

Brown, S. D. and **A. P. Austin.** 1971. A method of collecting periphyton in lentic habitats with procedures for subsequent sample preparation and quantitative assessment. Internationale Revue der Gesamte Hydrobiologie und Hydrographie 56(4): 557–580.

Cleve-Euler, A. 1951–1955. Die Diatomeen von Schweden und Findland. Kunglia Svenska Vetenskapsakademien Avhandlingar, Ser. 4. 961 pp.

Hohn, M. H. and **J. Hellerman.** 1963. The taxonomy and structure of diatom populations from three Eastern North American rivers, using three sampling methods. Transactions of the American Microscopical Society 82(3): 250–329.

Huber-Pestalozzi, G. 1942. Das Phytoplankton des Susswassers, Systematile und Biologie. *In* Die Biennengewasser Einyelderstellungen aus der Limnologie und ihren Nachbargekieten, Volume 16, Part 2 (1) Chrysophyceae; Farblose Flagellaten; Heterokonatae. (2) Diatomeae. *Edited by* A. Thienemann. Schweizerbart, Stuttgart. pp. 250–329.

Irenée-Marie, F. 1938. Flore desmidiale de la région de Montréal. Des Frères de l'Instruction Chrétienne, Laprairie, Québec.

Patrick, R. and **C. Reimer.** 1966. The diatoms of the United States. Volume 1. Monographs of the Academy of Natural Sciences of Philadelphia 13: 688 pp.

Prescott, G. W. 1962. Algae of the Western Great Lakes area. Wm. C. Brown Co., Dubuque, Iowa. 977 pp.

Rubec, P. 1975. Fish distribution in Gatineau Park, Quebec, in relation to postglacial dispersal, man's influence, and eutrophication. Canadian Field-Naturalist. This issue.

Sherman, B. J. and **H. K. Phinney.** 1971. Benthic algal communities of the Metolium River. Journal of Phycology 7: 269–273.

Sladèckova, A. 1962. Limnological investigation methods for the periphyton ("Aufwuchs") community. Botanical Review 1962 (April–June): 286–350.

Smith, G. M. 1950. Freshwater algae of the United States. McGraw-Hill Book Co., Inc., New York.

Received 6 October 1972
Accepted 23 July 1974

Macrobenthos of Five Lakes in Gatineau Park, Quebec

D. R. OLIVER and H. V. DANKS*

Biosystematics Research Institute, Canada Department of Agriculture, Ottawa, Ontario K1A 0C6

* Present address: Department of Biological Sciences, Brock University, St. Catharines, Ontario L2S 3A1

Oliver, D. R. and H. V. Danks. 1975. Macrobenthos of five lakes in Gatineau Park, Quebec. Canadian Field-Naturalist 89(4): 378-382.

Abstract. A survey of the macrobenthos of five lakes in Gatineau Park, Quebec was made in the summer of 1971. Over 160 invertebrate species (excluding molluscs) were collected. Information on the relative abundance of the species living in the deep parts of the lakes was recorded.

The macrobenthos of five lakes in Gatineau Park, Quebec was surveyed in the summer of 1971. This survey was part of a program, supported by the National Capital Commission, to establish baselines by which changes in these lakes caused by human activity might be assessed. Four of the five lakes, Pink Lake, Ramsay Lake, Lac Philippe, and Meach Lake are quite popular for public recreation, whereas the fifth, Kidder Lake, is less frequented. The five lakes differ in physical and chemical characteristics and were selected because they were believed to be representative of most of the lakes occurring in Gatineau Park.

Pink Lake is unusual in that oxygen concentration below 13 m is negligible (less than 0.1 ppm) throughout the year and as a result the bottom below this depth, forming about 60% of the total bottom area, is without macrobenthos. The waters of Kidder Lake and Ramsay Lake contain a considerable amount of brown humic material which is indicative of their bog-lake status. Ramsay Lake is in a later stage of succession from lake to bog than Kidder Lake. During the summer months the hypolimnetic oxygen concentrations dropped to below 5% saturation in Kidder Lake and below 1% in Ramsay Lake. The two largest lakes, Lac Philippe and Meach Lake, are long and narrow and are part of the same drainage system. The oxygen concentration in the deep part of Meach Lake did not drop below 32% saturation. In Lac Philippe the oxygen concentration may drop below 15% saturation during the late summer months. The physical and chemical characteristics of these lakes were studied by Dickman and Peters and the data are recorded in a 1971 report to the National Capital Commission.

The macrobenthos of the five lakes had not been investigated previously except for studies on the molluscs living in Meach Lake (La Rocque 1935). Therefore the objectives of the survey were to record the species present in each lake and to estimate the relative abundance of the species living in the profundal region of the lakes. Since it was not possible to initiate the survey before a considerable amount of insect emergence had occurred, the species list compiled in this study is incomplete and the quantitative data on the profundal macrobenthos reveal only the major differences between the five lakes. Nevertheless, over 160 invertebrate species were identified from the five lakes studied. The incompleteness of the species list also results from the fact that the immature stages of some groups are too poorly known to allow identifications beyond the generic level. The data collected on molluscs are presented in a companion paper by Grimm (*This issue*).

Methods

Most of the sampling was restricted to areas of the lakes less than 7 m deep and to the deepest part of each lake. The peripheral area was divided arbitrarily into a number of zones based on bottom type, emergent vegetation, depth, etc. An attempt was made to collect representatives of the various types of macrobenthos living in these zones by using a variety of qualitative methods such as dredging, dip nets, and turning over stones.

In approximately the deepest part of each lake a station was established at a fixed site and sampled on three dates during the summer (Table 1). Each sample consisted of five units collected with an Ekman dredge, 15 × 15 cm, except the samples from Pink Lake which consisted of two units. The early samples (during June, and for Pink Lake and Kidder Lake during July) were taken with a standard small Ekman dredge. The remainder of the samples were taken with a tall Ekman dredge 15 × 15 × 23 cm). Each unit was strained through nylon mesh nets (apertures 400 μ square). The residues were stored in plastic containers at about 2°C until they were sorted with the aid of a dissecting microscope. Sorting was usually completed within one or two days after the sample was taken.

Results and Discussion

A list of the macrobenthos (excluding Mollusca) found living in the five Gatineau Park lakes studied is available at a nominal charge from the Depository of Unpublished Data, National Science Library, National Research Council of Canada, Ottawa, Canada K1A 0S2. The number of species in each major group is summarized in Table 2. This table includes groups not in the main list. The Turbellaria and Decapoda have not been identified, and three species of Odonata (Anisoptera) and two species of Coleoptera (Dytiscidae and Helodidae) could not be identified to genus. The data given in Table 2 indicate that Lac Philippe and Meach Lake have a larger and more diverse fauna than the other three lakes. This is not unexpected as these larger lakes have a more diverse shoreline and littoral region, and so provide a greater variety of habitats for different species. Each of these two lakes has a number of species that were not collected in the other four lakes: 33 in Meach Lake and 20 in Lac Philippe. It must be remembered that we are reporting on a preliminary survey and future collection will probably show that Meach Lake and Lac Philippe have even more species in common.

The macrobenthos of Pink, Kidder, and Ramsay Lakes is less diverse and it has probably always been so because of the smaller size and relatively uniform peripheral areas of these lakes. Nevertheless the present physico-chemical conditions of the lakes limit their capacity to support a richer macrobenthos although probably more species occurred there in the past. The limnological history of these lakes is unknown but it can be assumed that the meromictic nature of Pink Lake and the more or less dystrophic condition of Ramsay and Kidder Lakes has developed over a period of years with a concurrent reduction in macrobenthic diversity. These general conclusions are supported by the observation that, despite their physico-chemical differences, they do not have a distinctive macrobenthos and have very few species that were not found in the other lakes. For example, most of the species living in Pink Lake are found in at least two of the other lakes. Except for *Chaoborus punctipennis* and *Oecetis* sp., if a species occurs in all of the other lakes it is found in Pink Lake (e.g., *Iloydrilus templetoni*, *Hyalella azteca*, *Stenonema* sp., *Metrobates hesperius*, and a number of species of Chironomidae). In contrast only three species, one leech and two dragonflies, were collected only from Pink

TABLE 1—Depths of profundal stations and dates of sampling

Lake	Station depth (m)	Sampling dates, 1971		
		June	July	August
Pink	18 – 18¾	5, 12	7	4
Kidder	14¼ – 14¾	13	12	9
Ramsay	9½ – 10	16	14	11
Philippe	13½ – 14¼	21	19	16
Meach	20¾ – 21¾	23	21	18

TABLE 2—Number of species in each major group of macrobenthic invertebrates (excluding molluscs) found in five Gatineau Park lakes

	Pink	Kidder	Ramsay	Philippe	Meach
Turbellaria	1	0	0	1	1
Annelida					
Oligochaeta	4	3	3	12	11
Hirudinea	3	2	3	3	1
Isopoda	0	0	0	0	4
Amphipoda	1	1	1	1	1
Decapoda	1	1	1	1	1
Hydracarina	1	9	6	16	18
Ephemeroptera	2	2	3	5	7
Odonata	6	5	3	7	7
Hemiptera	2	2	3	3	2
Trichoptera	2	6	4	4	3
Megaloptera	0	0	0	1	2
Coleoptera	0	4	1	6	8
Diptera					
Chaoboridae	0	3	2	1	2
Chironomidae	16	16	6	33	35
Others	0	1	1	2	3
Total	39	55	37	96	106

Lake. Pink Lake has about the same number of species as Ramsay Lake but some of the major groups appear to be absent. The Chaoboridae are absent, and no specimens of Ceratopogonidae or Coleoptera were collected, although they may be found with further collecting. None of the major groups is absent from Ramsay and Kidder Lakes. It is interesting to note that the more dystrophic of the two lakes, Ramsay Lake, has the smaller number of species.

The macrobenthos of all of these lakes is dominated by Diptera, largely by larvae of Chironomidae and Chaoboridae and not by Amphipoda and Sphaeriidae which are often the abundant forms in other types of lakes (Rawson 1960). In this broad sense these Gatineau Park lakes are similar to one another. Two lakes, however, Pink and Philippe, may be changing from the Diptera-dominant type to an oligochaete-dominant type. Oligochaetes in the profundal region of Lac Philippe and in the soft-bottom areas of the littoral region are more abundant than in comparable areas in Meach Lake. Although chironomid larvae are clearly dominant (about 70% of the total number of organisms) in the area shallower than 13 m in Pink Lake, the percentage of oligochaetes (about 20%) is higher than that of any other lake studied with the exception of Lac Philippe.

A comparison of the composition of the macrobenthos living in the deepest part of four of the five lakes is given in Table 3. Pink Lake is not included because of the lack of macrobenthos below 13 m. Only four groups, Chironomidae, Chaoboridae, Oligochaeta, and Hydracarina, are represented. The basic pattern of a Diptera-dominant macrobenthos common to all lakes is evident. In all of the lakes except Lac Philippe, which has a proportionately higher percentage of oligochaetes, dipteran larvae make up about 90% or higher of the total number of organisms. Except for one species of Hydracarina the macrobenthos of the deep part of Kidder Lake is composed of two species of *Chaoborus*. Chironomid larvae are absent from this region whereas in the littoral region they outnumber the Chaoboridae. As in Kidder Lake, oligochaetes are absent from the profundal region of Ramsay Lake. In this aspect these two bog lakes are quite different from Meach Lake and Lac Philippe although the percentage of oligochaetes in Meach Lake is low.

From the foregoing it is evident that these five lakes, although they differ in morphometry, chemistry, and other features—differences which are reflected in the composition

TABLE 3—Composition of macrobenthos in profundal region of four Gatineau Park lakes. Number of organisms in a group is given as a percentage of the total number of organisms collected on three sampling dates

	Kidder	Ramsay	Philippe	Meach
Oligochaeta				
Limnodrilus hoffmeisteri			2.9	3.1
Limnodrilus profundicolus			0.2	
Ilyodrilus templetoni			7.9	
Arcteonais lomondi			4.2	0.6
Immature Tubificidae			23.9	2.4
Nais barbata				
Total	(0)	(0)	(39.1)	(7.3)
Hydracarina				
Limnesia sp.			0.1	3.6
Huitfeldia sp.	1.2			
Total	(1.2)	(0)	(0.1)	(3.6)
Chaoboridae		93.6	41.4	60.6
Chaoborus punctipennis	71.3			
Chaoborus albatus	27.5			
Total	(98.8)	(93.6)	(41.4)	(60.6)
Chironomidae				
Procladius spp.		0.6	5.9	10.9
Chironomus spp		5.2	13.3	17.0
Cryptochironomus sp.		0.6	0.1	
Phaenopsectra sp.			0.1	
Cricotopus sp.				0.6
Heterotrissocladius sp.				
Total	(0)	(6.4)	(19.4)	(28.5)
Total number of organisms collected	80	155	732	165

of their macrobenthos—have faunal similarities. Their macrobenthos therefore probably represents an adequate sample characterizing the general features of the macrobenthos of Gatineau Park lakes as a whole.

The species list, though incomplete, provides an essential reference point in our knowledge of the five lakes. The profundal samples reveal major differences between lakes, and are likely to be more useful than littoral samples in establishing baselines by which changes within the lakes can be monitored; they would be expected to show long-term changes independently of short-term and local effects near the shore. Nevertheless, the profundal samples taken during this survey have limited value for providing baselines because the first samples were taken long after the beginning of insect emergence. A more suitable time for sampling would be soon after the ice leaves a lake and thus before much emergence had occurred (Hamilton 1972).

Acknowledgments

We are indebted to the following people for the identification of specimens: D. G. Cook (Oligochaeta), and F. Rafi (Hirudinea, Isopoda, and Amphipoda) of the National Museum of Natural Sciences, Ottawa; D. W. Barr and I. M. Smith (Hydracarina) of the Royal Ontario Museum, Toronto; F. Schmidt (Ephemeroptera and Trichoptera), J. E. H. Martin (Odonata and Megaloptera), D. J. E. Brown (Hemiptera), R. deRuette, A. Smetana, and E. Becker (Coleoptera), L. Forester (Ceratopogonidae and Chaoboridae), M. Roussel (Chironomidae), and H. J. Teskey (Tabanidae and Tipulidae) of the Biosystematics Research Institute, Ottawa; and P. Budd (Hemiptera) of the Department of Biology, Carleton University, Ottawa.

We thank D. A. Murchison and P. C. Nagler for assisting in the arduous task of taking and sorting the samples, and M. Dickman and W. R. Richards for helpful comments on the manuscript.

Literature Cited

Grimm, F. W. 1973. A preliminary survey of the molluscan fauna of nine lakes in Gatineau Park, Quebec. Canadian Field-Naturalist 89. *This issue.*

Hamilton, A. L. 1972. Zoobenthos of fifteen lakes in the experimental area, Northwestern Ontario. Journal of the Fisheries Research Board of Canada 28: 257–263.

La Rocque, A. 1935. The molluscan fauna of Meach Lake, Quebec. Canadian Journal of Research, C13: 45–59.

Rawson, D. S. 1960. A limnological comparison of twelve large lakes in northern Saskatchewan. Limnology and Oceanography 5: 195–211.

Received 28 December 1972
Accepted 21 May 1974

A Preliminary Survey of the Molluscan Fauna of Nine Lakes in Gatineau Park, Quebec

F. Wayne Grimm

P.O. Box 7227, Vanier, Ontario

Grimm, F. W. 1975. A preliminary survey of the molluscan fauna of nine lakes in Gatineau Park, Quebec. Canadian Field-Naturalist 89(4): 383-388.

Abstract. Twenty-seven species and two nominate subspecies of molluscs are reported from nine lakes in Gatineau Park in western Quebec. A short review of the history of the study of molluscs in Meach Lake is given, and the unique nature of two gastropod populations is discussed.

Meach Lake has been studied by malacologists and other naturalists for nearly a century. It is the only lake in Gatineau Park that has received this much attention. Justice F. R. Latchford, one of the early members of The Ottawa Field-Naturalists' Club, spent a considerable amount of time at Meach Lake, and was the first to notice the novelty of two snails that were eventually named after him. Most of his work on the molluscs of the Ottawa area was done between 1880 and 1925. H. B. Small, who was one of the founding members of The Ottawa Field-Naturalists' Club, collected there with Gilbert C. Heron, the first person to publish a list (1889), dealing exclusively with the molluscs of the Ottawa area. Later, many collections were made by Aurèle La Rocque (1933, 1935). La Rocque (1962) reviewed the history of malacology in this region. A detailed review of the Pleistocene molluscs of several deposits in the Ottawa-Gatineau region was done by Bickel (1970). This survey is an attempt to extend this early work in order to develop an understanding of the present fauna and to contribute to a general survey of the molluscan fauna of Gatineau Park, now being prepared by the author. Its preliminary nature must be stressed.

Human activity in various portions of the park is influencing the growth, development, and survival of a number of molluscan species. For this reason it is essential that we understand the composition of the various communities and the reactions of these communities to human activity, so that we may plan our future activities wisely. With its long history of study by naturalists, Meach Lake provides an excellent subject for continuing studies; the accumulated data provide a record of some of the changes occurring there. To my knowledge no detailed accounts have been published on the molluscan faunas of the other lakes. By continuing to study various representative lakes over a period of years and correlating the data obtained by specialists in several fields, the Gatineau Park lakes may be better protected for future generations.

Methods

In the summer and fall of 1971, Ramsay Lake, Kidder Lake, Meach Lake, Lac Philippe, Pink Lake, Fortune Lake, Mulvihill Lake, Lac Lapêche, and Lac Bourgeois were sampled for molluscs. The first five of these lakes were sampled by Hugh Danks of the University of Ottawa using an ekman dredge. All lakes were also sampled by the author, but my collecting was confined to shallow water (1–3 ft deep) near shore, and samples were obtained by screening and hand-collecting. Several habitats, such as (1) submerged and emergent vegetation, (2) bottom sediments, and (3) the surfaces of rocks, twigs, and logs were examined at each station.

The material collected in this survey has been placed in the collection of the National Museums of Canada. Determinations were made by the author, and confirmed by Arthur H. Clarke, Head of the Invertebrate Zoology Section, National Museum of Natural Sciences.

Results

A list of the species collected, their habitats, and the lakes in which they were collected are given in Table 1. Ramsay Lake, Fortune Lake, Kidder Lake, and Lac Bourgeois are quite humic and are surrounded partially by bog vegetation. The molluscan fauna of these lakes is impoverished. According to Budd (1971), Lac Bourgeois is somewhat isolated and contains no fish, but has a remarkably large and varied insect population. It has a small, intermittent outlet which plunges from the escarpment making it an unlikely route for the introduction of fish and molluscs. Thus the mollusc population of Lac Bourgeois may be entirely adventitious. The few molluscs of Kidder Lake, which is humic, deep, and poorly oxygenated, are confined to the muddy shallows near shore. Mulvihill Lake is a large artificial beaver pond. Its level fluctuates greatly and its molluscan population is small and restricted to forms which are tolerant of desiccation.

Unfortunately, Lac Lapêche was visited only once, near the end of the collecting season. I suspect that it has a larger fauna than is indicated by this report. It is a large, clear, oligotrophic-to-mesotrophic lake in which molluscs are somewhat abundant but scattered.

In Meach Lake, Lac Philippe, Lac Lapêche, and Pink Lake, a peculiar form of *Physa gyrina* occurs; it differs from most populations of that species by being much larger (adults are 1½–3 times the usual size of *P. gyrina*), stouter in outline, and smoother in sculpture (Figure 1a). In addition they have shouldered whorls and a conspicuously thickened columella. This form was described by Baker (1928, p. 423) as *Physella latchfordi* (type locality Meach Lake), and has been discussed in some detail by La Rocque (1933, 1935). In certain, but not all, oligotrophic habitats, *Physa gyrina* produces gigantic forms (Clarke 1973), but because the Gatineau Park form (Figure 1a) differs from typical *Physa gyrina* in several other characters and is not confined to oligotrophic habitats it may be best to retain it as a subspecies, *Physa gyrina latchfordi* (F. C. Baker) until it is better understood. Previously, this form has been recorded only from Meach Lake. Breeding experiments should be conducted with this form to determine the extent of genetic influence upon the characters which have been used to differentiate it from *Physa gyrina gyrina* Say (Figure 1b). The concentration of metabolites of *Physa* and perhaps of other molluscs in the water in which the young *Physa* develop may influence the maximum size reached by the adults (Clarke 1973, p. 379; personal communication). Experiments with captive specimens should be undertaken to verify this hypothesis. La Rocque (1935, p. 56) records typical *Physa gyrina* from mud habitats in Meach Lake but none were found in this survey.

The populations of *Helisoma anceps* (Menke) which occupy Meach Lake, Lac Philippe, Taylor Lake, and, in part, Lac Lapêche, differ from other local populations of this species by consisting of individuals which reach a greater maximum size, having broader shells, more distinct carinae, are lighter in color, and possess different sculpture. Other lakes in Gatineau Park contain populations which intergrade with typical *H. anceps*. The population in Lac Lapêche shows evidence of slight introgression from typical *H. anceps* and contains large numbers of albinos. A pure population of this unusual form has been named *Helisoma anceps latchfordi* (Pilsbry 1927), type locality, Meach Lake, Quebec (Figure 1e, f). A disjunct population of this form has been collected in Brome Lake, in the Eastern Townships of Quebec (Brome County). These populations may be relicts of a subspecies which in former times had a wider range, or they may have been derived independently from a similar stock. In any case, the Gatineau Park populations are unique in appearance and quite restricted in their distribution, and should be protected. These snails prefer clear, clean water, a sandy gravel or rocky bottom with a few logs and twigs, and are rarely found deeper than 4 ft. I have not observed them climbing about on vegetation, although this behavior is typical of *Helisoma anceps anceps* (Figure 1c, d). Variation in this species has been discussed by Walker (1909), Pilsbry (1927), Baker (1928), and Clarke (1973).

TABLE 1—List of species identified in the 1971 survey. I = Infrequent (1–10 specimens); C = Common (11–20 specimens); A = Abundant (21–250 specimens)

Species	Meach L.	L. Philippe	Ramsay L.	Kidder L.	Pink L.	L. Bourgeois	L. Lapêche	Fortune L.	Mulvihill L.	Primary habitats
Pisidium sp.	I									Sediments
Pisidium rotundatum Prime					C		I			Sediments (a calciphile)
Pisidium compressum Prime			I							Clean sand
Pisidium casertanum (Poli)	I	I		I		A	C			Sediments
Pisidium nitidum Jenyns									A	Sediments with much organic matter
Masculium securis (Prime)			I			I				Sediments with much organic matter
Sphaerium occidentale (Prime)						I				Sediments with much organic matter
Sphaerium simile (Say)	I									Sediments with much organic matter
Lampsilis radiata siliquoidea (Barnes)							I			Sand, gravel, hard silt
Elliptio complanata (Sol.)	C	C		A			A			Sand, gravel, hard silt
Anadonta grandis Say	I		I	C			I			Sand, gravel, hard silt, loose muck
Valvata tricarinata Say	A	C					C			Firm bottom; submerged plants, logs, twigs
Amnicola limosa (Say)	A	C	I				A			Firm bottom; submerged plants, logs, twigs
Campeloma decisum (Say)	A	A					I			Burrows in sand, silt, gravel
Helisoma trivolvis (Say)	I					C		I		On rocks, plants, pieces of wood
Helisoma campanulatum (Say)	C	I	I				A			On rocks, plants, pieces of wood
Helisoma anceps anceps (Menke)			I					I		On rocks, plants, pieces of wood
Helisoma anceps latchfordi (Pilsbry)	C	I					C			On firm sand or gravel bottom, clear water
Gyraulus deflectus (Say)	I		I				I			On plants, pieces of wood
Gyraulus circumstriatus (Tryon)		I			I					On plants, debris, organic sediments
Gyraulus parvus (Say)	I						I			On plants, debris, organic sediments
Promenetus exacuous (Say)	I				I	I				On plants, debris, organic sediments
Physa gyrina gyrina Say								I	I	On most available surfaces
Physa gyrina latchfordi (Baker)	I	I			I		I			On firm sand or gravel bottom, clear water
Ferrissia parallela (Hald.)	I		I					I		On surfaces of submerged plants, rocks, wood
Lymnaea columella Say	I							C		On plants or bottom in quiet water
Lymnaea modicella Say							C			On mud near or above water level
Lymnaea exigua Lea	I						A			On mud and in vegetation at water's edge
Lymnaea elodes Say						I				On any surface, shallow still water (calciphile)

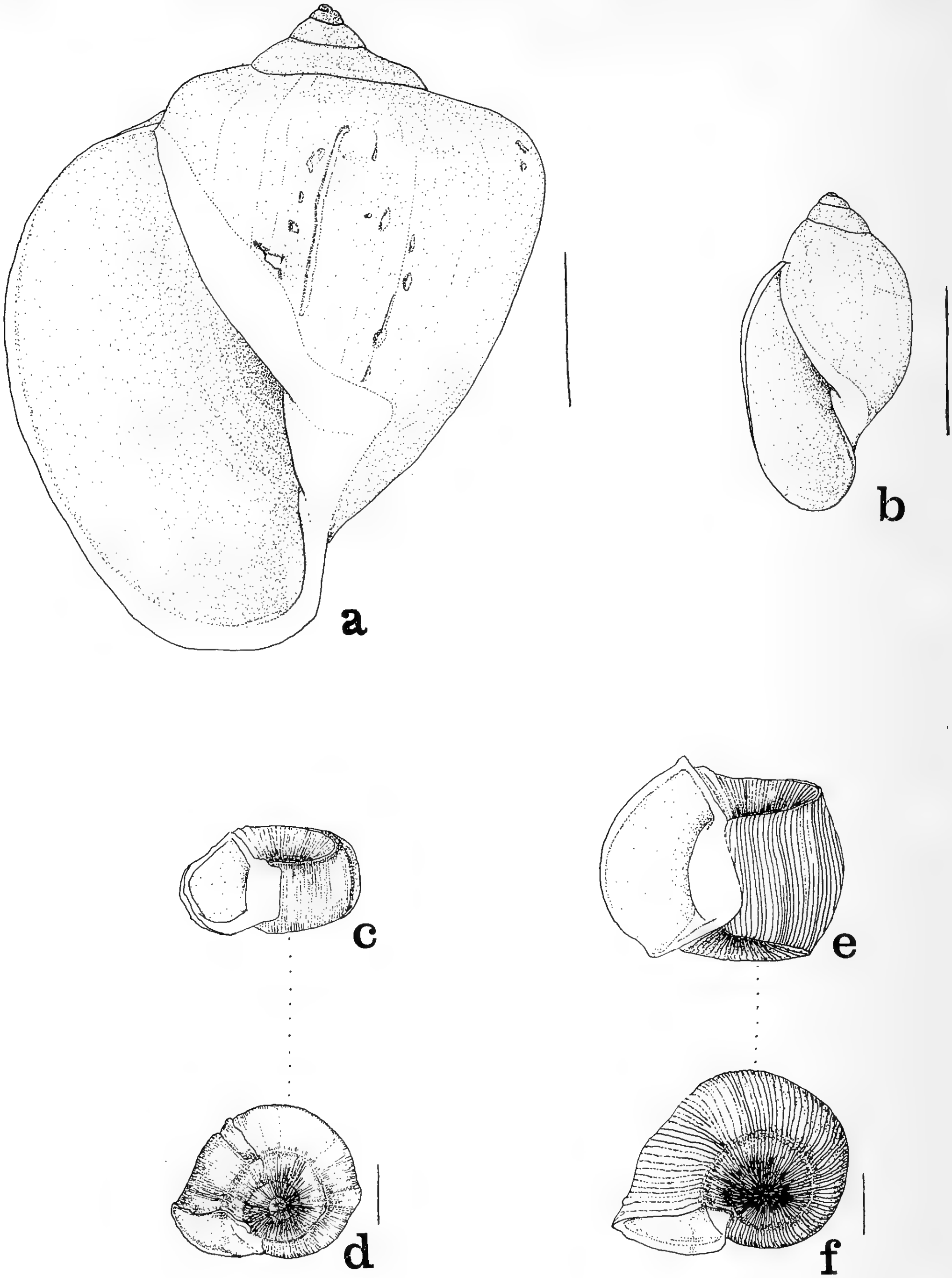


FIGURE 1. a, *Physa gyrina latchfordi* (Baker). Topotype from Meach Lake, collected by G. C. Heron, 1879. N.M.C. #2023. b, *Physa gyrina gyrina* Say. Small specimen from Fortune Lake, collected by the author. c, d, *Helisoma anceps anceps* (Menke). Specimen from Pink Lake, collected by the author. e, f, *Helisoma anceps latchfordi* (Pilsbry). Topotype from Meach Lake, collected by A. La Rocque, 1932. N.M.C. #26297.
Scale lines = 5 mm.

In portions of the St. Lawrence drainage, certain *Anodonta* populations appear to show intergradation between *Anodonta cataracta* (Say) of the Atlantic Coastal drainage and *Anodonta grandis* (Say) of the Great Lakes and upper Mississippi Valley (A. H. Clarke, personal communication; Clarke and Berg 1959). The Gatineau Park populations resemble *A. grandis* by possessing double-looped, slightly knobby beak sculpture, but resemble *A. cataracta* in their size and shape. The beak sculpture is reduced and shows introgression from *cataracta*.

Of the nine lakes studied, Meach Lake and Lac Lapêche have the richest fauna. Previously, the molluscan fauna of Meach Lake was surveyed by La Rocque from 1932 to 1934 (La Rocque 1935). If we disregard the fact that several names have been changed, a comparison of La Rocque's findings with those of this survey shows that considerable changes have taken place in the fauna of Meach Lake. The following species were found by La Rocque but were not found in this survey: *Lymnaea megasoma* Say (found many times by others prior to 1935 (see Small and Symes 1882), a few found in 1933 by La Rocque, apparently absent in 1934); *Lymnaea stagnalis* Linn. (found in abundance in all habitats). The following species were found in this survey but were not found by La Rocque: *Gyraulus deflectus* (Say) (rare on plants and wood); *Promenetus exacuous* (Say) (rare, on wood); *Valvata tricarinata* Say (abundant, on sand, gravel, wood, plants). The absence of *Lymnaea megasoma* from this survey is not surprising, since it was rare in 1934 and was not reported in the 1935 survey. The absence of *Lymnaea stagnalis,* which was abundant in the previous surveys, is more difficult to understand. This species is quite common in still waters elsewhere in the Ottawa region. It is very large and difficult to overlook. *Gyraulus deflectus* and *Promenetus exacuous* are easy to overlook, and were not abundant, so the absence of these species from the previous survey is not likely to be significant. But the absence of *Valvata tricarinata* from La Rocque's surveys and its abundant presence in this one is not so easily explained. It is now a dominant species in Meach Lake, but La Rocque (1933, 1935) did not report it, indicating that at that time it was either rare or absent. At present I am unable to explain the above changes in the fauna of the lake. It is possible, however, that the abundance of submerged plants, and a possible increase in the abundance of these snails may be due to the increasing eutrophication of the lake. Large populations of these snails do not occur where periphyton is sparse.

Discussion

When the molluscan fauna of the Gatineau Park lakes was compared with those of more calcareous lakes west of the Ottawa River, the former was found to be generally poorer in numbers of individuals and species. This impoverished Gatineau Park fauna may be attributed to the smaller quantity of calcium carbonate available in all lakes but Pink Lake. Pink Lake, which has a high concentration of calcium carbonate, is rather deep and is poorly oxygenated, hence its fauna is impoverished as well. In places it contains large numbers of shells which have been preserved by the alkaline water, but few living molluscs. Undoubtedly, more extensive sampling of these lakes will bring to light more species, but it is unlikely that any additional dominant species will be discovered.

A small lake is a relatively fragile system, and slight changes in water chemistry or in the character of the bottom can alter the regimen of the lake irreparably. Meach Lake and Lac Philippe contain pure populations of two unique molluscs which are poorly understood. Further development of Meach Lake without sufficient study of its effects may destroy forever the type populations of these animals. Since the summer of 1970 and the spring of 1971, at which time four beaches were created along the southern shore of Meach Lake by the National Capital Commission, I have noticed a rapid decline in the numbers of molluscs present in the shallows near this shore. In the spring of 1970 there were small numbers of *Physa gyrina latchfordi*, large numbers of *Helisoma anceps latchfordi*, and fairly large populations of several other species in this area. By the fall of 1971 most of these populations were severely reduced, and in places it took several hours to find a single specimen. The fine, slightly silty sand of the beaches has obliterated molluscan habitats that were available previously on portions of the firm sand-gravel substrate prior to the construction of these artificial beaches.

Within a period of 38 years, two molluscan species, one of which was quite common, have disappeared from Meach Lake. I believe that Meach Lake must be better managed if we are to preserve its unusual molluscan fauna for future generations.

Acknowledgments

I express my gratitude to A. H. Clarke of the National Museum of Natural Sciences, M. Dickman of Brock University, Leah Groff of Meach Lake, Quebec, and to Brian Kidd of Carleton University, for their assistance in the development of this study.

Addendum

Meach Lake was revisited in the summers of 1973 and 1974. At these times no living populations of either *Helisoma anceps latchfordi* or *Physa gyrina latchfordi* were seen. Unionid clam populations along the south shore were seen to be severely reduced. I suspect that the reduction of these populations is due to destruction of their primary habitats, the firm, sand-gravel beaches of the south shore, by the introduction of fine sand.

Literature Cited

Baker, F. C. 1928. Fresh water Mollusca of Wisconsin. Geological and Natural History Survey Bulletin 70(1): 423.

Bickel, D. 1970. Pleistocene non-marine Mollusca of the Gatineau Valley and Ottawa areas of Quebec and Ontario, Canada. Sterkiana 38: 1–50.

Budd, P. 1971. The ecology and taxonomy of the Notonectidae of the eastern Ontario region. M.Sc. thesis, Carleton University.

Clarke, A. H. 1973. The freshwater molluscs of the Canadian Interior Basin. Malacologia 13(1–2): 379–380.

Clarke, A. H. and **D. Berg.** 1959. The freshwater mussels of central New York. Cornell University Agricultural Experiment Station, Memoir 367.

Heron, G. C. 1880. On the land and freshwater shells of Ottawa. Transactions of the Ottawa Field-Naturalist's Club 1: 36–40.

La Rocque, A. 1933. Notes on *Helisoma latchfordi* Pils. and *Physa latchfordi* F. C. Baker. Canadian Field-Naturalist 47: 134–135.

La Rocque, A. 1935. The Molluscan fauna of Meach Lake, Quebec. Canadian Journal of Research, Section D 13: 45–59.

La Rocque, A. 1962. Contributions to the history of Canadian malacology. Sterkiana 6: 23–40.

Pilsbry, H. A. 1927. A new subspecies of *Planorbis*. Nautilus 40: 79.

Small, H. B. and **P. B. Symes.** 1882. Report of the Conchological Branch for 1882. Transactions of the Ottawa Field-Nautralist's Club 1(3): 57.

Walker, B. 1909. Notes on *Planorbis*. II: *Planorbis bicarinatus*. Nautilus 23: 6.

Received 20 June 1972
Accepted 21 May 1974

Fish Distribution in Gatineau Park, Quebec, in Relation to Postglacial Dispersal, Man's Influence, and Eutrophication

PETER J. RUBEC

Department of Biology, University of Ottawa, Ottawa, Ontario K1N 6N5

Present Address: Department of Biology, Texas A&M University, College Station, Texas 77843

Rubec, P. J. 1975. Fish distribution in Gatineau Park, Quebec, in relation to postglacial dispersal, man's influence, and eutrophication. Canadian Field-Naturalist 89(4): 389-399.

Abstract. Postglacial freshwater and marine inundations have affected the distribution of fishes in Gatineau Park. Glacial Lake Frontenac allowed a cold-water fish fauna to enter higher altitude lakes. These were isolated by the Champlain Sea which also brought euryhaline species to lakes at medium elevation. Warm-water fishes from the Ottawa River were blocked from entering higher Gatineau Park lakes by isostatic rebound. More species were able to enter the Lac Lapêche drainage than the Meach–Philippe drainage.

During the last hundred years, a general decline in abundance of lake trout (*Salvelinus namaycush*), brook trout (*Salvelinus fontinalis*), cisco (*Coreganus artedii*), and lake whitefish (*Coregonus clupeaformis*) has occurred, probably abetted by commercial fishing, poaching, and angling. Both smallmouth bass (*Micropterus dolomieui*) and brook trout prey on minnows which are scarce in lakes where bass were introduced. Low oxygen levels noted in the hypolimnia of most Gatineau Park lakes is thought to limit the coregonids and salmonids. An attempt has been made to replace those fish species that have disappeared.

Introduction

The present survey was part of a limnological study for the National Capital Commission. Previous studies include that of Dymond (1939) who compiled information concerning game fish and made collections of minnows in Ramsay and Meach Lakes. Cuerrier and Dadswell (1969) surveyed these lakes with gill nets, and Dadswell (1972) sampled the larger lakes with an otter trawl to locate deep-water forms. The present paper is an attempt to define species composition and distribution from previous records and a seining program carried out in 1971.

Geography of the Study Area

Gatineau Park is an area of about 88 000 acres (35 613 ha) situated just north of Ottawa. The Gatineau Hills are part of the Laurentian Shield which was denuded and eroded by the Wisconsin glaciation, contributing to the rough, irregular topography by depositing glacial debris over the underlying igneous bedrock. Rock-rimmed, drift-lined depressions were formed in which water collected to form some 50 lakes. An irregular drainage pattern resulted as water spilled from basin to basin in several directions (Figure 1).

Most lakes belong to one of two drainage systems. The Meach–Philippe watershed contains three of the larger Gatineau park lakes: Lac Philippe, Lac Mousseau, and Meach Lake range in size from 714 to 800 acres (289 to 324 ha). Rivière Lapêche comprises the second drainage basin containing the largest lake, Lac Lapêche with 1923 acres (657 ha). The two main drainages enter the Gatineau River to the north, while a number of smaller drainages empty over the Eardley escarpment into the Ottawa River to the south. The maximum elevation of the escarpment is 1361 feet.[1] The lakes range in altitude from Lac Charette, at 1138 feet, to Fairy Lake at 194 feet.

Methods

Twenty-five lakes and six streams were sampled utilizing a 35 × 8-foot seine (¼-in mesh, ⅛-in bag). A 15-foot (¼-in mesh) seine was used to sample adjoining streams and areas where the bottom precluded the use of a larger net. The specimens were initially

[1] Metric equivalents are given in Table 1.

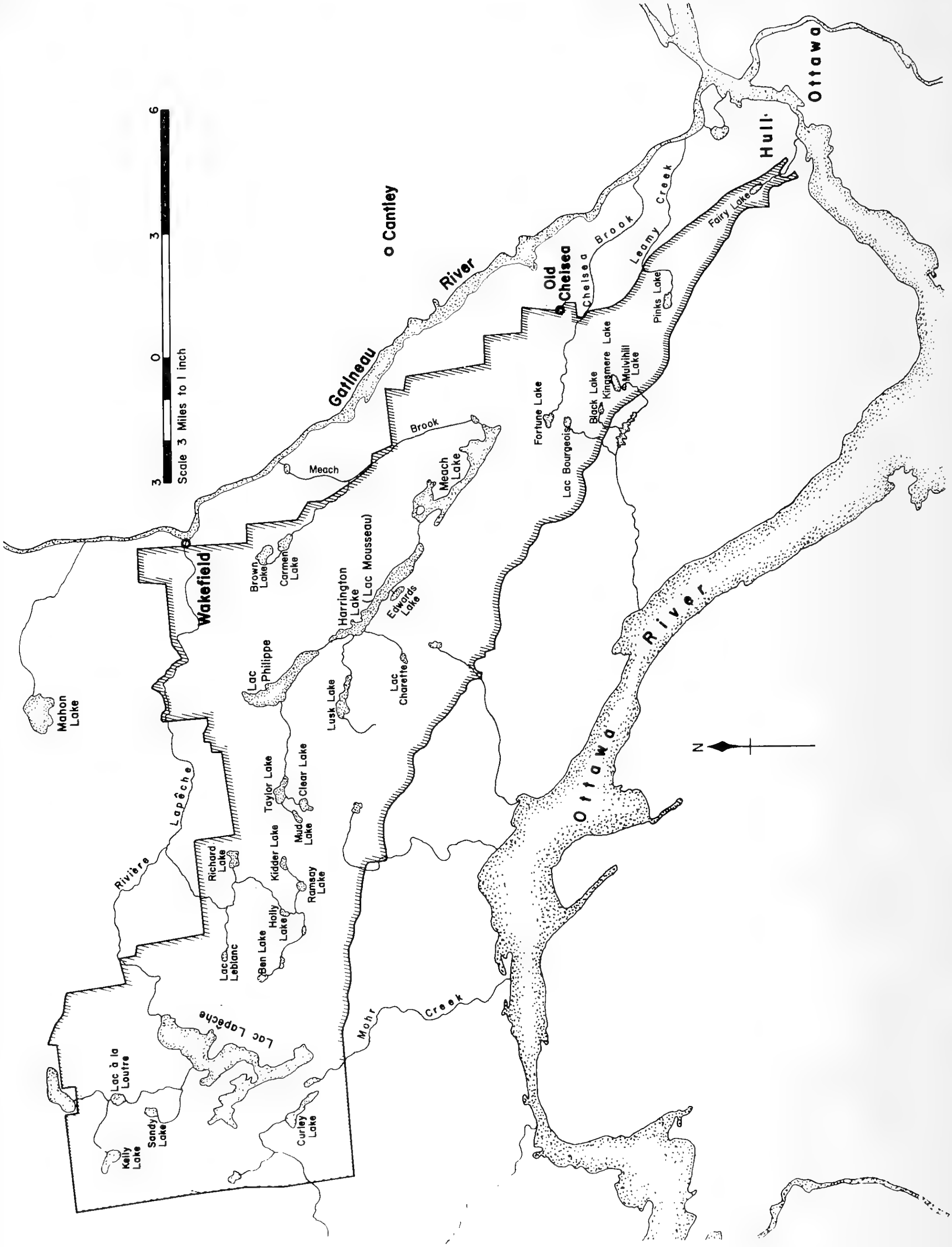


FIGURE 1. Drainage systems in Gatineau Park, Quebec.

preserved in 10% formalin and later placed in 40% isopropyl alcohol. All information concerning specimens and the nature of the sampling stations was recorded on National Museum of Natural Sciences field sheets where the collection is stored (NMC 73-104 to NMC 73-143). Specimens at the museum from 86 stations have been considered. Names used follow American Fisheries Society, Special Publication No. 6, *A List of Common and Scientific Names of Fishes from the United States and Canada*, Third Edition, 1970.

Results

Very different fish faunas occur in the Gatineau Park and in the Ottawa River. The higher-altitude lakes and streams of the park contained, until recently, a predominantly oligothermic fauna characterized by such species as lake trout (*Salvelinus namaycush*), brook trout (*S. fontinalis*), cisco (*Coregonus artedii*), and lake whitefish (*C. clupeaformis*). The Ottawa River has a polythermic fauna characterized by such species as brown bullhead (*Ictalurus nebulosus*), channel catfish (*I. punctatus*), walleye (*Stizostedion vitreum*), sauger (*S. canadense*), smallmouth bass (*Micropterus dolomieui*), largemouth bass (*M. salmoides*), and northern pike (*Esox lucius*). Dymond (1939) noted that species such as walleye, northern pike, and channel catfish are distributed far up the Gatineau River but are absent above the highest falls on its tributaries. The waterfall at Wakefield on the lower reaches of Rivière Lapêche and the falls on Meach Brook at the outlet of Meach Lake appear to be barriers to the dispersal of the Ottawa River fish fauna into the park (Figures 2 and 3).

Within the Gatineau Park are forms which usually have a more northerly distribution and are adapted to cold-water conditions. Species such as the brook trout, white sucker (*Catostomus commersoni*), pumpkinseed (*Lepomis gibbosus*), northern redbelly dace (*Phoxinus eos*), fathead minnow (*Pimephales promelas*), creek chub (*Semotilus atromaculatus*), brassy minnow (*Hybognathus hankinsoni*), golden shiner (*Notemigonus crysoleucas*), common shiner (*Notropis cornutus*), blacknose shiner (*N. heterolepis*), pearl dace (*Semotilus margarita*), and central mudminnow (*Umbra limi*) are widely distributed in the park's two main drainages and in lakes at higher elevations draining from the Eardley escarpment (Table 1).

In the larger lakes at medium elevation Dymond (1939) has shown that forms such as the lake trout, brook trout, cisco, and whitefish were abundant until recent times. Also well established in these larger lakes are smallmouth bass, brown bullhead, yellow perch (*Perca flavescens*), and the bluntnose minnow (*Pimephales notatus*) which appear to be invading smaller lakes at higher elevation. In Meach Lake, Cuerrier and Dadswell (1969) have shown that the rainbow smelt (*Osmerus mordax*) is very abundant. Generally these species are absent from the smaller lakes along the Eardley escarpment.

Species such as the longnose dace (*Rhinichthys cataractae*), finescale dace (*Semotilus margarita*), banded killifish (*Fundulus diaphanus*), mottled sculpin (*Cottus bairdi*), brook stickleback (*Culaea inconstans*), and margined madtom (*Noturus insignis*) are found in the Lapêche drainage above the falls but are absent above the falls in the Meach–Philippe system, and are absent from the park's smaller drainages along the Eardley escarpment. The falls at Old Chelsea on Chelsea Brook appear to be blocking the upstream dispersal of the longnose dace and the johnny darter (*Etheostoma nigrum*). Northern pike, rock bass (*Ambloplites rupestris*), and the blackchin shiner (*Notropis heterodon*), which are absent from the rest of the park, are present in the Fairy Lake drainage. All these species, except the margined madtom, are known to be present in the Ottawa River and appear to have penetrated the Gatineau Park drainages to some extent at lower elevations (Table 1).

Discussion and Conclusions

Postglacial Dispersal

Present fish distribution within the park can be understood only if one considers the sequence of inundations which followed glaciation. The edge of the receding Wisconsin

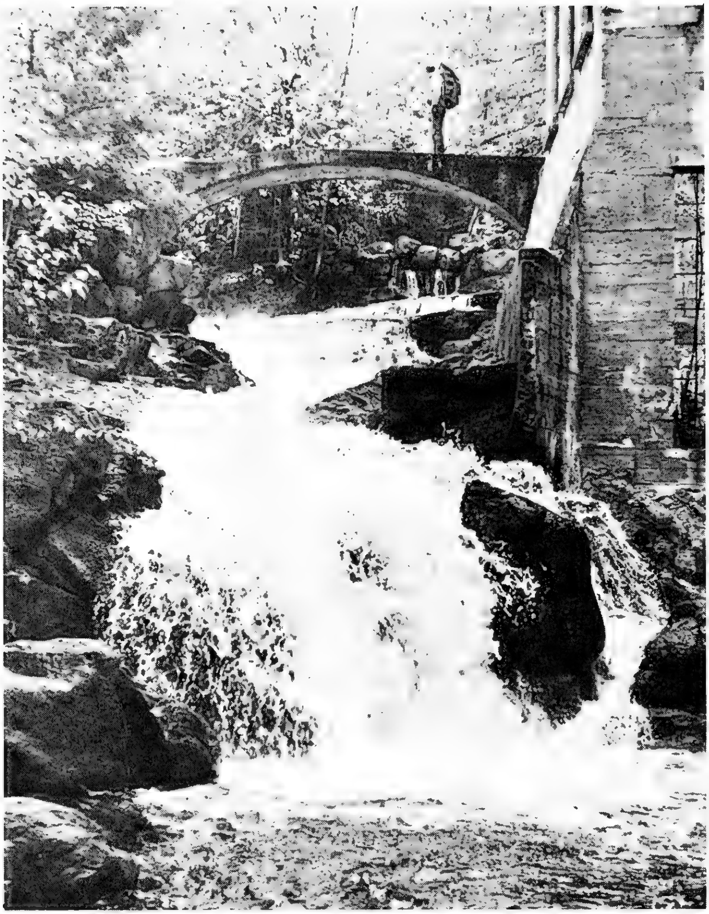


FIGURE 2. The waterfall on Rivière Lapêche near Wakefield.

ice sheet probably reached Ottawa about 12 300 years ago (Romanelli 1975). Varved clays in the Ottawa Valley indicate the Belleville – Fort Anne phase (Prest 1970) of glacial Lake Frontenac (Antevs 1925) occupied the area for 50 to 100 years (Gadd 1963). Goldthwait (1933) has suggested that Lake Frontenac reached the highlands north of Ottawa where Antevs (1925) has postulated it may have stood several hundred feet higher than the maximum marine limit of the Champlain Sea. Goldthwait has speculated that the highest marine beach of 690 feet (Johnston 1916) may have been part of this glacial lake. Most of the park was covered by ice, but lakes near the edge of the Eardley escarpment may have been ice free, and therefore it is possible that they were colonized at this time.

According to present evidence, Lake Frontenac was of relatively short duration in the Ottawa area but its overall history is much longer since it expanded in size as the glacier retreated (Prest 1970). Since this postglacial lake was confluent with glacial Lake Iroquois (present Lake Ontario) and glacial Lake Vermont (present Lake Champlain) it provided a corridor by which dispersal could have taken place from refugia beyond the maximum extent of the Wisconsin ice sheet. Fish species adapted to the cold postglacial lake environment could have dispersed into the Ottawa region.

The distribution of the brook trout, white sucker, and minnow species previously mentioned, which are found in escarpment lakes,

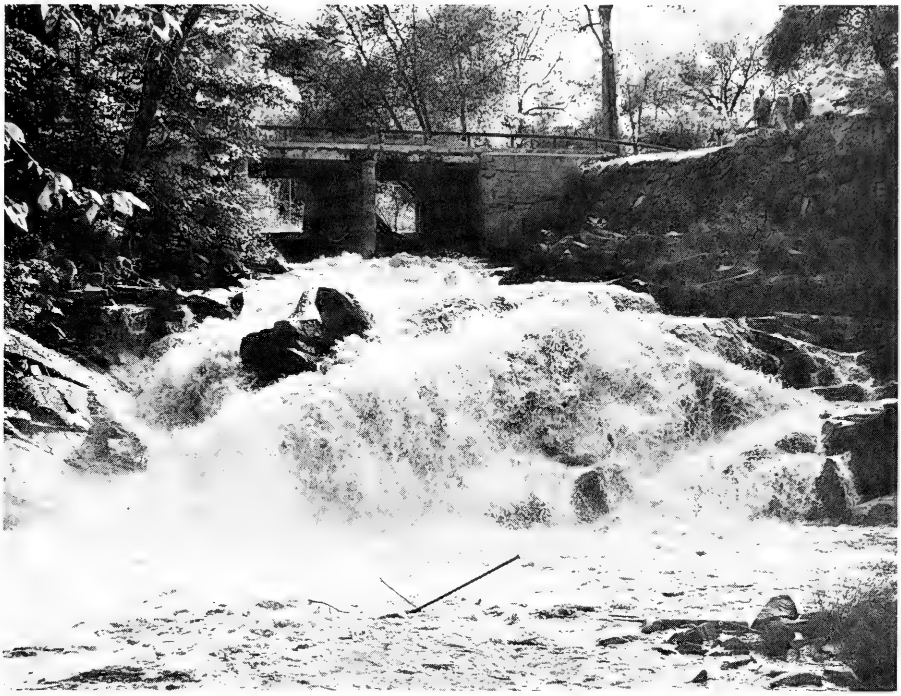


FIGURE 3. The waterfall on Meach Brook at the outlet of Meach Lake.

seem hard to explain in terms of upstream dispersal. Lakes such as Kingsmere, Mulvihill, Bourgeois, Curley, and Black drain over the Eardley escarpment. Other lakes such as Mud, Lusk, Ben, and Charette drain into the park's two main drainages in the other direction. These latter-named lakes are situated at altitudes above 700 feet and generally have steep intermittent drainages. The escarpment holding these lakes forms a sharp geological boundary which falls about 800 feet to the Ottawa Valley floor. It seems unlikely that as many species as are found at present could ascend these drainages to these lakes since the lakes have stood at their present elevation.

It has been suggested that perhaps these lakes originally lacked fish and that the fish found in them were introduced by anglers. It seems unlikely that the number of species found at present could have been introduced into so many separate drainages. During the Lake Frontenac phase the land was depressed about 400 feet and the waterplane of post-glacial Lake Frontenac stood close to the higher-altitude lakes facilitating fish dispersal.

Following Lake Frontenac, the Champlain Sea created a cold marine environment which blocked further dispersal of primary fresh-water fishes into the area. Evidence for the presence of the Champlain Sea is found in marine beaches and their associated fossils (Harington 1971). Romanelli (1975) has noted a marine beach dating to 12 200 ± 160 years ago (GSC-1646) just east of the Gatineau River near Cantley at 635 feet. J. T. Buckley (1968. Gatineau Park geomorphology. National Capital Commission Manuscript Report. 15 pp.) has mapped marine sediments up to 620 feet in Gatineau Park.

It has been suggested that various fish species including the rainbow smelt, arctic char, or Quebec red trout (*Salvelinus alpinus*) and threespine stickleback (*Gasterosteus aculeatus*) owe their origin to the incursion of the Champlain Sea in the Ottawa area (Dymond 1939; Harington 1971). The marine form of the threespine stickleback is present in Pink Lake, Ramsay Lake, Holly Lake, and Kidder Lake

Table 1 — Fish distribution in Gatineau Park waters.

	meters Alt.	feet Alt.	*Salvelinus fontinalis*	*Catostomus commersoni*	*Lepomis gibbosus*	*Phoxinus eos*	*Pimephales promelas*	*Semotilus atromaculatus*	*Hybognathus hankinsoni*	*Notemigonus crysoleucas*	*Notropis cornutus*	*Notropis heterolepis*	*Semotilus margarita*	*Umbra limi*	*Gasterosteus aculeatus*	*Coregonus artedii*	*Coregonus clupeaformis*	*Salvelinus namaycush*	*Culaea inconstans*	*Etheostoma exile*	*Phoxinus neogaeus*	*Cottus bairdi*	*Rhinichthys cataractae*	*Esox lucius*	*Ambloplites rupestris*	*Notropis heterodon*	*Etheostoma nigrum*	*Noturus insignis*	*Fundulus diaphanus*	*Notropis hudsonius*	*Ictalurus nebulosus*	*Pimephales notatus*	*Perca flavescens*	*Micropterus dolomieui*	*Osmerux mordax*	No. of species
			Lake Frontenac													Champlain Sea			Ottawa River fauna									Introduced species								
LAPECHE DRAINAGE																																				
Rivière Lapêche	168	550	●	●		●		●			●		●	●	○				●		●	●	●							●						2
Lac Lapêche	181	593	●	●	●	●	●	●		●	●	●		●		○		○		●			●						●	●	●		●	●		7
Outlet stream Lac à Loutre	198	650			●			●												●								●						●		5
Holly Lake	199	653		●	●	●	●	●	●	●	●	●		●	●				●		●										●					4
Ramsay Lake	200	657	○	●	●	●	●	●	●	●	●	●	●	●	●				●	●	●											●				6
Leblanc Lake	202	663			●			●																										●		3
Sandy Lake	206	676	○																												●		●	●		3
Kidder Lake	207	679			●	●	●	●	●	●	●	●	●		●				●	●																2
Ben Lake	216	708			●	●	●			●	●			●																						5
Richard Lake	218	716		●		●	●	●				●								●																6
Kelly Lake	237	778	○	●	●		●						●																			●	●			6
MEACH-PHILIPPE DRAINAGE																																				
Carmen Lake	144	473			●			●																							●		●	●		5
Brown Lake	145	474	●	●	●					●	●			●																	●	●	●	●		0
Meach Brook	152	500	●	●				●			●												●									●				6
Meach Lake	170	550	●	●	●		●	●		●	●	●				○	○	●													●	●	●	●	●	4
Harrington Lake	171	561	●	●	●					●	●	●	●			○	●	○													●	●	●	●		12
Edwards Lake	172	564			●																										●	●	●	●		5
outlet stream Lac Philippe	172	564		●	●	●	●	●		●	●		●	●																	●	●	●			2
Lac Philippe	172	564	●	●	●		●				●					○		○													●	●	●	●		9
Taylor Lake	203	666	○	●	●						●																				●	●	●	●		7
Clear Lake	242	793				●	●	●																								●	●			5
Mud Lake	253	829				●	●							●																						3
Lusk Lake	284	930	○	●			●	●		●	●																				●					6
Lac Charette	347	1138	○																																	0
OTHER DRAINAGES																																				
Fairy Lake	59	194		●	●			●		●				●					●	●				●	●	●					●	●				12
Chelsea Brook	152	500	○	●	●	●	●	●														○	●				●									7
Pinks Lake	162	532		●	●	●	●	●					●		●																					7
outlet stream Curley Lake	183	600		●	●	●	●	●											●																	6
Curley Lake	198	648	○		●																													●		2
Mulvihill Lake	226	741		●	●		●	●			●	●																								6
Kingsmere Lake	231	759	●	●	●		●	●		●	●	●																								8
Fortune Lake	282	925	○	●				●																												2
Black Lake	301	988							●	●																										2
Lac Bourgeois	302	991																																		0

● Present distribution

○ Formerly present (Dymond, 1939)

(Table 1). It is not certain whether the last three lakes were inundated by the sea. They lie between 653 and 679 feet and may have been colonized by threespine sticklebacks while the sea was situated nearby. The rainbow smelt, native to much of the Gatineau Valley (Delisle and Veilleux 1969), was introduced into Meach Lake in 1924 from Lake Utopia, New Brunswick (Dymond 1939).

The marine waters of the Champlain Sea gradually fell as the land, free of the weight of the glaciers, gradually rose as a result of isostatic rebound (Antevs 1925; Romanelli 1975). With continued glacial retreat a large influx of water from the Great Lakes entered the shallow marine estuary and caused a decrease in salinity during the latter stages of the sea between 11 000 and 10 000 years ago (Terasmae and Hughes 1960; Elson 1969). Elson believed that the salinity during the final stages of the sea was about 6 ‰. Low salinities could have allowed euryhaline fish to invade the area.

Cold-water fish species such as lake trout, cisco, and lake whitefish may have dispersed through the Champlain Sea into the newly formed lakes such as Meach, Mousseau, Philippe, and Lapêche. The coregonid species are tolerant to saline conditions while the lake trout is generally considered a freshwater species which has occasionally been known to enter the sea (Ryder et al. 1964), Gruchy (1968) has described a fossil lake trout, found in the same area as marine forms near Green's Creek, which could indicate lake trout entered the estuary during the latter stages of the Champlain Sea (Harington 1971).

One could argue that the coregonids and lake trout entered the Gatineau area during the Lake Frontenac phase and survived the invasion of the Champlain Sea in lakes at higher elevation. While this is probably true for the brook trout and other species previously mentioned, I doubt whether it is true for the lake whitefish, cisco, or lake trout. It seems unlikely that the small Gatineau Park lakes at higher elevation could support these species. Lake trout are found at lower elevations than the Quebec red trout in the Gatineau region suggesting that the lake trout dispersed into the area at a later date (M. J. Dadswell, personal communication). The other possibility, that these forms entered after the Champlain Sea seems equally unlikely. The uplifting of the land, which caused a drop in the level of the Champlain Sea, exposed areas which were previously under the sea. Topographical barriers such as waterfalls were most likely formed during the Champlain Sea era and these would have blocked upstream dispersal into Gatineau Park lakes after the sea.

The formation of the Mer Bleue bog east of Ottawa indicates that the ancestral Ottawa River draining the Great Lakes stood at about 250 feet between about 10 000 and 7000 years ago, before occupying its present channel (Johnston 1916; Romanelli 1975). Rapid warming conditions about 10 000 years ago (Ogden 1965) led to a warmer climate than exists today. Warm-water fish species entered the region by way of the Ottawa River. With the exception of those species which have passed the falls on Rivière Lapêche, most were not able to disperse into Gatineau Park lakes because of the existing barriers.

The falls on Rivière Lapêche at 440 feet altitude appear to have been negotiable, although the steeper falls on Meach Brook at 550 feet have not. Most of the species which have penetrated the Lapêche drainage, with the exception of the spottail shiner and the banded killifish, are species, adapted to fast-water habitats, which could have penetrated the falls on Rivière Lapêche. The occurrence of these exceptions may be the result of bait introductions by anglers. The margined madtom is most probably an introduction (Rubec and Coad 1974). The greater diversity of the Lapêche drainage over the Meach-Philippe drainage is largely due to its greater accessibility. This has allowed some Ottawa River forms to penetrate Rivière Lapêche after the present drainage pattern had become established. Likewise, northern pike, rockbass, and blackchin shiners are present in the Fairy Lake drainage due to the relative accessibility of the lake at 194 feet from the nearby Ottawa River at 180 feet.

Forms such as the brown bullhead, yellow perch, bluntnose minnow, and pumpkinseed are considered warm-water species on the basis of their physiology and limited northern distribution. If they entered the area after the Champlain Sea episode, the falls on Meach Brook would have blocked their dispersal into the Meach–Philippe drainage, where they are known to be present. If they entered before the Champlain Sea, they should be present in the lakes along the escarpment. Only the pumpkinseed is found in lakes draining over the escarpment. Dymond (1939) has suggested that the pumpkinseed may not have been native to Meach Lake, but this is difficult to believe in light of its widespread distribution in Gatineau Park drainages. Pumpkinseeds were present in Chelsea Brook when Small (1883) first fished these waters. In light of the distribution, I believe the pumpkinseed entered the Gatineau Park during the Lake Frontenac phase. The bluntnose minnow, yellow perch, and brown bullhead have distributions similar to that of the smallmouth bass which is known to have been introduced, leading me to believe that these species may be present due to introductions. Since the yellow perch, brown bullhead, and banded killifish have salinity tolerances as high as 10–15 parts per thousand, it is also possible that they entered the area during the latter part of the Champlain Sea.

Man's Influence on the Fish Fauna

Cuerrier and Dadswell (1969) found that the lake trout, brook trout, lake whitefish, and cisco, which were abundant in the late 1800s (Dymond 1939), had disappeared from many Gatineau Park lakes and had very reduced populations in the remainder. Cuerrier (personal communication) has talked to local residents who remember taking whitefish and lake trout from Lac Mousseau "by the barrel load" no more than 50 years ago. Intensive gill netting in the same lake showed that lake trout had disappeared and whitefish were on the verge of extinction (Cuerrier and Dadswell 1969). Dymond's information can be compared with data supplied by Cuerrier to show this general decline (Table 2).

The causes of the decline are difficult to assess. The lakes of the Gatineau district supported a substantial fishery in the late 1800s (Dymond 1939). Dymond cites a series of annual reports of the Department of Marine and Fisheries in which, in 1870, W. L. Holland reported that local residents used nets and spears in and out of season, wastefully fishing to supply American dealers. In 1875, 78 commercial fishing licences were granted in Gatineau district lakes. In 1873 Holland reported that local residents had complained that the lumbermen injured the fisheries by erecting dams at the outlet of lakes, thus preventing fish from reaching their spawning grounds. It was noted that the yield of fish had decreased in places where the dams had been constructed.

As the urban population of Ottawa and Hull grew, the Gatineau lakes became a resort area. Increased angling pressure may have been an important factor in depleting trout species, but this does not explain the decline of whitefish and cisco. Cuerrier and Dadswell (1969) cite illegal netting as one important factor which may have helped cause the disappearance of lake trout from Lac Lapêche and Lac Mousseau about 1940. With the creation of the park area in 1938 the remaining fish population have not recovered to their former abundance.

In 1908 smallmouth bass were introduced by anglers into Lac Lapêche, Lac Philippe, Lac Mousseau, and Meach Lake (Dymond 1939). My survey indicates they have also gained access to Brown, Taylor, Carmen, Sandy, Curley, and Leblanc Lakes where they were found to be abundant in the seine catches (Table 1).

In the larger lakes I found a low general abundance of minnows per seine haul. With the exception of the bluntnose minnow, most cyprinids were taken in secluded areas such as stream entrances, bays, and weedy areas where bass were uncommon. The smallmouth bass tended to be found over open areas, with either rock or sand bottoms, occupying the predominant habitat in these larger lakes.

In the small lakes, where bass were found to be present, minnows were either scarce or absent. No minnows were taken in Curley and Sandy Lakes, while Carmen Lake and Leblanc Lake, each yielded a single creek chub, after considerable seining effort. In Taylor and Brown Lakes minnows were captured but

TABLE 2—Present and past distribution of cold-water fish in Gatineau Park waters

	Lac Lapêche	Lac Philippe	Lac Mousseau	Meach Lake	Curley Lake	Ramsay Lake	Taylor Lake	Lusk Lake	Kingsmere Lake	Kelly Lake	Sandy Lake	Fortune Lake	Mohr Creek	Chelsea Brook	Lac Charette
Distribution in late 1800s															
Coregonus clupeaformis			X	X											
Coregonus artedii	X	X	X	X											
Salvelinus fontinalis	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Salvelinus namaycush	X	X	X	X											
Present indigenous distribution															
Coregonus clupeaformis			X												
Coregonus artedii															
Salvelinus fontinalis	X	X	X	X					X						
Salvelinus namaycush				X											

appeared to be of larger size-classes. The scarcity of minnows in these small lakes seems unusual since abundant minnow populations were noted in tributary streams and in other nearby lakes lacking bass.

Dymond (1939) noted that it was unusual to find smallmouth bass and trout species occurring in the same water except in large lakes such as the Great Lakes. Competition for the same food supply usually results in the eventual elimination of either bass or trout in small and medium-sized lakes. The larger lakes in Gatineau Park have reduced populations of brook trout while these fish have completely disappeared from most of the smaller lakes (Table 2). Whether food competition between smallmouth bass and brook trout has occurred cannot be determined on the basis of this survey. It can only be stated that the introduction of smallmouth bass, especially in the smaller lakes, coincides with the depletion of the minnow fauna and the decline or disappearance of brook trout. Cuerrier and Dadswell (1969) showed that smallmouth bass in Lac Mousseau preferred the same foods as brook trout and yellow perch during the spring. Smallmouth bass, as well as being a predator on brook trout, appeared to be a direct competitor with trout for food with respect to mayflies, dragonflies, and small perch during June. Food competition with overpopulated bass and perch is believed to be the greatest factor affecting the trout population of Lac Mousseau.

While food competition between smallmouth bass and brook trout may have contributed to the decline of the trout, it cannot account for the disappearance of other species such as lake whitefish and cisco. Indeed, brook trout have disappeared from small lakes where bass were not introduced, suggesting that the competition with bass for food was only one factor leading to a decline of the original salmonid fauna.

Oxygen Depletion

The other major factor noted by Cuerrier and Dadswell (1969) was that most of the lakes in the Gatineau Park had hypolimnia containing very little oxygen during the late summer (0–2 ppm). M. Dickman (1971. Report to the National Capital Commission) confirmed this observation with detailed oxygen profiles. Intense phytoplankton production had caused an oxygen maximum to occur below the thermocline in Pink, Meach, and Kidder Lakes. In most lakes examined, a marked decline in oxygen levels, characteristic of eutrophic conditions, was noted below the thermocline.

This widespread depletion of the hypolimnia of Gatineau Park lakes would seem to offer the most likely explanation for the disappearance of its cold-water salmonid species (Larkin and Northcote 1970). The persistence of lake trout in Meach Lake and their disappearance in Lac Lapêche, Lac Mousseau, and Lac Philippe becomes understandable in view of the relatively high oxygen values in the hypolimnion of Meach Lake compared with those of the other lakes (Dickman 1971. Report to the National Capital Commission). As recently as about 1960 abnormally warm summer conditions may have brought about an oxygen depletion resulting in a mass mortality which exterminated cisco in Lac Lapêche (D. Sauvé, personal communication).

The cause of the low oxygen levels in the hypolimnia of these lakes is not known. Deforestation between 1850 and 1924, a forest fire which swept along the escarpment from Old Chelsea past Luskville during the fall of 1924 (J. C. McCuaig, personal communication), and drainage from outdoor privies are factors which may have allowed excessive nutrients to enter the lakes, resulting in depletion of hypolimnia.

Recent Introductions

The decline of native cold-water species has created a sport fisherman's vacuum. Larger fishes are absent from such lakes which usually support abundant minnow populations. In other lakes stunted smallmouth bass (Doan 1940) and yellow perch are the only game fish available during the summer.

In an effort to maintain a fauna compatible with the original fish fauna, the National Capital Commission has initiated introductions of various fish species within the last 5 years. A limited number of cisco were introduced into Meach Lake to replace those which had disappeared. About a half million smelt eggs were introduced into streams adjoining Lac Mousseau (Cuerrier and Dadswell 1969). Limited introductions of lake trout, splake (*Salvelinus fontinalis* × *S. namaycush*), rainbow trout (*Salmo gairdneri*), and atlantic salmon (*Salmo salar*) have also been made mainly in the larger lakes of the Meach–Philippe system. Widespread introductions of brook trout have been made mainly in the smaller lakes, with partial success, suggesting that some of these lakes may still be capable of supporting trout species. Black Lake is an example where stocking of brook trout provided sport for anglers in the spring of 1972 and 1973.

The success or failure of such plantings may help clarify whether exploitation or environmental deterioration has been the dominant factor in causing a decline in the native cold-water fish fauna. It remains to be seen whether any of the introduced species will establish self-sustaining populations. Cuerrier and Dadswell (1969) noted limited reproduction of brook trout introduced into Lusk Lake. The introduction of about 4.5 million walleye fry into Lac Lapêche in 1968 may have failed owing to predatory yellow perch. Of about 80 adult walleye introduced into Lac Lapêche only one is known to have been recaptured and no signs of natural reproduction have yet been noted.

Gatineau Park is fortunate to have small lakes which can be manipulated and which lend to management techniques. Careful studies by biologists are needed to evaluate the effect of these introductions and to apply a consistent management policy.

Acknowledgments

I am grateful to G. Hamre and R. Plummer who assisted in making the collections; J.-P. Cuerrier of the Canadian Wildlife Service supplied unpublished data concerning game fish species and D. E. McAllister supplied advice and information from National Museum of Natural Sciences collections; M. Outhet and V. Edey of the National Capital Commission, D. Sauvé, J. Harrison, J. C. McCuaig, long-time local residents, and M. J. Dadswell supplied further information concerning the history of these lakes. The study that made this survey possible was directed by M. Dickman, Brock University. I thank G. Ben-Tchavtchavadze and J. Hélie for preparing the map and tabulations, and B. Woodley for photographing the waterfalls. I am also indebted to the reviewers who suggested improvements to this paper.

Literature Cited

Antevs, E. 1925. Retreat of the last ice-sheet in Eastern Canada. Geological Survey of Canada Memoir 146: 59–89.

Cuerrier, J.-P. and **M. J. Dadswell.** 1969. Limnology and experimental fishery management studies in Gatineau Park during 1968. Canadian Wildlife Service Manuscript Report. 107 pp.

Dadswell, M. J. 1972. Postglacial dispersal of four deepwater fishes on the basis of new distribution records in eastern Ontario and western Quebec. Journal of the Fisheries Research Board of Canada 29: 545–553.

Delisle, C. and **C. Veilleux.** 1969. Répartition géographique de l'éperlan arc-en-ciel *Osmerus eperlanus mordax* et de *Glugea hertwigi* (Sporozoa: Microsporidea) en eau douce, au Québec. Naturaliste Canadien 96: 337–358.

Doan, K. H. 1940. Studies of the smallmouth bass. Journal of Wildlife Management 4(3): 241–266.

Dymond, J. R. 1939. The fishes of the Ottawa region. Contribution of the Royal Ontario Museum 15: 1–43.

Elson, J. A. 1969. Radiocarbon dates, *Mya arenaria* phase of the Champlain Sea. Canadian Journal of Earth Sciences 6: 367–372.

Gadd, N. R. 1963. Surficial geology of Ottawa map-area, Ontario and Quebec. Geological Survey of Canada 62-16: 1–3.

Goldthwait, J. W. 1933. Selected passages from the St. Lawrence lowland. *In* Pleistocene geology of the central St. Lawrence lowland. Geological Survey of Canada Memoir 359(1971): 113–153.

Gruchy, C. G. 1968. Two late Quaternary Salmonidae (Pisces) from the Ottawa area, Canada. Vêstnik Ceskoslovenské Spolecnosti Zoologické Acta Societatis Zoologicae Bohemoslovacae (32 (4): 337–341.

Harington, C. R. 1971. The Champlain Sea and its vertebrate fauna. Part 1. Trail & Landscape 5: 137–141.

Johnston, W. A. 1916. Late Pleistocene oscillations of sea-level in the Ottawa Valley. Geological Survey of Canada Bulletin 24: 1–14.

Larkin, P. A. and **T. G. Northcote.** 1970. Fish as indices of eutrophication. *In* Eutrophication: causes, consequences, correctives. National Academy of Sciences, Washington, D.C. pp. 256–273.

Ogden, J. G. 1965. Radiocarbon and pollen evidence for a sudden change in climate in the Great Lakes region approximately 10 000 years ago. *In* Quaternary paleoecology. *Edited by* E. J. Cushing and H. E. Wright. Yale University Press. pp. 117–130.

Prest, V. K. 1970. Quaternary geology of Canada. *In* Geology and economical minerals of Canada. 5th edition. Department of Energy, Mines and Resources, Ottawa. pp. 675–764.

Romanelli, R. 1975. The Champlain Sea episode: the Gatineau Valley and Ottawa area. Canadian Field-Naturalist 89. *This issue.*

Rubec, P. J. and **B. W. Coad.** 1974. First record of the margined madtom (*Noturus insignis*) from Canada. Journal of the Fisheries Research Board of Canada 31(8): 1430–1431.

Ryder, R. A., W. B. Scott, and **E. J. Crossman.** 1964. Fishes of northern Ontario, north of the Albany River. Contributions of the Royal Ontario Museum 60: 1–30.

Small, H. B. 1883. Fishes of the Ottawa District. Transactions of the Ottawa Field-Naturalists' Club 4: 31–49.

Terasmae, J. and **O. L. Hughes.** 1960. Glacial retreat in the North Bay area, Ontario. Science (Washington) 131: 1444–1446.

Received 2 October 1972
Accepted 21 May 1974

Vegetation-habitat Changes Caused by Damming a Peatland Drainageway in Northern Ontario

John K. Jeglum

Department of the Environment, Canadian Forestry Service, Great Lakes Forest Research Centre, Sault Ste. Marie, Ontario P6A 5M7

Jeglum, J. K. 1975. Vegetation-habitat changes caused by damming a peatland drainageway in northern Ontario. Canadian Field-Naturalist 89(4): 400–412.

Abstract. A striking example of road damming in wetlands is found 3 miles (5 km) south of Kenogami, Ontario, where Highway 11 crosses a narrow, slowly drained, peatland valley. Below the road dam is forested peatland, somewhat less wet than before the damming but probably not much changed from the original condition, with a central treed bog zone and swamps at the margins. Above the road dam is an open, floating-to-spongy, mostly *Sphagnum*-dominated mat which is bog in the poorest central areas and fen in the less poor marginal areas near small collecting pools and beaver channels. Measures of vegetation and habitat from quadrats along transects above and below the road dam suggest that there is continuous variation between fen and bog, and between swamp and treed bog. The open and treed bogs are interpreted as minerotrophic transitional bogs. Implications of the changes caused by the road dam for other road-building and damming activities in northern Canada are discussed.

Résumé. Un exemple typique d'un barrage routier sur terrain marécageux est situé à 3 milles (5 km) de Kénogami, Ontario, où la route 11 traverse une vallée tourbeuse, étroite, à drainage lent. On retrouve au bas de la route une tourbière boisée, probablement pas tellement différente de sa condition originale, bien que moins humide qu'avant l'installation du barrage, avec une zone centrale de sphaignes arbreuses et des marais le long des bords. Au-dessus du barrage routier, on trouve un tapis à ciel ouvert, flottant à spongieux, qui consiste en grande partie de sphaignes; ce tapis forme une tourbière dans les zones centrales les plus pauvres et un fen le long des bords moins pauvres, près de marres collectrices et de passes de castors. Les données accumulées sur la végétation et son habitat, provenant de quadrats divisés transversallement au-dessus et au-dessous du barrage, indiquent une variation continue entre le fen et la tourbe et entre le marécage et la tourbière arbreuse. On définit les tourbières à ciel ouvert et arbreuses comme étant minérotrophiques et de transition. L'auteur discute des implications des perturbations causées par le barrage pour la construction d'autres routes et barrages dans le nord du Canada.

Roads and highways that traverse peatlands in northern Ontario are frequently observed to block drainage. Often the result is flooding on the upslope side of the road, with subsequent killing of woody vegetation and retrogression of the site to open vegetation and/or water bodies, and a partial drying of the downslope side of the road.

A striking example of just such a road damming was observed in northern Ontario, and a study was carried out in 1969 and 1970 to document its effects. The purpose of this paper is to describe and compare vegetation and habitat on both sides of the highway. The vegetational and ecological relationships will be interesting to botanists and ecologists, and the changes caused will have important implications for future road damming and other damming activities in northern Canada.

Study Area

The site is 3 miles (5 km) south of Kenogami (near Kirkland Lake) in the Missinaibi-Cabonga Forest Section (Rowe 1972) of northern Ontario. In this section the underlying bedrocks are of Precambrian age, and from them the shallow till overburden has inherited varying degrees of fertility. In the area in which the site is located there has been water-modification of the surface drift — resulting from previous flooding by postglacial lakes Barlow-Ojibway — and fine-textured surface deposits are frequent (Rowe 1972). The mean annual precipitation for this area is 81 cm, and there is no mean annual water deficiency. Mean daily temperatures for July and January are 63°F (17.2°C) and 0°F (−17.8°C), respectively (Chapman and Thomas 1968).

The study area occurs where Highway 11 crosses a peatland valley, approximately ¼ mile (0.4 km) wide, which lies between two parallel ridges (Figures 1–3). The highway, built in 1938, has obstructed natural drainage. One side of the road has been flooded and the treed vegetation previously found there replaced by an open, spongy or floating, *Sphagnum*-dominated mat.

Methods

Two transects were established across the peatland, one on either side of the highway, approximately parallel to and 50 m from the cleared margins of the highway (Figures 2 and 3). Quadrats, 2 × 2 m, were placed at 10-m intervals along each side of the transects, 43 on the treed side and 25 on the open side.

Ocular estimates of percentage canopy cover were made for all species. Nonvascular species not known in the field were collected for later identification only if they attained at least 25% cover in the quadrat. Nomenclature for vascular species is according to Gleason and Cronquist (1963), that for *Sphagna* is according to Nyholm (1969).

Quadrats were classified as one of three main peatland formations — bog, fen, or swamp (cf. Zoltai et al. 1974). "Bog" is defined as a nutrient-poor ecosystem that is *Sphagnum*-rich, underlain by a relatively continuous horizon of *Sphagnum* peat, and is relatively isolated from any influx of mineral soil-influenced waters. In this study we did not use the strict definition of bog as equivalent to ombrotrophic (Sjörs 1961, 1963) — nourished only by nutrients contained in precipitation; rather, we preferred a slightly broader construct which includes minerotrophic, transitional bogs with ombrotrophic bogs. Quadrats were further characterized according to dominant species in tree, tall shrub, low shrub, and herb strata (cf. Jeglum

FIGURE 1. Ground photograph of the road dam. The open peatland is to the right, the treed peatland to the left. Cat-tails (*Typha latifolia*) are in the ditch on the right. The view is from southeast to northwest.

FIGURE 2. Aerial photograph of the road dam. In the treed peatland (left) the cut line along the transect is visible, roughly parallel to the highway. In the open peatland (right) the line is not visible, but the darker area in the bottom third (approximately) of the area is what was designated low-shrub fen, whereas the upper two-thirds were designated graminoid or low-shrub bog (see Figure 4). The view is oriented with south at the bottom, north at the top.

et al. 1974). Zones of similar vegetation were then segregated along each transect.

In mid-August 1969 peat depths were measured (mean of low and high point in each quadrat), and peat samples were collected. For the peat samples, moist-peat pH values were measured (electronic meter, combination electrode, three values averaged). Depths to groundwater (mean of low and high point in each quadrat) were measured and water samples were collected in early September 1970 after a period of summer drought with very little precipitation. The samples were collected in polyethylene bottles treated with iodine to reduce biological activity (MacKereth 1963), stored frozen in the dark, and filtered before analysis. Measurements and analyses included water pH (electronic meter), conductivity (μmhos/cm at 77°F (25°C) minus contribution owing to hydrogen ion concentrations, K_{corr} in Sjörs 1952), alkalinity (titration with HCl, MacKereth 1963), calcium and magnesium (atomic absorption spectrophotometry), potassium (flame-emission spectrophotometry), sulphate (turbidimetric method, Anonymous 1969), and ferric and ferrous iron (1, 10-phenanthroline method, Anonymous 1969).

For the treed peatland transect, three black spruce trees in or close to each quadrat were measured for height and age at ground level and site index (height at 50 years) derived from height – age curves (Plonski 1956).

Results

The open, flooded side of the highway had a water level 55 cm higher than that of the treed side in the valley center in mid-August 1969 and ground surface differences between the two sides of the road were only slightly less. In the treed swamps near the uplands on either side of the valley, the hollows and channels showed signs of being less water-filled than

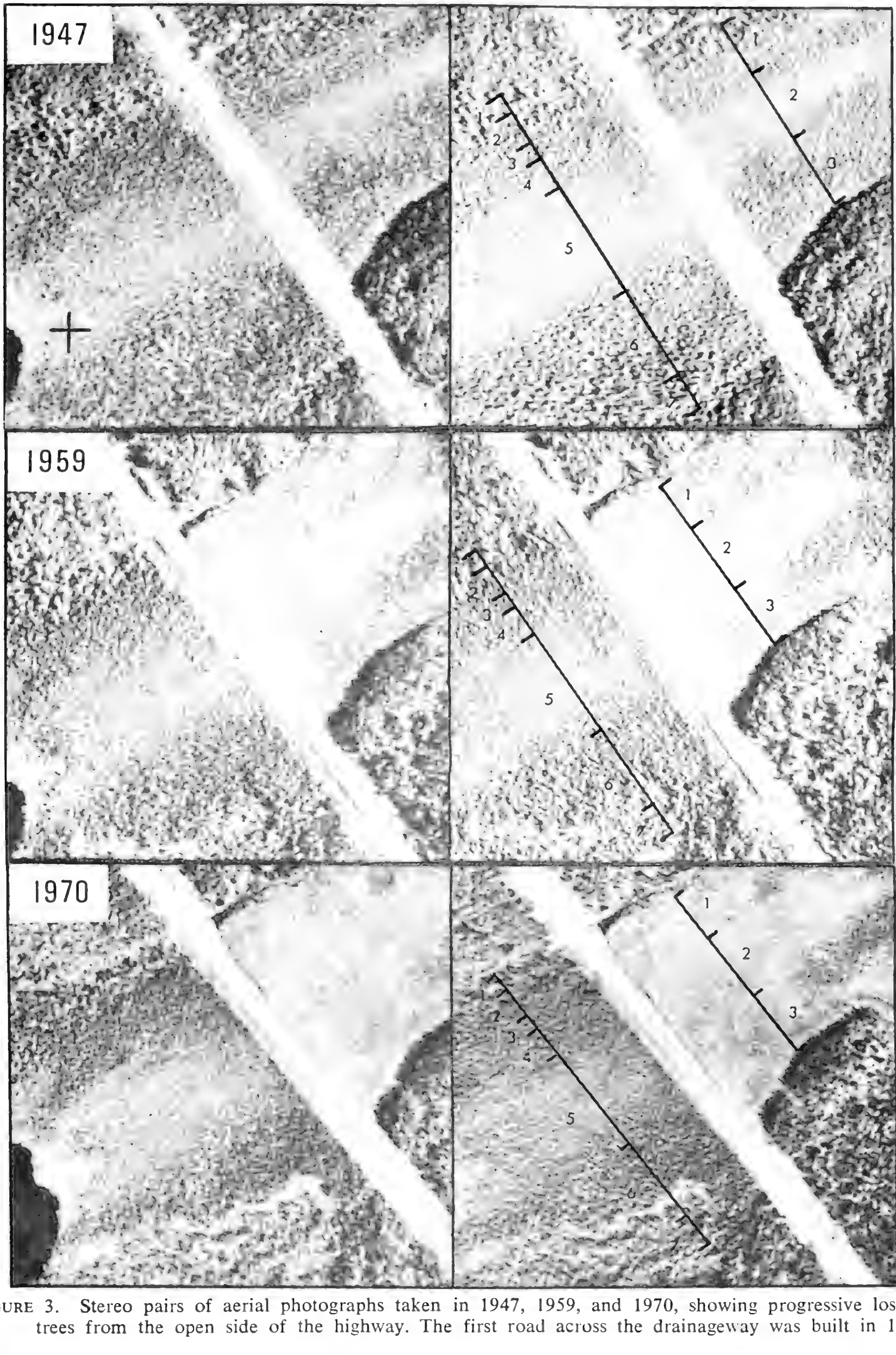


FIGURE 3. Stereo pairs of aerial photographs taken in 1947, 1959, and 1970, showing progressive loss of trees from the open side of the highway. The first road across the drainageway was built in 1938.

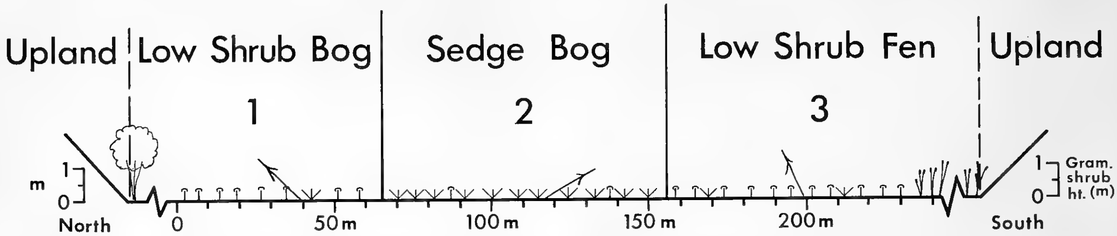


FIGURE 4. Profile sketch of the transect in the open peatland. Zone 1—Leather-leaf (*Chamaedaphne calyculata*) low-shrub bog; Zone 2—Stunted Sedge (*Carex paupercula*) graminoid bog; Zone 3—Leather-leaf – Sweet Gale (*Myrica gale*) low-shrub fen. Quadrats were located at 10-m intervals along the transect.

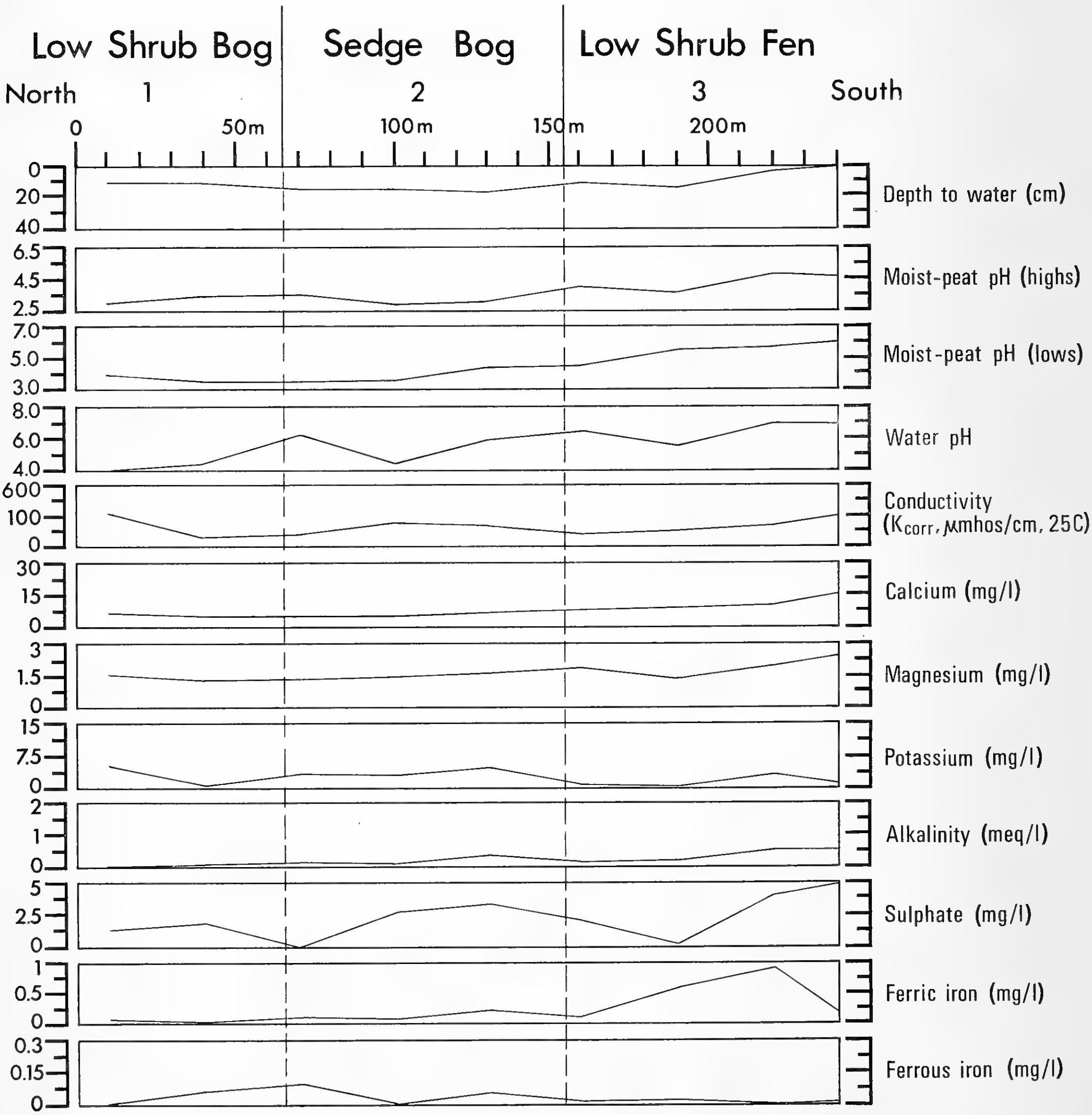


FIGURE 5. Habitat measurements along the transect in the open peatland.

in the past, indicating that the treed side of the highway has experienced some drying.

The Open Peatland

Aerial photographs taken in 1947, 1959, and 1970 demonstrate the progressive loss of trees from the open side of the highway (Figure 3). Not much tree loss had occurred by 1947, 9 years after the road causeway had been built. By 1959, 21 years later, however, there was considerable loss close to the highway, and by 1970, 32 years after drainage blockage, trees were killed as far back from the highway as the width of the peatland valley, about ¼ mi (0.4 km).

On the open side there has been ponding of water near both upland margins (Figures 1–3); the transect extended between these open-water areas. As an initial orientation, a profile sketch of the transect showing the vegetational zones is presented in Figure 4.

Trends in habitat measures along the transect are presented in Figure 5. Depths to groundwater reveal standing water in the marginal quadrats, and the low depths to groundwater across the rest of the area reflect the wetness of the floating spongy *Sphagnum* mat. The several measures of nutrients reflect low nutrient status in the northern and central sections (zones 1 and 2), and a higher nutrient status in the southern section (zone 3) of the transect. The higher degree of minerotrophy in the southern section may reflect flooding in spring by mineral soil waters draining off adjacent mineral soil uplands. Furthermore, the ferric and ferrous iron values suggest that aeration of groundwater is better in the southern third of the transect.

Three zones, based on the leading dominant of the uppermost vegetational stratum, are indicated in Figure 6: (1) Leather-leaf (*Chamaedaphne calyculata*) low shrub bog, (2)

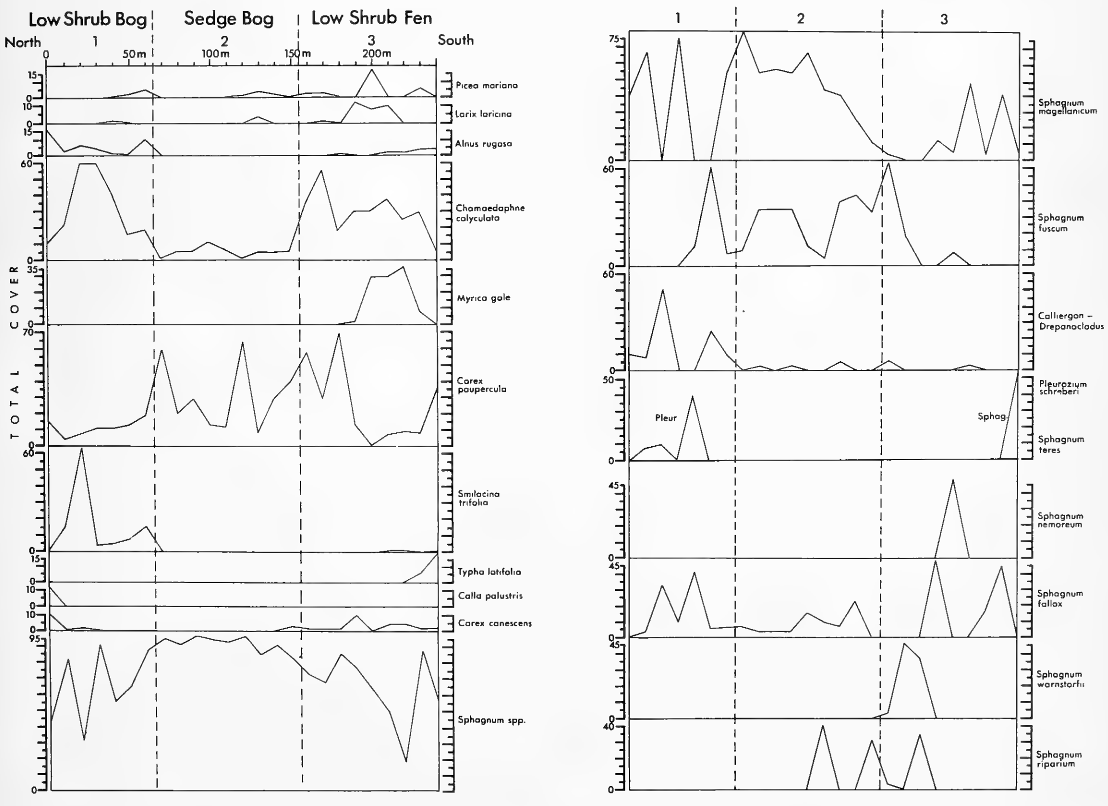


FIGURE 6. Species cover values along the transect in the open peatland. Species shown are those which attained at least 10% cover in one quadrat.

Stunted Sedge (*Carex paupercula*) graminoid bog, and (3) Leather-leaf–Sweet Gale (*Myrica gale*) low shrub fen. A complete list of species encountered along with their mean cover values and frequencies in the zones is given in Appendix A.* (Means for habitat measures in the zones are also included in this appendix.)

A number of species occur exclusively, or with highest values, in zones 1 and 3: e.g., Speckled Alder (*Alnus rugosa*), Silvery Sedge (*Carex canescens*), and *Sphagnum fallax* (Figure 6). These distributions suggest a relationship between these zones, although zone 1 is less nutrient-rich than zone 3 (Figure 5) and also supports fewer species (Figure 6, Appendix A*).

Water Arum (*Calla palustris*) is in the open beaver channel in the quadrat furthest north in zone 1 (Figure 6). Three-leaved False Solomon's-seal (*Smilacina trifolia*) achieves high abundance in zone 1; its abundance may reflect slightly higher minerotrophic influence in zone 1 next to the marginal channels than in the centrally located zone 2.

A number of species have their highest values in zone 3: Black Spruce (*Picea mariana*), Tamarack (*Larix laricina*), Sweet Gale, Broad-leaved Cat-tail (*Typha latifolia*), *Sphagnum teres*, *S. nemoreum*, *S. warnstorfii*, and *S. riparium* (Figure 6). In addition, a number of species with lower cover values also peak in zone 3, including Hairy Fly-honeysuckle (*Lonicera villosa*), Pear-leaved Willow (*Salix pyrifolia*), Blue-joint (*Calamagrostis canadensis*), and *Aulacomnium palustre* (Appendix A*).

Species having highest values in the middle of the transect (zone 2) are Stunted Sedge, *Sphagnum magellanicum*, and *S. fuscum*.

The Treed Peatland

The transect extended from the upland on the north side of the valley through swamp, treed bog in the valley center, again through swamp, and finally ended at the upland on the south side of the valley (Figures 2 and 3). As an initial orientation, a profile sketch of the transect showing the vegetational zones is presented in Figure 7.

Trends in habitat measures along the transect are presented in Figure 8. Peat depths are greatest near the center of the peatland, exceeding 7.6 m. Levelling along the transect revealed that the ground surfaces and depths to groundwater are lowest in the zones nearest the upland margins. The other measures relate to nutrient status and indicate that the margins are richer than the center. Values tend to be higher, however, and cover a wider zone on the north side (zones 1–4) than on the south side (zone 8) of the valley. Clearly, drainage of richer mineral soil water in this valley has been, and still is (though to a lesser degree since the road-damming), along both upland margins. The ferric and ferrous iron values suggest that groundwater aeration is better at the valley margins, poorer in the center.

Site index, a measure of black-spruce tree growth, shows the same pattern as nutrient-related measures, highest at the margins, lowest in the center (Figure 8).

Seven zones, based on the leading dominant of one or more vegetational strata, are indicated in Figure 9: (1) Speckled Alder swamp, (2) Black Spruce/Speckled Alder swamp, (3) Black Spruce/*Sphagnum*–Schreber's Feather Moss (*Pleurozium schreberi*) swamp, (4) Black Spruce/Labrador-tea (*Ledum groenlandicum*) swamp, (5) Black Spruce/Leather-leaf treed bog, (6) Black Spruce/Labrador-tea swamp, and (7) White Cedar (*Thuja occidentalis*)–Balsam Fir (*Abies balsamea*)/Speckled Alder swamp. A complete list of species encountered along with their mean cover values and frequencies in the zones is given in Appendix B.* (Means for habitat measures are also included in this appendix.)

A number of species occur exclusively, or with highest values, in the swamp types close to the uplands (zones 1–3, 7): Speckled Alder, Fowl-meadow Grass (*Glyceria striata*), Oak-fern (*Gymnocarpium dryopteris*), and *Sphagnum warnstorfii* (Figure 9). In addition, *Sphagnum girgensohnii* (which includes the taxon *S. russowii* in this study) occurs with high values in zone 7 but also extends slightly into zone 6

* Available at nominal charge, from the Depository of Unpublished Data, National Science Library, National Research Council of Canada, Ottawa, Canada K1A 0S2.

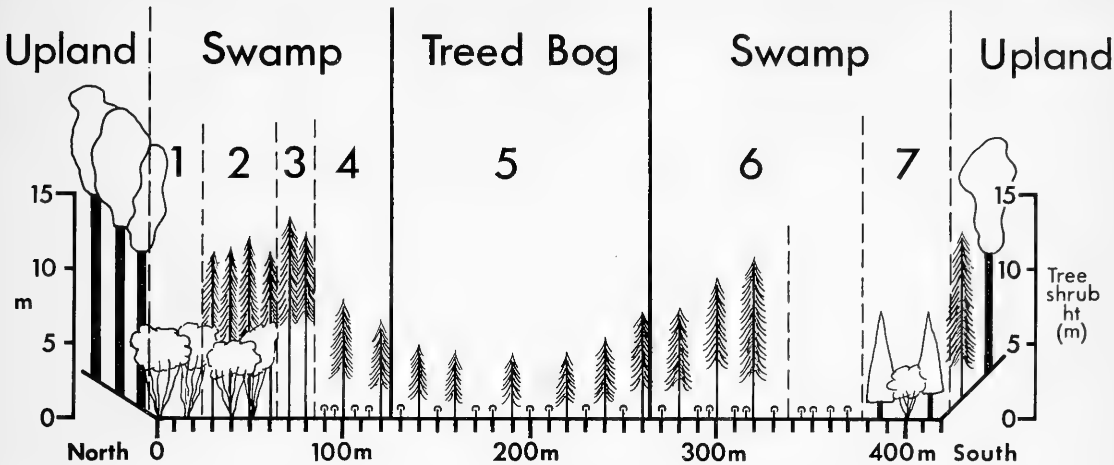


FIGURE 7. Profile sketch of the transect in the treed peatland. Zone 1—Speckled Alder (*Alnus rugosa*) swamp; Zone 2—Black Spruce (*Picea mariana*)/Speckled Alder swamp; Zone 3—Black Spruce/*Sphagnum*–Schreber's Feather Moss (*Pleurozium schreberi*) swamp; Zone 4—Black Spruce/Labrador-tea (*Ledum groenlandicum*) swamp; Zone 5—Black Spruce/Leather-leaf (*Chamaedaphne calyculata*) treed bog; Zone 6—Black Spruce/Labrador-tea swamp; Zone 7—White Cedar (*Thuja occidentalis*)–Balsam Fir (*Abies balsamea*)/Speckled Alder swamp. Quadrats were located at 10-m intervals along the transect.

(see Appendix B* for other species occurring in these zones).

Zone 2 is Black Spruce/Speckled Alder swamp, which occurs closest to the nutrient-rich, marginal Speckled Alder swamp (zone 1) (Figure 9) and, by implication, is the richest Black Spruce swamp type. Site indices (Figure 8), however, suggest that tree growth is as good in zone 3 as in zone 2.

Zone 3 is shrub-poor undoubtedly because of the shading by the dense Black Spruce canopy. Two phases are represented, Black Spruce/*Sphagnum* swamp and Black Spruce/Schreber's Feather Moss swamp (Figure 9). Both phases are more extensive elsewhere and are recognized as site types of Black Spruce swamp (Jeglum et al. 1974).

Zones 4 and 6 are both characterized as Black Spruce/Labrador-tea swamp (Figure 9). Zone 6 has a swath cut out of it, demonstrating that logging occurs in the Black Spruce/Labrador-tea site type. The openness of the canopy of this site type is suggested by the mean cover for Black Spruce (all size classes) in zones 4 and 6 (excluding the cut zone), 35% and 28%, respectively.

Labrador-tea, Three-seeded Sedge (*Carex trisperma*), and Schreber's Feather Moss achieve high values in or centering about the Black Spruce/Labrador-tea swamp in both zones 4 and 6 (Figure 9). In addition, *Sphagnum nemoreum* (= *S. capillaceum*) occurs in zone 6 with a high value. The fact that zone 4 is more nutrient-rich than zone 6 may explain the higher values for Three-seeded Sedge in zone 4. Zone 4 also contains more species, many of which are more typical of fens and swamps, than does zone 6 (e.g., Speckled Alder, Figure 9; see also Appendix B*).

Black Spruce achieves a mean cover of 35% in the Black Spruce/Leather-leaf treed bog (zone 5, Figure 9). Much of this cover however is accounted for by seedling-sized individuals, and the zone is actually more open in appearance and has shorter trees on the average than the Black Spruce/Labrador-tea swamps bordering it (Figure 7). *Sphagnum fuscum* occurs mainly in zone 5, although it does overlap the nutrient-poor Black Spruce/Labrador-tea swamp (zone 6). *Sphagnum fallax* and *S. magellanicum* also are abundant but both extend into the swamp types on either side of

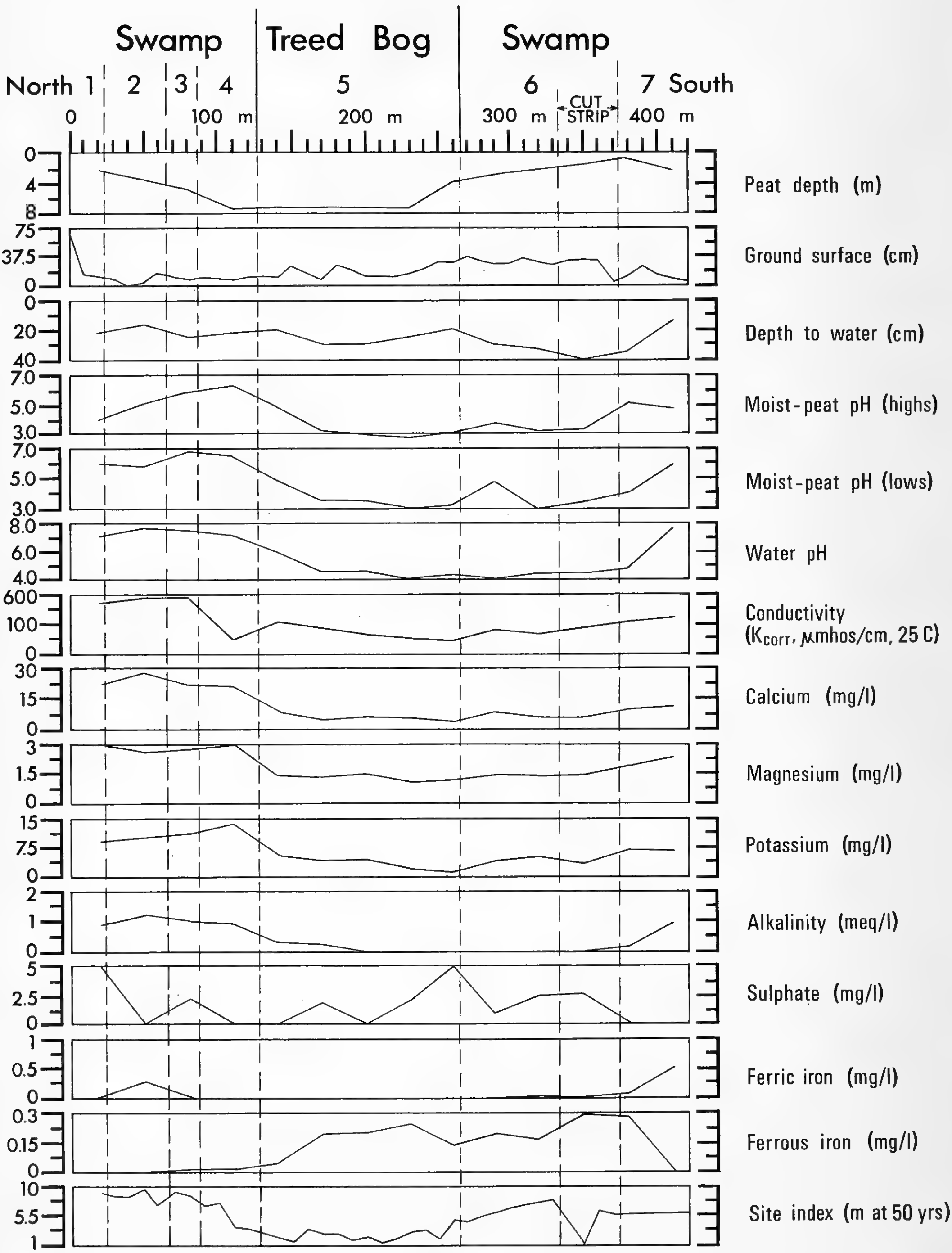


FIGURE 8. Habitat measurements along the transect in the treed peatland

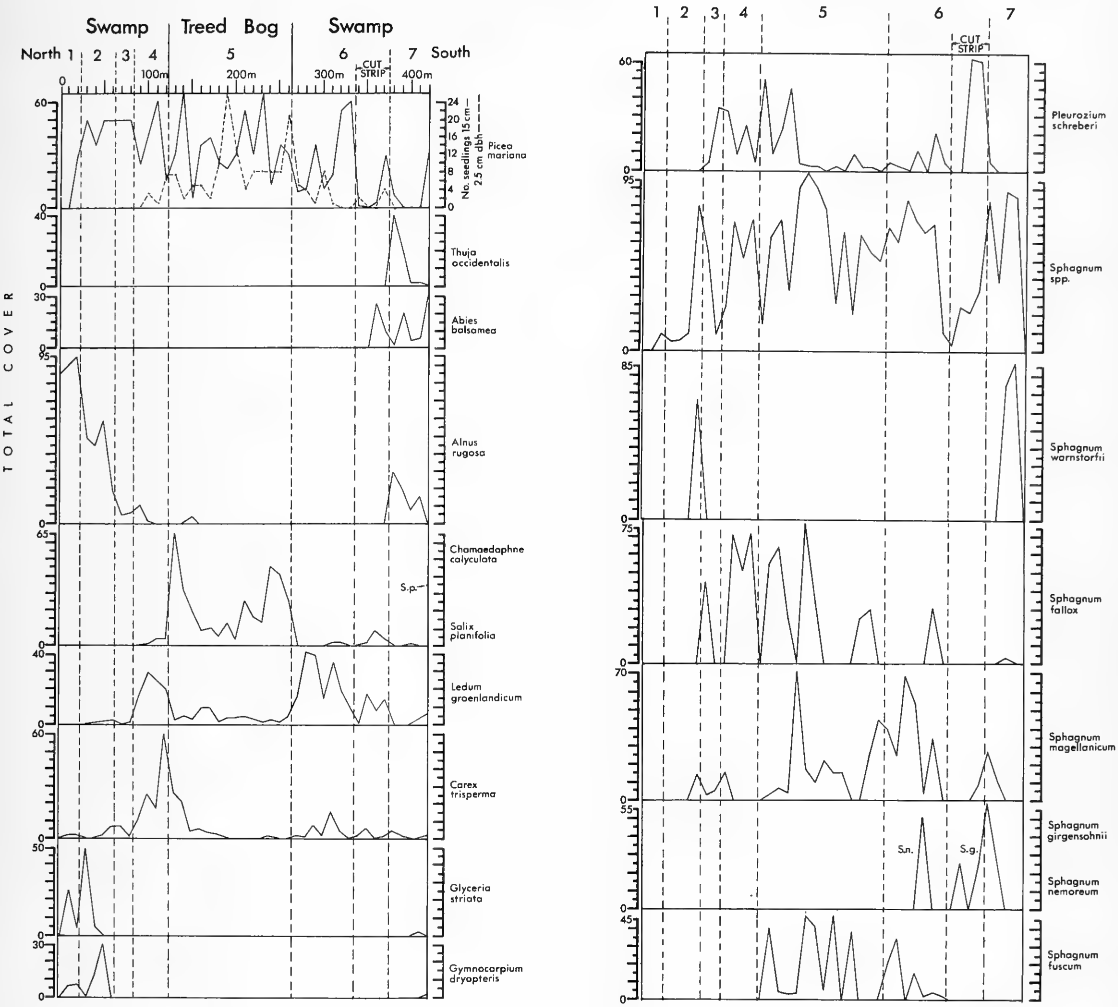


FIGURE 9. Species cover values along the transect in the treed peatland. Species shown are those which attained at least 10% cover in one quadrat.

the valley. The openness of the central zone 5 and its low nutrient status together account for the high importance of Leather-leaf and *Sphagnum fuscum*, as well as the relatively lesser importance of Labrador-tea and Schreber's Feather Moss which may require more shade and nutrients. Other less abundant species peaking in the central zone are Pauciflorous Sedge (*Carex pauciflora*), Dense Cotton-grass (*Eriophorum spissum*), and Small Cranberry (*Vaccinium oxycoccos*) (Appendix B*).

Discussion

Vegetation–Habitat Relationships

In this study the term "bog" is defined as a nutrient-poor ecosystem that is *Sphagnum*-rich, underlain by a relatively continuous horizon of *Sphagnum* peat, and is relatively isolated from any influx of mineral soil-influenced waters (cf. Zoltai et al. 1974). For a bog to be ombrotrophic it must not have present any sensitive plant indicators of minerotrophy (e.g., see Sjörs

1961, 1963). Furthermore, it must have pH values less than 4.2 (Sjörs 1952) or 4.4 (Gorham and Pearsall 1956) and Ca concentrations less than 2 mg/litre (Gorham and Pearsall 1956). The bog zones in this study are probably slightly minerotrophic because they do have small amounts of some plant indicators of minerotrophy, and they have pH and Ca values exceeding the limits given above.

In the open peatland, sensitive plant indicators of minerotrophy were present in low quantities in the low-shrub bog and graminoid bog zones. These included Speckled Alder, Silvery Sedge, *Calliergon–Drepanocladus*, and *Sphagnum riparium* (Figure 6). Values for water pH were 4.0, 4.4, 6.2, 4.5, and 5.8 and Ca values ranged from 5.3 to 6.0 mg/litre.

Sensitive plant indicators of minerotrophy were also present in low amounts in the treed bog zone on the treed peatland side of the highway. These included Speckled Alder, Swamp Fly-honeysuckle (*Lonicera oblongifolia*), and Large Pussy-willow (*Salix-discolor*) (Figure 9; Appendix B*). Values of water pH were 4.3 to 4.4, except for a value of 6.0 in the quadrat nearest zone 4 (Figure 8). Hence, pH values were, for the most part, low enough for the bog limits given above. But Ca values were all above the 2 mg/litre limit, ranging between 5.6 and 6.0 mg/litre (except for a value of 8.5 mg/litre in the quadrat nearest zone 4).

The occurrence of small numbers of minerotrophic indicators and the higher levels of pH and Ca in the open bog and treed bog zones suggest that the zones are probably still weakly influenced by mineral soil waters, and hence could be termed "minerotrophic bog" or possibly "transitional bog" (cf. Tarnocai 1970). They also partly fit the concept of "mesotrophic," characterized by Ratcliffe (1964) as having water pH values from 5.7 to 6.5, and Ca in water of 4–10 mg/litre. "Mesotrophic bog" has been used as a category by Damman (1963), and Walmsley and Lavkulich (1973) report a Ca value of 7.2 mg/litre for a bog in the vicinity of Fort Simpson, Northwest Territories.

In the open peatland transect a low-shrub fen zone (zone 3, Figures 4–6) was recognized even though this zone was *Sphagnum*-rich. Zone 3 appeared to be more minerotrophic in many respects than zone 1. Nutrient-related measures were highest in zone 3, and several species with reasonably high cover values were related more to fen and marsh than to bog, *viz.*, Sweet Gale, Broad-leaved Cat-tail, and Silvery Sedge. Also occurring in this zone were several *Sphagnum* species that have been regarded as belonging to the "brown moss" group in fens (*Sphagnum riparium, S. teres*, and *S. warnstorfii*, listed in types of "letto," McEwen 1964). The zone called "low-shrub fen" is distinguishable on the aerial photographs as a darker area than the graminoid and low-shrub bog zones (Figures 2 and 3).

Zones 4 and 6 on the treed side of the highway were designated Black Spruce/Labrador-tea swamp (Figures 7–9). Zone 4 had relatively high values for nutrient-related measures, similar to zones 1–3 and 7, whereas zone 6 had relatively low values similar to zone 5. In spite of these differences it was decided to call both zones 4 and 6 swamp, mainly because they had somewhat taller trees than zone 5, with some even attaining merchantable size in the cut swath in zone 6 (Figure 7).

Changes Caused by the Road Dam: Some Implications

Before construction of the road, this peatland valley probably had vegetational zonations similar to those on the treed side of the road (Figure 7). Swamps occurred adjacent to the upland, whereas a treed bog occupied the central area. With the building of a log-based road in 1938, followed by more filling and causeway build-up over the years, the east side of the road gradually became wetter as water was partially empounded by the causeway. The trees gradually died (Figure 3), an open bog replaced the previously treed bog in the center of the peatland, and fens and marshes developed where mineral-enriched waters accumulated in the marginal areas and road ditch. On the other side of the road, damming caused a partial drying, tree growth probably increased, and slightly drier treed bog developed in the central zone. It is notable, however, that the values for Ca remained similar in the treed and open bogs, 5.3–6.0 mg/litre, suggesting that the levels of nutrition have remained the same in the central areas, and that only the moisture levels have changed.

The changes caused by the road damming are similar to those caused by beaver dams in that there are increased water tables behind the dam, and slightly drier conditions below it (on sites not in the main outflow channel). Beaver dams, however, are found in areas with continuous water flow in channels or small streams. In the example documented here, there were probably no definite channels before damming, and there was a much slower seepage of water through the peatlands adjacent to the uplands. Because of this a large central pond did not develop behind the road dam; rather, there was a gradual rise in water table which was accompanied by progressive change of treed bog to open bog with a floating *Sphagnum* mat. There is probably little or no flush of marginal, mineral-rich waters over the floating-mat surface, since the mat floats up and down with seasonal variation in water table in the empoundment.

The damming observed in this study could have been avoided by placing culverts beneath the original road on both sides of the valley where there was drainage. There may have been some attempt to provide for seepage by criss-crossing logs, and by filling with large rocks in subsequent stages of highway build-up. Seepage beneath the road does in fact occur, but it is obviously imperfect.

The major disadvantages of such conversion of treed to open peatland are that the sites become unproductive in terms of forest growth, more difficult to traverse, and unsightly (a dying forest is unsightly to the eyes of most beholders), and that the roads which dam them may be subject to washing out. But some advantages may be inadvertently achieved by damming. One advantage is the creation, in some instances, of wetland habitat for ducks, geese, beaver, moose, and other harvestable wildlife. Relatively rapid water-level rises and flooding by mineral- and silt-enriched waters would favor development of vegetatively rich and diverse sites with water, marshes, meadows, and thickets habitable by a wide variety of wildlife species. In our example, the open bog mat is not as productive in terms of wildlife, but there are nonetheless marginal pools and marshes which are attractive to waterfowl, beavers, and other wildlife. Another positive aspect of damming is that there is a partial drying below the dam, which allows for some improvement in tree growth. This improvement, however, is of little significance to the forest manager at present since only small areas along roads are influenced.

The case of road-damming documented here is but one example of similar changes that are occurring throughout northern Canada where logging and mining roads, seismic lines, pipelines, and the like are being constructed without adequate provision for beneath-the-road (-line) drainage. Changes similar to the one reported here could also occur in embayments and along shores of reservoirs created by hydroelectric projects. The fact that the treed peatland on the flooded side of the road was converted to an open bog of considerable extent in a very short time, probably less than 20 years, gives some indication of the rapidity of such changes. The relative advantages and disadvantages of creating large areas of open wetlands of various kinds and complexes should be an important part of environmental impact considerations in the future development of roads, various kinds of lines, and dams in Canada.

Acknowledgments

I gratefully acknowledge the aid of R. K. McCron, J. Cameron, and D. E. Harvey in the field, and of J. R. Ramakers in chemical analyses of water samples.

Literature Cited

Anonymous. 1969. Colorimetric procedures and chemicals for water and wastewater analysis. 3rd ed. Hach Chemical Company, Ames, Iowa.

Chapman, L. J. and **M. K. Thomas.** 1968. The climate of northern Ontario. Canada Department of Transport, Meteorological Branch, Climatology Study Number 6. 58 pp.

Damman, A. W. H. 1963. Key to the *Carex* species of Newfoundland by vegetative characteristics. Department of Forestry Publication Number 1017. 39 pp.

Gleason, H. A. and **A. Cronquist.** 1963. Manual of vascular plants of northeastern United States and adjacent Canada. van Nostrand Company, Princeton, New Jersey.

Gorham, E. and **W. H. Pearsall.** 1956. Acidity, specific conductivity and calcium content of some bog and fen waters in northern Britain. Journal of Ecology 44: 129–141.

Jeglum, J. K., A. N. Boissonneau, and **V. F. Haavisto.** 1974. Toward a wetland classification for Ontario. Canadian Forestry Service, Sault Ste. Marie, Ontario. Information Report O-X-215. 54 pp. + appendices.

MacKereth, F. J. H. 1963. Some methods of water analysis for limnologists. Freshwater Biology Association (United Kingdom), Scientific Publication Number 21. 72 pp.

McEwen, J. K. 1964. Swamp types. Ontario Department of Lands and Forests, Research Information Report Number 28. 51 pp. [*Translated from* Heikurainen, L. 1960. Metsäojitus ja sen persteet. Helsinki. pp. 64–110.]

Nyholm, E. 1969. Illustrated moss flora of Fennoscandia. II. Musci (Fascicle 6). Swedish Natural Science Research Council, Stockholm. pp. 647–799.

Plonski, W. L. 1956. Normal yield tables for black spruce, jack pine, aspen and white birch in northern Ontario. Ontario Department of Lands and Forests, Division of Timber Management, Report Number 24. 40 pp. (Reprinted as condensed booklet in 1960.)

Ratcliffe, D. A. 1964. Mires and bogs. *In* The vegetation of Scotland. *Edited by* J. H. Barnett. Oliver and Boyd, London. pp. 426–466.

Rowe, J. S. 1972. Forest regions of Canada. Forestry Service Publication Number 1300. 172 pp.

Sjörs, H. 1952. On the relation between vegetation and electrolytes in north Swedish mire waters. Oikos 2(1950): 241–258.

Sjörs, H. 1961. Forest and peatland at Hawley Lake, northern Ontario. National Museum of Canada Bulletin 171. 31 pp.

Sjörs, H. 1963. Bogs and fens on Attawapiskat River, northern Ontario. National Museum of Canada Bulletin 186. pp. 45–133.

Tarnocai, C. 1970. Classification of peat landforms in Manitoba. Canada Department of Agriculture Research Station, Pedology Unit, Winnipeg, September 1970. 45 pp.

Walmsley, M. E. and **L. M. Lavkulich.** 1973. *In situ* measurement of dissolved materials as an indicator of organic terrain type. Canadian Journal of Soil Science 53: 231–236.

Zoltai, S. C., F. C. Pollett, J. K. Jeglum, and **G. D. Adams.** 1974. Developing a wetland classification for Canada. Proceedings of the Fourth North American Forest Soils Conference, Quebec City, August 1973. pp. 497–511.

Received 21 February 1975
Accepted 26 April 1975

Birds of the Tundra Biome at Cape Churchill and La Pérouse Bay

F. Cooke,[1] R. K. Ross,[2] R. K. Schmidt,[3] and A. J. Pakulak[3]*

[1] Department of Biology, Queen's University, Kingston, Ontario
[2] Canadian Wildlife Service, Ottawa, Ontario
[3] Manitoba Department of Mines, Resources and Environmental Management, Winnipeg, Manitoba

Cooke, F., R. K. Ross, R. K. Schmidt, and A. J. Pakulak. 1975. Birds of the tundra biome at Cape Churchill and La Pérouse Bay. Canadian Field-Naturalist 89(4): 413–422.

Abstract. The birds of the Cape Churchill tundra biome are described on the basis of six field seasons in the Cape Churchill – La Pérouse Bay region. The habitat and migration characteristics of the area are described. The status of 111 species is compared and contrasted with the findings of Jehl and Smith.

Introduction

Although the avifauna of Churchill, Manitoba, and the easily accessible surroundings have been summarized in the book *Birds of the Churchill Region, Manitoba* by Jehl and Smith (1970), the tundra biome 25–40 miles east of Churchill has seldom been visited. The aim of this paper is to summarize the ornithological observations made in this region during six field seasons by two research teams, one headed by Cooke studying Snow Geese at La Pérouse Bay, and the other by Pakulak studying Canada Geese near Cape Churchill. The observations are compared and contrasted with the findings of Jehl and Smith (1970).

The area covered in this paper is shown in Figure 1. It includes the coastal area east of Watson Point and the associated tundra habitat lying within 5 miles of the coast. The region differs in two important respects from the area accessible to most visitors to the Churchill area. First, it lacks the typical boreal forest zone with its dominant black spruce (*Picea mariana*) and tamarack (*Larix laricina*); and second, access to the region is restricted so there has been little human disturbance. Casual visits to the area have been reported (Wellein and Lumsden 1964; Foster 1957) and Jehl (Jehl and Smith 1970) includes some of his observations from there in the above-mentioned book.

The present observations cover the years 1968 to 1973 and range from early May to early August, with coverage at Cape Churchill until mid-September in 1969.

The locations of the research camps are shown on the map. Most of the 1968 observations by Pakulak and co-workers were made in the vicinity of Cape Churchill, while those of the 1969 and 1970 seasons were made within 1 mile of the Cape Churchill camp, located 7 miles south of the Cape. From 1968 to 1971, Cooke's group was located on the Watson Point esker at Camp Flicek, less than a mile north of Knight's Hill. Most of the observations of this group were made either from the esker or between the esker and the Snow Goose colony located around the shoreline of La Pérouse Bay. In 1972, most observations were made in the vicinity of the Snow Goose colony after the establishment of Camp Finney at the mouth of the Mast River, which flows out of Norton Lake.

Systematic records of birds sighted were kept in all years except 1971. A few noteworthy records from 1973 are included. Few attempts were made to make quantitative observations since much of our time was taken up with goose studies. Details of the nesting observations are available in the field notes of the senior author and can be made available on request.

* Mr. Pakulak was affiliated with the Department of Mines, Resources and Environmental Management at the time of his tragic death in a plane accident in 1973.

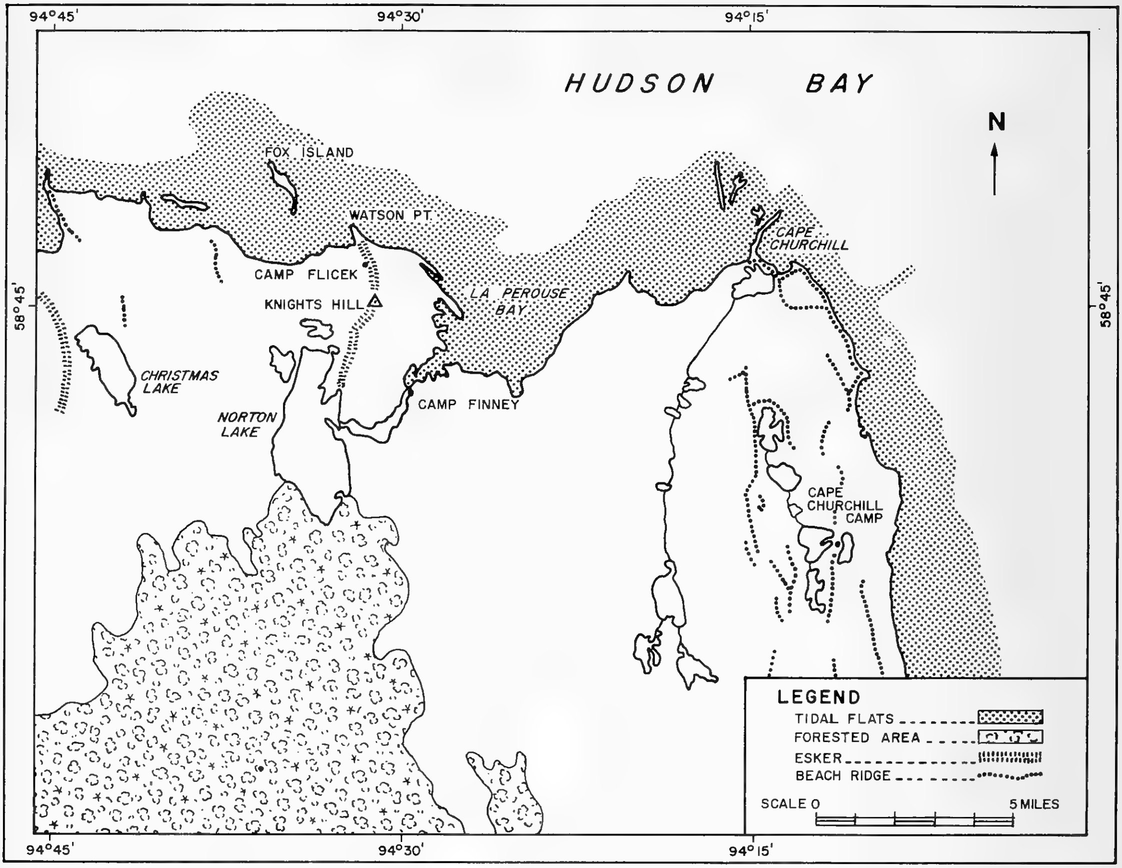


FIGURE 1. Map of study area.

The time span of the observations gives adequate coverage of spring migration and nesting seasons; observations during fall migration are somewhat scanty and winter observations non-existent.

Habitat and Bird Migration

The area around La Pérouse Bay and Cape Churchill is a flat lowland underlain by Ordovician limestone. Surface features, however, are entirely glacial or postglacial in origin. These consist of eskers, raised beaches, boulder fields, and glacial till. The whole area continues to respond to isostatic uplift which has caused the postglacial Tyrrell Sea to shrink, thereby creating the present Hudson Bay. Thus, the entire lowland area was submerged until recently. Most of the land is very moist and contains many shallow tundra pools and a few larger lakes.

The study area can be divided into seven major habitats; these have been described in some detail by Scoggan (1959).

(1) Hudson Bay. The Bay remains ice-covered until late June or early July. After that time the open water attracts Arctic Terns, Parasitic Jaegers, three species of scoters, Red-breasted Mergansers, and Common Goldeneyes.

(2) Boulder-strewn coastal mudflat. These extensive mudflats, visible at low tide, and the seaweed mats which mark the high-tide line are favorite locations for myriads of migrating shorebirds.

(3) River deltas. The shallow rivers which flow into La Pérouse Bay have many low islands at their mouths. These and the nearby mainland provide the major breeding sites for Lesser Snow Geese, Pintails, Oldsquaws, and Common Eiders. Lyme grass (*Elymus arenarius*) is common in this region.

(4) Marshy tundra and pond margins. Sedges, grasses, and low willows, birches, and sweet gale (*Myrica gale*) are the predominant vegetation in this, the most extensive habitat in the area. Nesting Canada Geese and most of the breeding shorebirds are found in this habitat.

(5) Tall willow scrub. At a few places along eskers, old beach ridges, and on the tundra, especially along the west side of La Pérouse Bay, willow growth is much taller, reaching over 3 m (10 ft) in places. Blackpoll and Yellow Warblers are common in these areas.

(6) Tundra pools. These are scattered throughout the area and reflect the poor drainage of the terrain. Arctic Loons, Whistling Swans, Canada Geese, and other waterfowl are the principal nesting species.

(7) Stable ridges above the upper beach. These eskers and raised beach ridges are comparatively dry and poorly vegetated. Arctic avens (*Dryas integrifolia*), Lapland rosebay (*Rhododendron lapponicum*), and various mosses and lichens are the most conspicuous plant species. Birds such as Golden Plover, Semipalmated Plover, and Horned Lark nest in this habitat.

In the flat expanses of this region, bird migration is not difficult to observe. Several physiographic factors combine to concentrate birds in this area during migration.

To some species of birds the north-facing stretch of coast with its peninsulae of Watson Point and Cape Churchill provides the last land fall for birds moving north across Hudson Bay. Tiring migrants may be grounded and concentrate in these coastal areas, in a manner similar to the well-known migration concentrations at Point Pelee, Ontario, and Cape May, New Jersey. This could account for the presence of such rarities as Brown Thrasher, Common Yellowthroat, and Barn Swallow.

For other species the coastline acts as a migration route. The most dramatic example of this is provided by the Lesser Snow Geese, which after the long overland flight to the Hudson Bay coast, continue their migration north and west along the coastline. Many Canada Geese on route to the northern molting grounds, Rough-legged Hawks, and Pintails also use this route. While most migrants move in a northerly and westerly direction in the spring, some birds migrate predominantly eastwards; Sabine's Gulls and Arctic Loons are examples.

Most influxes of birds in the spring coincide with southerly winds. This is particularly true for small birds such as Yellow Rail and Yellow and Blackpoll Warblers.

Birds Seen

Several species of birds occur in the Cape Churchill – La Pérouse Bay region with a frequency and status similar to that described by Jehl and Smith (1970) for the immediate Churchill area. To minimize duplication, detailed information is presented in this paper only for species whose status is different from that recorded by Jehl and Smith. The remaining species seen in the Cape Churchill – La Pérouse Bay region, together with their status and earliest arrival date, are summarized in Table 1.

Most of the differences in bird distribution are attributable to the absence of *Picea* and *Larix* woodland in the Cape Churchill area. Birds such as Robins, Rusty Blackbirds, woodpeckers, Blackpoll Warblers, Dowitchers, Merlins, and Lesser Yellowlegs are uncommon or absent even though the area is within sight of the tree-line.

Other species which are more commonly seen in Churchill than in the Cape area are those whose feeding is influenced by the Churchill River. Red-throated Loons, scoters, and goldeneyes often feed in the mouth of the Churchill River but are seldom seen at the Cape except during migration.

Birds associated with man, such as House Sparrows, Starlings, and swallows are seen more frequently in Churchill, as are nonbreeding gulls and crows associated with the garbage dumps. On the other hand Willow Ptarmigan may be more frequent near the Cape because of the lack of human disturbance.

The Snow Goose colony at La Pérouse Bay provides a focal point for certain species in addition to the geese. Eagles are attracted to the colony and eiders nest more numerously within the confines of the colony.

The following list follows mainly the order and nomenclature of Godfrey (1966). Nomenclatural changes reported in the 32nd supplement to the AOU Checklist (1973) are incorporated.

TABLE 1—Status and earliest arrival date of some birds in the Cape Churchill area

Species	Status	Evidence of nesting	Earliest record
Common Loon (*Gavia immer*)	three records	None	6 June 1970
Arctic Loon (*Gavia arctica*)	common migrant and summer resident	Several nests	28 May 1972
Horned Grebe (*Podiceps auritus*)	one record	None	3 June 1970
American Bittern (*Botaurus lentiginosus*)	uncommon visitor	None	5 June 1968
Whistling Swan (*Olor columbianus*)	fairly common migrant and summer resident	Several nests	22 May 1972
Brant (*Branta bernicla*)	rare migrant	None	28 May 1970
White-fronted Goose (*Anser albifrons*)	three records	None	1 June 1969
Black Duck (*Anas rubripes*)	common migrant and non-breeding resident	None	20 May 1972
Gadwall (*Anas strepera*)	two records	None	8 June 1968
Pintail (*Anas acuta*)	common migrant and summer resident	Several nests	20 May 1972
Green-winged Teal (*Anas crecca*)	common migrant and summer resident	Several nests	23 May 1972
Blue-winged Teal (*Anas discors*)	two records	None	1 June 1969
Greater Scaup (*Aythya marila*)	common migrant and summer resident	Several nests	29 May 1972
Oldsquaw (*Clangula hyemalis*)	common migrant and summer resident	Several nests	24 May 1972
King Eider (*Somateria spectabilis*)	rare migrant	None	15 June 1972
Red-breasted Merganser (*Mergus serrator*)	common migrant and summer resident	None	24 May 1972
Marsh Hawk (*Circus cyaneus*)	common summer resident	None	23 May 1972
Peregrine Falcon (*Falco peregrinus*)	uncommon migrant	None	22 May 1972
Willow Ptarmigan (*Lagopus lagopus*)	common resident	Several nests	
Rock Ptarmigan (*Lagopus mutus*)	winter resident	None	
Sandhill Crane (*Grus canadensis*)	uncommon visitor	None	9 June 1972
Sora (*Porzana carolina*)	two records	None	20 June 1968
Semipalmated Plover (*Charadrius semipalmatus*)	common migrant and summer resident	Several nests	24 May 1972
American Golden Plover (*Pluvialis dominica*)	common migrant, uncommon summer resident	Three nests	22 May 1972
Black-bellied Plover (*Pluvialis squatarola*)	common migrant, rare summer resident	None	24 May 1972
Ruddy Turnstone (*Arenaria interpres*)	common migrant, uncommon summer resident	None	25 May 1972
Common Snipe (*Capella gallinago*)	common summer resident	Two nests	1 June 1969
Greater Yellowlegs (*Tringa melanoleuca*)	common late summer visitor	None	3 July 1968
Pectoral Sandpiper (*Calidris melanotos*)	rare summer visitor, common fall migrant	None	3 June 1970
White-rumped Sandpiper (*Calidris pusilla*)	abundant migrant	None	24 May 1972
Baird's Sandpiper (*Calidris bairdii*)	fairly common migrant	None	25 May 1972
Dunlin (*Calidris alpina*)	common migrant and summer resident	Several nests	22 May 1972
Stilt Sandpiper (*Micropalama himantopus*)	common migrant and summer resident	Few nests	22 May 1972

TABLE 1—*continued*

Species	Status	Evidence of nesting	Earliest record
Semipalmated Sandpiper (*Calidris pusilla*)	abundant migrant and common summer resident	Few nests	24 May 1972
Sanderling (*Calidris alba*)	fairly common migrant	None	22 May 1972
Red Phalarope (*Phalaropus fulicarius*)	irregular spring migrant	None	9 June 1969
Northern Phalarope (*Lobipes lobatus*)	abundant migrant and common summer resident	Several nests	24 May 1972
Pomarine Jaeger (*Stercorarius pomarinus*)	rare spring migrant	None	2 June 1969
Long-tailed Jaeger (*Stercorarius longicaudus*)	uncommon spring migrant/irregular	None	2 June 1969
Herring Gull (*Larus argentatus*)	common summer resident	Several nests	16 May 1970
Sabine's Gull (*Xema sabini*)	irregular and uncommon migrant	None	7 June 1968
Arctic Tern (*Sterna paradisaea*)	common migrant and breeding resident	Many nests	3 June 1969
Short-eared Owl (*Asio flammeus*)	irregularly common summer resident	None	26 May 1972
Common Nighthawk (*Chordeiles minor*)	one record	None	15 June 1968
Horned Lark (*Eremophila alpestris*)	common migrant and summer resident	Several nests	16 May 1969
Northern Shrike (*Lanius excubitor*)	three records	None	3 June 1970
Yellow Warbler (*Dendroica petechia*)	uncommon summer resident	A pair feeding young	8 June 1970
Common Yellowthroat (*Geothlypis trichas*)	one record	None	15 June 1968
Yellow-headed Blackbird (*Xanthocephalus xanthocephalus*)	one record	None	31 May 1973
Red-winged Blackbird (*Agelaius phoeniceus*)	two records	None	26 June 1972
Savannah Sparrow (*Passerculus sandwichensis*)	abundant migrant and summer resident	Many nests	22 May 1972
Tree Sparrow (*Spizella arborea*)	common summer resident	Several nests	19 May 1972
Lapland Longspur (*Calcarius lapponicus*)	abundant migrant and summer resident	Few nests	20 May 1972
Snow Bunting (*Plectrophenax nivalis*)	abundant migrant, irregular summer resident	None	19 May 1972

RED-THROATED LOON. *Gavia stellata.* Seen less frequently here than at Churchill. Flying birds were sighted each year near the Cape but were recorded only once in the vicinity of La Pérouse Bay. No evidence of nesting. Earliest record, 2 June 1969.

CANADA GOOSE. *Branta canadensis.* A very common migrant and resident. The first resident birds arrive in late April and early May, but the peak spring migration occurs in late May and early June. The nesting population belongs to the race *B. c. interior.* In late May and early June, flocks of a smaller race can be seen migrating northward. The times of migration of these smaller birds is 1–2 days earlier than the arrival of small Canada Geese to their breeding grounds in the McConnell River, N.W.T. area 150 miles to the north (C.D. MacInnes, personal communication), and MacInnes feels that these birds should be ascribed to the subspecies *parvipes.* Nesting occurs throughout the area especially in the marshy tundra and on islands in the river systems. Maximum nesting densities in the Cape Churchill region varied from 17 nests per square mile in 1969 to 27 nests per square mile in 1970. Large molt migrations, where flocks can be seen flying north and northwest, occur in late June and early July. Fourteen thousand migrating birds were counted in 1969, and 6000 in 1970. Earliest record, 22 April 1968.

SNOW GOOSE. *Anser caerulescens.* Abundant migrant and locally abundant breeder. The main movement to the northern colonies at McConnell River and Southampton Island passes along the west coast of Hudson Bay in late May and early June (R. Vaught and R. Barrett estimated that 40 000 passed over Cape Churchill on 10 June 1969).

The main breeding colony concentrates around the deltas of the Mast River and Wawao Creek which flow into La Pérouse Bay, but scattered groups of birds also nest inland on river islands and on a larger lake near Cape Churchill.

Some parameters of the La Pérouse Bay colony are presented below.

Date	Breeding pairs	Percentage blue phase	First hatch date
1968	1200 ± 200	28	26 June
1969	1960 ± 100	23	30 June
1970	2500 ± 300	26	29 June
1971	1500 ± 50	25	15 June
1972	2500 ± 500	26	17 June
1973	3000 ± 200	27	18 June
1974	3000 ± 200	28	21 June

It appears that the colony is of recent origin. The first reported nesting was by Wellein and Newcomb (1953), and geese apparently occupied the area intermittently until 1963 (Lumsden, personal communication). Since then, the colony has been used each year. Earliest arrival, 14 May 1972.

ROSS' GOOSE. *Anser rossii.* Although the Snow Goose colony has been studied intensively since 1968, no nesting Ross' Geese were found in the area until 1972. This is the first nesting record of the Ross' Goose in Manitoba, and is the southernmost breeding record to date. Nesting records are as follows. One nest attended by a pair of Ross' Geese and containing four eggs was found on 7 June; all four eggs hatched on 29 June. Two other nests, each with four eggs, were located 7 and 14 June, respectively. These nests were attended by a male Ross' Goose and a female white-phase Snow Goose. Two non-breeding Ross' Geese were seen also, as were two probable Ross' – Lesser Snow Goose hybrids (Trauger et al. 1971). Further details of these sightings are reported by Ryder and Cooke (1973). Earliest record, 6 June 1972.

MALLARD. *Anas platyrhynchos.* The area, particularly the tundra pools and brackish ponds, seems to serve as summering habitat for a few non-breeding birds, most of them males. A female with partly grown young was observed near La Pérouse Bay on 27 July 1973, the first evidence of breeding in the Churchill area. Earliest record, 24 May 1972.

AMERICAN WIGEON. *Anas americana.* Although pairs and non-breeding flocks commonly are seen throughout the summer, no direct evidence of breeding has been noted. The largest flock, numbering about 100, was near Cape Churchill on 27 June 1970. Males predominated in the non-breeding flocks. This species is much less common in July and August than in June. Small flocks (mostly males) can be seen migrating east and south along the coast in late June. Earliest record, 24 May 1972.

NORTHERN SHOVELER. *Anas clypeata.* A few pairs have been seen in the area each summer, but no nesting was observed until 1972 when two nests with eggs were found by D. Bartlett in the vicinity of Knight's Hill but neither was successful in raising any young. Successful nests were found near Camp Finney in 1973. Unlike most of the dabbling ducks mentioned above, no male-dominated flocks of non-breeders were noted. Earliest record, 3 June 1972.

COMMON GOLDENEYE. *Bucephala clangula.* An irregular migrant and non-breeding resident. This species is usually observed flying east and south along the coast, but is rarely seen inland or before the ice leaves the Bay in late June or early July. Flocks of up to 70 birds (mostly drakes) were occasionally observed. Earliest record, 2 June 1970.

COMMON EIDER. *Somateria mollissima.* Common migrant and breeding resident. Several colonies were located in the area, most of them on islands in rivers or coastal lagoons. These colonies existed within the Snow Goose colony and contained an estimated 250 and 200 nests in 1971 and 1972, respectively. In July 1932, Twomey (*in* Taverner and Sutton 1934) saw between 1000 and 5000 Common Eiders on Fox Island, but found no evidence of breeding. We, too, found no evidence of breeding there.

There is considerable plumage variation in the eider population. Female plumage varies in color from pale gray to warm brown. Measurements of trapped birds suggest that only *S. m. sedentaria* occurs in the region. Earliest record, 20 May 1972.

WHITE-WINGED SCOTER. *Melanitta deglandi.* Except for one flock of seven observed flying near Norton Lake on 27 June 1968, all other White-winged Scoters have been seen flying and on the water offshore in late June or early July. These flocks were predominantly male and were usually flying east and south. We saw birds each year but obtained no evidence of breeding. Earliest record, 25 June 1970.

SURF SCOTER. *Melanitta perspicillata.* The rarest of the three scoters. Small groups were seen offshore from late June onwards with status similar to that of the preceding species. Earliest record, 25 June 1968.

BLACK SCOTER. *Melanitta nigra.* Status similar to that of Surf Scoter, but slightly more numerous. Earliest record, 25 June 1970.

HOODED MERGANSER. *Lophodytes cucullatus.* One record. An immature bird was flushed from a pond near Watson Point by K. Ross, A. Baldridge, and F. Cooke on 6 August 1970.

RED-TAILED HAWK. *Buteo jamaicensis.* One record. An immature bird was observed 7 miles south of Cape Churchill on 2 July 1969.

ROUGH-LEGGED HAWK. *Buteo lagopus.* Uncommon migrant and rare summer resident. Most records of this species are from late May and early June. High-flying migrant birds were seen moving west on 20 May 1972. On 19 June 1970, Pakulak discovered an active nest with six eggs located on a rock in the middle of a tundra pool. This nest, constructed largely of sticks and twigs, was approximately 1 m (3 ft) high and apparently had been occupied for several years. Earliest record, 20 May 1972.

GOLDEN EAGLE. *Aquila chrysaetos.* One record. Two were seen by G. Finney over the Snow Goose colony on 26 June 1970.

BALD EAGLE. *Haliaeetus leucocephalus.* Five records, all from the Snow Goose colony except for one adult seen near Pakulak's camp by R. Vaught on 8 June 1969. The La Pérouse Bay records are as follows: 17 June 1968, immature; 10 July 1969, adult; 17 June 1969, adult; 9 June 1972, immature. Bald Eagles caused a great commotion in the Snow Goose colony and are believed to prey on the geese.

GYRFALCON. *Falco rusticolus.* One record. A bird of an intermediate phase flew northwest at La Pérouse Bay on 4 July 1969 and was observed by M. H. Edwards, K. F. Edwards, E. L. Mills, and F. Cooke. No summer records are reported by Jehl and Smith (1970).

MERLIN. *Falco columbarius.* Much less common on the tundra than in forest habitat near Churchill. Only two records, both from Cape Churchill: one on 1 June 1969 and the other 19 June 1969.

YELLOW RAIL. *Coturnicops noveboracensis.* Common summer resident. Arrival dates at La Pérouse Bay were 27 June 1968, 6 July 1969, 24 June 1970, and 30 June 1972. Although rarely seen, the species was often heard calling from moist sedge meadows. Calling is sporadic during the day but becomes more frequent in the evening. Birds often called all night. No definite evidence of nesting was found, but it seems probable that they do nest in the area. This bird is particularly common near Camp Finney.

KILLDEER. *Charadrius vociferus.* Irregular migrant and summer visitor. This species nests in the immediate Churchill area, but not in the area described in this paper. Birds were sighted in the Watson Point and Knight's Hill area but not in the Cape Churchill area. Earliest record, 20 May 1972.

WHIMBREL. *Numenius phaeopus.* Common breeder throughout the tundra areas. Pakulak recorded 17 Whimbrels all apparently territorial, in the Cape Churchill area in 1968. A nest was found in June 1972 by D. Bartlett. Flocks began forming in late summer. By August, groups of up to 10 were commonly observed. Earliest record, 24 May 1972.

LESSER YELLOWLEGS. *Tringa flavipes.* Common late summer visitor and rare spring migrant. We have two spring records: two birds were observed at La Pérouse Bay on 24 May 1972 and one was sighted near Cape Churchill on 9 June 1968.

RED KNOT. *Calidris canutus.* Locally common spring and fall migrant. Knots are more common than indicated by Jehl and Smith (1970). A flock of 110 was seen on 13 June 1969. The peak of spring migration occurs in mid-June. The two largest flocks observed during the fall concentration period obtained 50 to 60 birds, both flocks at Watson Point on 2 August 1970. Earliest record, 3 June 1972.

LEAST SANDPIPER. *Calidris minutilla.* Common migrant and fairly common breeder. Not seen in large numbers in the spring when it is perhaps the least common of the "peeps." Nests were found in 1968, 1969, and 1972 on Watson Point esker and in tall willow areas west of La Pérouse Bay. Flocking occurred in late July and August. Maximum count was 20 on 3 August 1970. Earliest record, 25 May 1972.

WESTERN SANDPIPER. *Calidris mauri.* Two records. A bird in full breeding plumage was carefully observed by F. Cooke at the shoreline of La Pérouse Bay on 27 May 1972. Another bird was sighted by R. Schmidt near Cape Churchill with a flock of Semipalmated Sandpipers on 27 June 1970. No specimen was collected.

SHORT-BILLED DOWITCHER. *Limnodromus griseus.* Irregular visitor, considerably less common than at Churchill. Small flocks and single birds were sighted occasionally; the largest group recorded (13 birds) was on the mudflats near Watson Point on 14 June 1968. Five to ten were seen daily near Watson Point between 5 and 8 August 1970. None was seen in the Cape Churchill area. Earliest record, 24 May 1972.

BUFF-BREASTED SANDPIPER. *Tryngites subruficollis.* Rare spring and fall migrant on the short-grass covered mudflats at La Pérouse Bay. This species was recorded there on two occasions in late July and early August in both 1969 and 1970. A maximum of four birds was seen. H. Burgess also observed six in flight north of Cape Churchill on 6 August 1969. One seen at La Pérouse Bay on 14

June 1973 by F. Cooke represents the only spring record. Earliest record, 14 June 1973.

HUDSONIAN GODWIT. *Limosa haemastica.* Common migrant and summer resident, perhaps more common in the tundra area than Jehl and Smith (1970) indicate. Spring migration peaks in early or mid-June when up to 50 birds may be seen. The large tundra pools west of La Pérouse Bay are favorite concentration areas. Many territorial birds were observed during June but, surprisingly, no nests were found. The number of godwit sightings increased starting in early July; as many as 100 individuals per day were recorded regularly in the fall. Earliest record, 20 May 1972.

PARASITIC JAEGER. *Stercorarius parasiticus.* Fairly common migrant and summer resident. Arrival dates for this species were 1 June 1968, 1 June 1969, 4 June 1970, and 28 May 1972. Single migrating birds were seen flying high and direct as late as 21 June 1972. This species is a major egg predator of Snow Geese at La Pérouse Bay where several jaeger nests were found in the vicinity of the colony. Maximum daily count was 30 on 25 June 1970. All resident birds were of light or intermediate color phase. Only five dark phase birds were seen during the study period.

GLAUCOUS GULL. *Larus hyperboreus.* Rare summer visitor. Sighted occasionally in the vicinity of Camp Flicek and La Pérouse Bay. Single immature birds were noted each year except 1968. Earliest record, 28 May 1972.

THAYER'S GULL. *Larus thayeri.* Irregular spring migrant. This species, unlike the Herring Gull, was attracted to the research cabins. In 1972, waves of Thayer's Gulls passed through the area. On 14 June 1972, 80 were seen around the cabin at La Pérouse Bay, but on the next day there was none. Prior to 1972, seven sightings had been made.

BONAPARTE'S GULL. *Larus philadelphia.* Uncommon summer visitor. Non-breeding birds were seen singly or in small groups in the La Pérouse Bay area each year. None has been reported from the Cape Churchill area, which is farther from the tree-line. Maximum number, 40 at La Pérouse Bay on 8 June 1972. Earliest record, 24 May 1972.

BLACK GUILLEMOT. *Cepphus grylle.* One record. An adult was seen off Watson Point on 8 July 1969.

MOURNING DOVE. *Zenaidura macroura.* One record. One was seen by D. Bartlett at Camp Flicek on 12 July 1972

SNOWY OWL. *Nyctea scandiaca.* Uncommon spring migrant and summer visitor. Snowy Owls were seen occasionally each year but only one was observed in 1970. This species preys on nesting female Snow Geese and migrant birds were most frequently seen in the vicinity of the Snow Goose colony. We found no evidence of nesting. Earliest record, 19 May 1972.

HAWK OWL. *Surnia ulula.* Three records, probably involving only two birds. One was seen south of Cape Churchill on 6 and 10 June 1969 and another near La Pérouse Bay on 3 June 1970.

GREAT GRAY OWL. *Strix nebulosa.* One was sighted flying high over La Pérouse Bay on 4 June 1972. The same bird, presumably, was seen twice the next day perched on some high willows.

BOREAL OWL. *Aegolius funereus.* One record. A group of three, probably a family party, was observed hunting on the tundra in late evening in mid-July 1970 near Knight's Hill (G. Finney). The birds flew in from the south, were apparently attracted to the observer who saw them at ranges of as close as 3 m (10 ft). The tree-line is around 4 miles south of Knight's Hill. This species is not recorded by Jehl and Smith (1970); the nearest sighting location for Boreal Owls is York Factory, Manitoba (Godfrey 1966).

TREE SWALLOW. *Iridoprocne bicolor.* Rare visitor. This species was seen only in the vicinity of buildings. There are two records for 1968 and six for 1970. Sighting dates range from 20 June 1968 to 7 July 1970.

BARN SWALLOW. *Hirundo rustica.* Two records, both at Camp Finney, a single bird on 21 June 1972, and a pair on 25 June 1972.

GRAY JAY. *Perisoreus canadensis.* One record. An immature bird was observed near Knight's Hill on 1 July 1969.

COMMON RAVEN. *Corvus corax.* Regular visitor, recorded almost daily at La Pérouse Bay particularly in the vicinity of the Snow Goose colony. Ravens were less common at Cape Churchill. From our observations it seemed that ravens made regular forays between tundra and forest habitats. Birds were rarely seen on the ground and no instances of egg predation were recorded. The maximum number recorded at any one time was four.

COMMON CROW. *Corvus brachyrhynchos.* One record of a bird at Watson Point on 15 June 1969.

MOCKINGBIRD. *Mimus polyglottos.* One was seen at La Pérouse Bay on 24 June 1973.

BROWN THRASHER. *Toxostoma rufum.* Three records. Single birds were present at Watson Point from 8 to 23 June 1968 and on 29 June 1969. One was sighted in the vicinity of Camp Finney on 29 and 30 June 1972.

AMERICAN ROBIN. *Turdus migratorius.* Rare visitor. Despite its abundance near Churchill, we have only four records of this species. Two were observed near Pakulak's camp on 5 June 1969; one was seen near the Snow Goose colony on 1 August 1969, and single birds on 8 and 25 June 1972.

SWAINSON'S THRUSH. *Catharus ustulatus.* One record. Schmidt observed one feeding with a small flock of Lapland Longspurs near Pakulak's camp on 3 June 1970.

GRAY-CHEEKED THRUSH. *Catharus minimus.* One record. G. Sherwood sighted a single bird near Pakulak's cabin on 5 June 1969.

WATER PIPIT. *Anthus spinoletta.* Common migrant. It was recorded intermittently from late May until mid-June and in August and September. Since there appear to be suitable locations for nests, the absence of summer records is somewhat surprising. Earliest record, 21 May 1972.

BLACKPOLL WARBLER. *Dendroica striata.* Uncommon summer resident in the willows near La Pérouse Bay. The arrival dates there were 20 June 1968, 7 July 1969, and 24 June 1970; G. Sherwood observed a pair near Cape Churchill on 5 June 1969. Birds were seen or heard occasionally in late June and early July but there was no evidence of nesting.

RUSTY BLACKBIRD. *Euphagus carolinus.* Rare visitor, and late summer migrant; seen singly or in pairs three times in 1968, once in 1969, six times in 1970, and once in 1972. Earliest date, 28 May 1970. A large migration with small flocks passing east throughout the day was observed on 28 July 1973.

HOARY REDPOLL. *Acanthis hornemanni.* Breeding summer resident of widely varying abundance. In 1968 it was common, comprising at least 50% of all redpolls seen. In 1969, 30–40% of the redpolls were Hoary, but in 1970 and 1972 this frequency was less than 10%. In 1973 redpolls were frequent and the proportion of this species was again high. An adult was seen feeding young on 31 July 1970. Numbers increase in early August. Earliest record, 7 June 1968.

COMMON REDPOLL. *Acanthis flammea.* Common summer breeder. It was noted almost daily, especially around heavy willow scrub. No evidence of habitat difference between this and the previous species was noted. A nest with four eggs was found on 16 June 1968. Earliest record, 20 May 1972.

HARRIS' SPARROW. *Zonotrichia querula.* Three records. One was seen 5 miles south of Cape Churchill on 19 June 1968 and singles were observed near Camp Flicek on 15 June 1968 and 2 July 1969.

WHITE-CROWNED SPARROW. *Zonotrichia leucophrys.* Uncommon summer resident in the willows near La Pérouse Bay, but individuals were occasionally seen elsewhere. Although territorial behavior was noted, no nests were found. Earliest record, 24 May 1972.

SMITH'S LONGSPUR. *Calcarius pictus.* Uncommon local summer resident on the drier tundra in the Knight's Hill area, but unknown in the Cape Churchill area. One or two pairs were seen each year and presumably bred, since birds were seen carrying food in early July 1972. We sighted 12 south of Knight's Hill near the tree-line on 27 June 1970.

Acknowledgments

The work on geese was supported by the Canadian Wildlife Service; the Manitoba Department of Mines, Resources and Environmental Management; Delta Waterfowl Research Station; and the National Research Council of Canada. We are grateful for the logistic support given to us by the Churchill Rocket Research Range at Fort Churchill, Manitoba.

Thanks are due also to the following for their assistance in identifying some of the species listed above: Alan Baldridge, Ted Bargiello, Des Bartlett, Harold Burgess, Robert Barrett, Jim Bayly, Ken Edwards, Martin Edwards, George Finney, Ben Guild, Charles Jonkel, Larry Lawson, Carroll Littlefield, Eric Mills, Paul Mirsky, Ian Newton, Ron Pittaway, Robert Rockwell, John Ryder, Glenn Sherwood, and Richard Vaught.

Literature Cited

American Ornithologist's Union. 1973, 32nd supplement to the checklist of North American Birds. Auk 90: 411–419.

Foster, J. B. 1957. Snow and Blue Geese nesting in the southern Arctic. Ontario Field Biologist 11: 22.

Godfrey, W. E. 1966. The birds of Canada. National Museum of Canada Bulletin 203. 428 pp.

Jehl, J. R., Jr. and **B. A. Smith.** 1970. Birds of the Churchill Region, Manitoba. Manitoba Museum of Man and Nature, Winnipeg, Special Publication 1. 87 pp.

Ryder, J. P. and **F. Cooke.** 1973. Ross' Geese nesting in Manitoba. Auk 90: 692–693.

Scoggan, H. J. 1959. The native flora of Churchill, Manitoba, with notes on the history, geology and climate of the area. National Museum of Canada Guide Book. 51 pp.

Taverner, P. A. and **G. M. Sutton.** 1934. The birds of Churchill, Manitoba. Annals of the Carnegie Museum 23: 1–83.

Trauger, D. L., A. Dzubin, and **J. P. Ryder.** 1971. White Geese intermediate between Ross' Geese and Lesser Snow Geese. Auk 88: 856–875.

Wellein, E. G. and **H. G. Lumsden.** 1964. Northern forests and tundra. *In* Waterfowl tomorrow.

Edited by J. P. Linduska. United States Department of Interior, Washington. pp. 67–76.

Wellein, E. G. and **W. Newcomb.** 1953. Aerial waterfowl breeding ground explorations in sections of the far North. *In* Waterfowl populations and breeding conditions, summer 1953. Canadian Wildlife Service, Special Scientific Report, Wildlife Number 25. pp. 16–19.

Received 15 October 1974
Accepted 25 April 1975

Observations on the Fish Fauna of the Peace River in Alberta

FRANK G. BISHOP

Fish and Wildlife Division, Alberta Department of Lands and Forests, Peace River, Alberta

Bishop, F. G. 1975. Observations on the fish fauna of the Peace River in Alberta. Canadian Field-Naturalist 89(4):423–430.

Abstract. The distribution and relative abundance are shown for 22 species of fishes collected in the Alberta portion of the Peace River. Limited growth data and general observations are given for 10 of the larger-growing species: Dolly Varden, Arctic grayling, goldeye, northern pike, flathead chub, squawfish, longnose sucker, white sucker, burbot, and walleye. Concentrations of chlorinated insecticides and mercury in some of the more important species of fish in the river were found to be quite low.

Besides being the largest tributary of the Mackenzie River system, the Peace River is the second largest river in Alberta. It drains an area of 118 000 square miles and has a length of 820 miles, 636 miles of which are in Alberta (Figure 1).

The Peace River is formed in the interior of British Columbia at the junction of the Finlay and Parsnip Rivers. From its source west of the Rocky Mountains, the river flows eastwards towards Alberta where it gradually turns northwards as it flows through the northern extension of the Great Plains region. In some places, the river valley in this plains country has been incised as deep as 900 feet. Near Fort Vermilion, the river again turns eastward and becomes broader and shallower before connecting with outlet streams from Lake Athabasca, at this point becoming known as the Slave River. The total descent from its sources to its mouth is 1300 feet. The mean discharge of the river as it enters Alberta is 51 900 cubic feet per second and the mean outflow is 131 000 cubic feet per second (Neill et al. 1970).

Since the late 1960s there has been considerable attention placed on the effects of the W. A. C. Bennett Dam on the Peace River, especially on the delta near Lake Athabasca. Before the Bennett Dam in British Columbia was completed in 1968, the mean monthly flow recorded at the town of Peace River was 73 000 cubic feet per second (1958–1967). From 1967 to 1972 (the period when the reservoir behind the dam was filling) the river's mean monthly flow at the town was reduced to approximately 43 000 cubic feet per second. In July 1972 Williston Reservoir behind the Bennett Dam reached its full supply level; it is thought that the mean monthly flows will again approach the preimpoundment flows although the flow regime will probably be altered towards a more constant flow throughout the year instead of peak flows in June and low water in winter.

Prior to 1958 there was little information on the fishes of the Peace River. In 1952 some seine hauls were made in the river at the town of Peace River and 10 species of fish were collected (Miller and Paetz 1953); in 1956 Miller and Paetz recorded some additional species in the river and its tributaries in an unpublished report.

In 1968 I seined 15 sites downstream of the town of Peace River to obtain some idea of the distribution and abundance of various minnow species in the river (Bishop 1969). These distributions were included in *The Fishes of Alberta* (Paetz and Nelson 1970). Additional fish collections were made in 1969, 1970, and 1971 using seine nets, gill nets, and rotenone. In 1970 fish were also collected and analyzed for concentrations of chlorinated insecticides (DDT and derivatives) and mercury. This report is a compilation of the results found from 1968 to 1971 and is intended to provide some baseline information on the

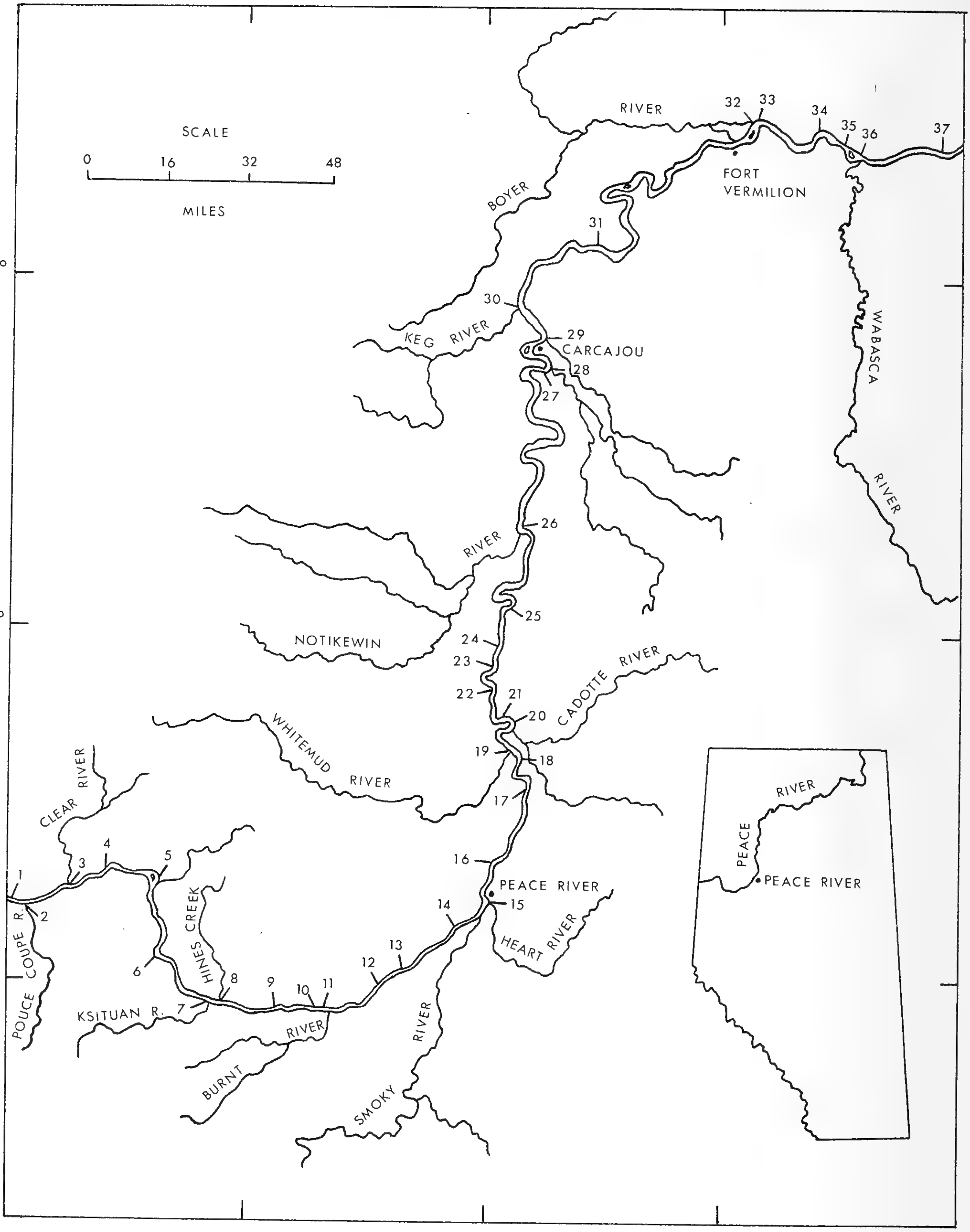


FIGURE 1. Sampling areas on the Alberta portion of the Peace River.

biology of the fishes of the Alberta portion of the Peace River.

Methods

Fishes were collected at 37 sites on the Peace River from the British Columbia – Alberta border to the Vermilion Chutes, a distance of about 724 km (Figure 1). Fish collected in tributaries within 800 m of their confluence with the Peace River were considered indigenous to the Peace River.

Most of the 3600 fish collected from 1968 to 1971 were captured with seines having a length of 7.6 m and a mesh size of 3 mm. Usually two seine hauls were made at each location. Seining locations were usually chosen more for ease of sampling than for any other criterion. Nylon gill nets of various mesh sizes and lengths were used in 1969 and 1971; the sizes most commonly used were 45.7-m lengths of 6.1-cm and 10.0-cm nets (210/3 twine) with a 2.4-m depth. Rotenone was used to collect fishes from 91-m sections of two small tributaries (Map locations 21 and 24, Figure 1.) The concentration of rotenone in both cases was calculated to be 1.5 ppm.

Most of the fish collections were made soon after ice break-up, in the month of May, just prior to the peak river flows which normally occurred about mid-June. Seine hauls were usually carried out over shallow gravel bars or on the upstream side of an island. Most of the gill nets were set in the mouth of tributary streams. Gill nets tended to collect much debris and were quite ineffective after two or three days of use.

Results

Of the 45 known native Albertan species of fish, I found 20 in the Peace River. Two other species not found in the present survey but recorded in the river by Paetz and Nelson (1970) are the mountain whitefish, *Prosopium williamsoni* (Girard), and the largescale sucker, *Catostomus macrocheilus* (Girard).

The relative abundance of the fishes caught in the Peace River are described as follows: abundant, more than 100 specimens; common, 20–100 specimens; rare, less than 20 specimens.

SALMONIDAE

Dolly Varden, *Salvelinus malma* (Walbaum). Map locations 15, 21. Occurrence: rare.

Only one Dolly Varden was caught during the present study, which extended its range down the Peace River by approximately 130 miles (Bishop 1973). I have since seen two others caught by anglers in the town of Peace River. The single specimen caught during the study was an immature male with a fork length of 518 mm and weighing 1075 g. The age, as calculated from the scales, was 3 years. Until these specimens were caught, there was no official record of the Dolly Varden in the Peace River in Alberta but both Paetz and Nelson (1970) and McPhail and Lindsey (1970) mention that Dolly Varden are found in the headwaters of the Peace River.

Arctic grayling, *Thymallus arcticus* (Pallas). Map locations 20, 21. Occurrence: rare.

This species is probably not common in the river except in early spring at spawning time, when it is found near the mouths of smaller streams. It is also possible that some grayling descend smaller tributaries into the Peace River to spend the winter there. The single specimen was a mature male, with a fork length of 262 mm and a weight of 200 g. Its age was 3 years.

Lake whitefish, *Coregonus clupeaformis* (Mitchill). Map location 17. Occurrence: rare.

Only a single specimen was collected of this species and it is unlikely that lake whitefish are common in the river. The only nearby source of lake whitefish is Haig Lake (56°54′ N, 116°5′ W) which is drained by Cadotte River, which in turn empties into the Peace River 19 miles below where this fish was caught.

HIODONTIDAE

Goldeye, *Hiodon alosides* (Rafinesque). Map locations 3, 7, 16, 17, 20, 30, 34–36. Occurrence: abundant.

Goldeye were abundant in the lower stretches of the Peace River. One 50-yard, 2½-inch net caught 112 goldeye at the mouth of the Wabasca River (Sample Site 36) and literally hundreds of goldeye were observed rising to the surface of the Peace River towards dusk in the same vicinity. Lengths, weights, sex, and age were determined from 131 specimens from various points in the river (Table 1). Growth rates of male and female goldeye were quite similar up to age 6 but thereafter, females grew faster than males and there was some indication that they lived longer than males. The growth rates in this section of the river compare to growth rates in Lake Claire which is located close to the termination of the Peace River (Kennedy and Sprules 1967). The Peace River goldeye grow faster than goldeye from Sandy Lake, Ontario (Kennedy and Sprules 1967) and Great Slave Lake (Rawson 1951), but slower than goldeye

TABLE 1 — Average fork length and weight of 131 goldeye from the Peace River, 1968–1970.

Age (years)	Females (n = 68) Percent	Length (mm)	Weight (g)	Males (n = 63) Percent	Length (mm)	Weight (g)
1	3	87	7	3	96	9
2	3	181	56	3	174	32
3	—	—	—	6	207	100
4	10	244	187	14	241	154
5	9	271	223	10	279	238
6	7	311	382	11	303	343
7	13	335	431	19	315	371
8	17	354	498	8	334	476
9	15	364	576	13	354	517
10	10	395	696	11	303	509
11	9	403	758	2	381	630
12	2	427	725	—	—	—
13	2	441	930	—	—	—

from the Saskatchewan River delta and Lake Winnipegosis (Kennedy and Sprules 1967), Oldman and South Saskatchewan Rivers (D. Radford, personal communication), Montana (Hill 1966) and Minnesota (Grosslein and Smith 1959). The largest goldeye caught during the study was an age 13 female which had fork length of 441 mm (17.4 inches) and weighed 930 g (2.0 pounds).

Stomach samples from 47 goldeye were examined for food contents (Table 2). Corixids and insect larvae were the most common items being taken. Goldeye appear to be opportunistic feeders, and in this respect their feeding habits are similar to that of the Arctic grayling (Bishop 1967). The five shrews noted in the sample were found in five different goldeye caught in the Wabasca River location. It is doubtful, however, that shrews form an important part of a goldeye's regular diet.

Male and female goldeye could be easily distinguished by using the anal fin as a sex character. The sex ratio of the 131 goldeye in the sample was close to the expected 1:1 ratio (68F:63M). Male fish matured at age 4, about 1 year earlier than the females. Many goldeye caught in May were classified as non-spawners because of their lack of gonad development in comparison to their size. This was especially noticeable in the females. It is possible that not all the adult goldeye in the Peace River spawn every year.

Only a few of the goldeye caught in early May were in a sexually ripe condition. One female weighing 720 g (length 415 mm) contained an estimated 12 240 eggs. Egg diameter was approximately 2 mm (measurement made after ovaries were preserved in 10% formalin).

The fact that 1-year-old goldeye were caught in various locations in the river probably indicates that some spawning occurs in or near the river.

TABLE 2 — Stomach contents of 47 goldeye from the Peace River

Organism	Volume of stomach samples (ml)	Percent volume of stomach contents
Plecoptera larvae	8.4	11.1
Ephemeroptera larvae	2.3	3.1
Trichoptera larvae	1.4	1.9
Diptera larvae	1.6	2.1
Odonata larvae	0.8	1.1
Coleoptera	1.8	2.4
Corixidae	21.1	27.9
Fish	8.2	10.9
Shrews	26.0	34.5
Miscellaneous	3.8	5.0
Total	75.4	

ESOCIDAE

Northern pike, *Esox lucius* Linnaeus. Map locations 3, 7, 16, 17, 20, 24, 28, 32–34, 36. Occurrence: common.

Pike were caught at various locations throughout the length of the river but never in any large quantity. Growth data of 19 pike caught in the river is shown in Table 3.

Growth rates of pike in the river are considerably slower than those I have found in Sturgeon or Lesser Slave Lakes in Alberta. For example, an average age 6 female pike from Sturgeon Lake would be 190 mm longer and weigh 2260 g more than a similarly-aged pike from the Peace River. The largest pike caught in the survey was a 12-year-old male with a fork length of 855 mm and a weight of 4870 g. Female pike from the river grew faster than male pike of the same age. All pike were sexually mature by age 4.

TABLE 3 — Average fork length and weight of 19 northern pike from the Peace River, 1969–1971

Age (years)	Males (n = 12) Percent	Length (mm)	Weight (g)	Females (n = 7) Percent	Length (mm)	Weight (g)
3	—	—	—	15	391	400
4	17	392	370	29	440	535
5	58	459	754	14	485	890
6	17	549	1160	14	548	1220
7	—	—	—	—	—	—
8	—	—	—	14	628	1700
9	—	—	—	—	—	—
10	—	—	—	14	796	2724
11	—	—	—	—	—	—
12	8	855	4870	—	—	—

CYPRINIDAE

Flathead chub, *Hybopsis gracilis* (Richardson). Map locations 1, 3–17, 19, 20, 22, 23, 31–37. Occurrence: abundant.

The flathead chub was the most abundant of all the fish species sampled during the study. Specimens of all ages from young-of-the-year to age 10 were caught (Table 4).

Most of the chub were young-of-the-year and these were usually present in large numbers in the seine hauls. Peace River flathead chub appear to become sexually mature by age 4 and they spawn in the month of July. The largest specimen caught during the study was a female measuring 324 mm in fork length and weighing 350 g; this chub was slightly larger than the largest specimen reported by McPhail and Lindsey (1970), which was the largest known specimen at that time.

Stomach samples indicate that the chub feed mainly on terrestrial drift insects such as hymenopterans, hemipterans, and to a lesser degree, trichopterans.

During the summer months many flathead chub are caught in the river by children who use lines baited with a piece of meat. Flathead chub are caught very close to shore in as little as 6 inches of water.

TABLE 4 — Average fork length and weight of 203 flathead chub from the Peace River, 1968–1971

Age (years)	Percent	Length (mm)	Weight (g)
0	67.5	61	4
1	7.9	91	9
2	6.9	112	19
3	1.0	168	50
4	3.0	182	73
5	3.9	221	108
6	4.4	239	149
7	4.4	268	220
8	.5	287	250
9	—	—	—
10	.5	324	350

Lake chub, *Couesius plumbeus* (Agassiz). Map locations 1, 4–9, 11–13, 15–17, 21–25, 32–34, and 37. Occurrence: abundant.

The lake chub were very abundant throughout the study but especially so in the sites upstream from the town of Peace River (Sites 1–15).

Spottail shiner, *Notropis hudsonius* (Clinton). Map locations 13, 15, 17, 23, 24, 25, 26, 29, 31, 32, 33. Occurrence: abundant.

Spottail shiners were not found in the upper parts of the study area but were fairly common in the catches made in the lower portion of the river.

Northern squawfish, *Ptychocheilus oregonensis* (Richardson). Map locations 3 and 7. Occurrence: rare.

Although squawfish have been reported being caught as far downstream as the town of Peace River (Paetz and Nelson 1970), only two were caught during the present study, both in the upper reaches of the Alberta portion of the Peace River. This may indicate that these fish are probably recent migrants from British Columbia. Furthermore, Lindsey (1956) suggests that pike and squawfish occupy similar ecological niches and so it is possible that competition between these two species is holding the spread of squawfish in check. The size and age data are as follows:

Age (years)	Fork length (mm)	Weight (g)	Sex
4	342	530	♂
5	371	680	♀

Longnose dace, *Rhinichthys cataractae* (Valenciennes). Map locations 1, 4, 5, 6, 7, 8, 11, 12, 13, 14, 15, 21, 24, 25, 33. Occurrence: common.

Longnose dace were fairly common in the upper portion of the Peace River within the area of study. Very few were caught in the lower stretches of the river although Nelson and Paetz (1972) found them as far downstream as near the mouth of the Peace River.

Redside shiner, *Richardsonius balteatus* (Richardson). Map locations 1, 4–6, 8, 9, 11–13, 15, 17, 21, 24. Occurrence: rare.

Like the northern squawfish and largescale sucker, the redside shiner was found only in the upper half of the Alberta portion of the Peace River and it is thought to be a recent invader from the Pacific slope (Lindsey 1956). Redside shiners were not very numerous in the river.

CATOSTOMIDAE

Longnose sucker, *Catostomus catostomus* (Forster). Map locations 1–10, 12, 13, 15–17, 20, 22–26, 28–33, 36, 37. Occurrence: abundant.

Longnose suckers were very common throughout the study area. Age determinations were made from the scales of 94 suckers (Table 5). The specimens ranged between 1 and 5 years of age and grew at a similar rate as those that I found in Lesser Slave Lake. Longnose suckers from the Peace River started to mature at age 3 and by age 4 most were sexually mature. Sex ratio of the suckers in the survey was 1.3 females to 1 male. The largest specimen caught during the study was an age 6 mature female, 480 mm in length and weighing 1300 g.

TABLE 5 — Average fork length and weight of 94 longnose suckers from the Peace River, 1969–1971

Age (years)	Percent	Length (mm)	Weight (g)
1	20	132	285
2	13	197	305
3	22	323	452
4	29	393	759
5	16	444	1041

White sucker, *Catostomus commersoni* (Lacepède). Map locations 14, 15, 17, 20, 24, 29. Occurrence: rare.

Very few white suckers were caught in the Peace River. Measurements of an age 6 mature female showed that it had a fork length of 426 mm and weighed 1050 g.

GADIDAE

Burbot, *Lota lota* (Linnaeus). Map locations 6, 7, 15, 18–21, 24, 26. Occurrence: common.

Although not many burbot were caught during the study, I suspect that they are plentiful in the river and that set lines would be a better method of capturing them. The otoliths from six burbot were aged with the following results:

Age	Number	Average fork length (cm)	Average weight (g)
5	2	47.4	725
6	2	55.3	1230
7	2	60.1	1375

The largest burbot caught had a length of 913 mm. Burbot smaller than 40 mm were eating stoneflies and mayflies, whereas larger burbot were eating fish such as flathead chub, longnose dace, and longnose suckers.

GASTEROSTEIDAE

Brook stickleback, *Culaea inconstans* (Kirtland). Map locations 15 and 25. Occurrence: rare.

Most of the specimens found in this study were from Buchanan Creek, Sample Site 24 in Figure 1, a small tributary of the Peace River. The stream was treated with rotenone.

PERCOPSIDAE

Trout-perch, *Percopsis omiscomaycus* (Walbaum). Map locations 4–9, 11–13, 15, 16, 21–24, 26, 29, 31–33, 35. Occurrence: rare.

Trout-perch were found throughout the study area but they were more abundant in the northern portions of the river.

Yellow perch, *Perca flavescens* (Mitchill). Map location 16. Occurrence: rare.

Only one immature specimen was found in the river and it is unlikely that perch are normally found in the Peace River.

PERCIDAE

Walleye, *Stizostedion vitreum* (Mitchill). Map locations 7, 8, 11, 15, 20, 21, 24, 26–28, 30, 34, 36. Occurrence: common.

Although walleye were found throughout the study area, they were not abundant in any single location in the river with the exception of the mouth of the Wabasca River (Sampling Site 36). Length, weight, sex and age data were gathered from 55 individuals (Table 6).

The rate of growth shown by the Peace River walleye is similar to that found in Sturgeon and North Wabasca Lakes in northern Alberta, but somewhat slower than I found in Lesser Slave Lake. The largest walleye taken during the study was a 10-year-old female with a length of 646 mm and a weight of 2960 g.

Walleye in the Peace River start to mature at age 4 and are all mature by age 6. Twice as many males as females were caught.

COTTIDAE

Slimy sculpin, *Cottus cognatus* (Richardson). Map locations 1, 4, 12. Occurrence: rare.

TABLE 6 — Average fork length and weight of 55 walleye from the Peace River, 1969–1971

Age (years)	Percent	Length (mm)	Weight (g)
2	2	259	170
3	15	347	475
4	18	369	536
5	18	439	961
6	18	482	1185
7	16	485	1261
8	7	548	1868
9	2	619	2620
10	4	656	3155

Sculpins were not very common in the river and their distribution was scattered. The spoonhead sculpin appeared to be more common in the upper portions of the study area.

DDT and Mercury in Peace River Fishes

DDT

Thirty-six fishes of various species from three locations in the river were analyzed for chlorinated insecticide levels in 1970. The analyses were carried out by the gas chromatograph method at the Provincial Dairy and Laboratory in Edmonton. The results are shown in Table 7 and are expressed in parts per million (ppm) of insecticide per gram wet weight of tissue. (Total DDT is defined as DDT plus its metabolic products, DDE, DDD, ortha-para DDT, and para-para DDT.)

DDT concentrations in walleye were highest in the fatty tissues, next highest in the liver, lower in the gonads, and lowest in the muscle tissue. In the goldeye, the highest DDT concentration was found in the gonads, then the muscle, and the lowest concentration was in the liver. (Fatty tissue was not analyzed because it is almost non-existent in the spring.) Burbot tissues showed a similar pattern to those of the walleye, with the highest DDT concentration being in the liver and the lowest in the muscle. DDT concentration in the muscle of the sucker was higher than in the gonads.

Mercury

In nine goldeye and five walleye from Sampling Site 36 on the Peace River, September 1970, the mean concentration of mercury was 0.159 (range 0.08–0.28) ppm and 0.208 (range 0.03–0.30) ppm, respectively. These analyses were made by the Fisheries Research Board of Canada laboratory in Winnipeg. Mercury concentrations in these fish are all below the accepted limit of 0.5 ppm mercury but are somewhat higher than levels found in lakes in the Peace River area.

TABLE 7 — Concentrations of DDT in various organs and tissues of 36 Peace River fish

Number	Species	Sampling site	Date	Tissue	Total DDT (ppm)
5	Walleye	20	May 6/70	Muscle	0.007
5	Walleye	20	May 6/70	Gonads	0.082
5	Walleye	20	May 6/70	Liver	0.033
4	Walleye	20	May 6/70	Fat	2.197
5	Goldeye	20	May 6/70	Muscle	0.013
5	Goldeye	20	May 6/70	Gonads	0.158
5	Goldeye	20	May 6/70	Liver	0.007
3	Burbot	20	May 6/70	Muscle	0.001
3	Burbot	20	May 6/70	Liver	0.339
3	Burbot	20	May 6/70	Gonads	0.009
8	Longnose sucker	20, 30	May 6, 9/70	Muscle	0.017
8	Longnose sucker	20, 30	May 6, 9/70	Gonads	0.009
5	Walleye	28	May 8/70	Muscle	0.017
5	Walleye	28	May 8/70	Liver	0.053
5	Walleye	28	May 8/70	Gonads	0.030
5	Walleye	28	May 8/70	Fat	0.452
5	Goldeye	28	May 8/70	Muscle	0.006
5	Goldeye	28	May 8/70	Liver	0.001
5	Goldeye	28	May 8/70	Gonads	0.009
5	Goldeye	30	May 9/70	Muscle	0.005

Discussion and Conclusions

The most abundant species of fish collected in this study was the flathead chub which was found at virtually all of the sampling sites. Lake chub, trout-perch, and longnose suckers were also very numerous throughout the river. Longnose dace, slimy sculpins, spoonhead sculpins, northern squawfish, and redside shiners were found mainly in sites upstream from the town of Peace River and usually in small numbers. It is possible that the squawfish, redside shiner, and largescale sucker are recent migrants to the Peace system from the Pacific slope. Goldeye and spottail shiners tended to be more abundant downstream from the town of Peace River. Walleye, pike, white suckers, and burbot were found throughout the length of the river but never in any abundance. Perch, whitefish, Dolly Varden, brook sticklebacks, and Artic grayling were very limited in number and distribution and probably inhabit the river only incidentally.

The concentration of chlorinated insecticides and mercury in the Peace River fishes was found to be relatively low.

At present, the Peace River is not popular with sports fishermen, probably because its large size and its swift and turbid water do not fit in with many anglers' idea of a fishing stream. The Peace River does have considerable potential for sports fishing, however, especially for goldeye which exist in large numbers and which are taken quite easily on flies and bait. The mouths of many of the larger tributaries of the Peace are also good areas for angling, especially in the springtime.

Acknowledgments

I thank the Alberta Fish and Wildlife Division staff for their assistance and patience during this study: Officers Frank Koteles, Gary Morton, Chuck Shipley, Bud Johnston, Ben Covey, and technicians Don Schroeder, Garry Mann, and Vic Gillman. I also thank J. S. Nelson of the University of Alberta for confirming the identification of the lake whitefish and some of the sucker specimens.

Literature Cited

Bishop, F. G. 1967. The Arctic grayling of Great Slave Lake. M.Sc. thesis, University of Alberta, Edmonton, Alberta. 166 pp.

Bishop, F. G. 1969. A report of the fishes collected in the Peace River, 1968. Fish and Wildlife Division, Alberta Department of Lands and Forests, Survey Report Number 4. 13 pp.

Bishop, F. G. 1973. Range extension of the Dolly Varden, *Salvelinus malma* (Walbaum), in Alberta. Canadian Field-Naturalist 87(1): 52.

Grosslein, M. D. and **L. L. Smith, Jr.** 1959. The goldeye, *Amphiodon alosoides* (Rafinesque), in the commercial fishery of the Red Lakes, Minnesota. United States Fish and Wildlife Service, Fishery Bulletin 157, Volume 60: 33–41.

Hill, W. J. 1966. Observations in the life history and movement of the goldeye, *Hiodon alosoides* in Montana. Proceedings of the Montana Academy of Sciences 26: 45–53.

Kennedy, W. A. and **W. M. Sprules.** 1967. Goldeye in Canada. Fisheries Research Board of Canada Bulletin 161. 45 pp.

Lindsey, C. C. 1956. Distribution and taxonomy of fishes in the Mackenzie drainage of British Columbia. Journal of the Fisheries Research Board of Canada 13(6): 759–789.

McPhail, J. D. and **C. C. Lindsey.** 1970. Freshwater fishes of Northwestern Canada and Alaska. Fisheries Research Board of Canada Bulletin 173. 381 pp.

Miller, R. B. and **M. J. Paetz.** 1953. Preliminary biological surveys of Alberta watersheds 1950–1952. Report of the Alberta Department of Lands and Forests.

Neill, C. R., D. I. Bray, M. F. Schouten, and **J. R. Card.** 1970. Selected characteristics of streamflow in Alberta. A publication of the Alberta Cooperative Research Program in highway and river engineering, Edmonton, Alberta. 55 pp.

Nelson, J. S. and **M. J. Paetz.** 1972. Fishes of the Northeastern Wood Buffalo National Park region, Alberta and Northwest Territories. Canadian Field-Naturalist 86(2): 133–143.

Paetz, M. J. and **J. S. Nelson.** 1970. The fishes of Alberta. Queen's Printer, Edmonton, Alberta. 282 pp.

Rawson, D. S. 1951. Studies of the fish of Great Slave Lake. Journal of the Fisheries Research Board of Canada 8(4): 207–240.

Received 19 August 1974
Accepted 17 April 1975

The Distribution and Abundance of the Wolverine (*Gulo gulo*) in Canada

C. G. VAN ZYLL DE JONG

National Museum of Natural Sciences, Ottawa, Ontario K1A 0M8

van Zyll de Jong, C. G. 1975. The distribution and abundance of the wolverine (*Gulo gulo*) in Canada. Canadian Field-Naturalist 89(4): 431–437

Abstract. Trends in the distribution and abundance of the wolverine in Canada and their probable causes are reviewed. The species declined and the southern boundary of its distribution moved northward in eastern Canada and the prairie provinces. In British Columbia, the Yukon, and the Northwest Territories wolverine numbers were less affected and major changes in distribution were not apparent. Fur production statistics suggest a possible increase in some areas in recent years. Probable causes for the observed changes in distribution and abundance are exploitation by humans, decline of caribou populations, and possibly wolf control.

The wolverine (*Gulo gulo*) remains one of the most poorly known of the larger carnivores of Canada, a fact reflected by the dearth of information in the literature on the species. A few studies dealing with various aspects of the species' biology in North America have been published (e.g., Kurtén and Rausch 1959; Rausch and Pearson 1972; Wright and Rausch 1955; Wright 1963), but virtually no field studies have been done on this continent. In Europe field studies by Krott (1959) and Haglund (1966) and others have contributed substantial information on the animal in its natural environment. Undoubtedly the small number of field studies is in no small measure due to the species being uncommon, highly mobile, and restricted to the more remote and inaccessible parts of the country.

Although there is much to be learned about the wolverine's ecology before we can understand the effects of the different components in the species' environment on its distribution and abundance, it will be useful to review the wolverine's current status in Canada and to speculate on the possible factors underlying observed changes. The present paper attempts to do this using information drawn from fur production statistics, provincial wildlife management agencies and the literature.

Results

Status in Eastern Canada

Peterson (1966) gives the most recent summary of the wolverine's distribution in eastern Canada, where the species is reported to occur in Labrador, Quebec, and Ontario. But there have been no recent reports of wolverines from Labrador, Newfoundland (Manuel, personal communication 1971) and no wolverine pelts have been listed for the province since it joined Confederation. Elton (1942) reported a drop in the trade of wolverine pelts at the Labrador Moravian Missions from an average of 5.5 and 8 wolverine pelts per year in the decades 1894–1903 and 1904–1913 to an average of only 1 wolverine pelt per year for the decade 1914–1923.

Little information is available on the present status of the wolverine in northern Quebec, but it appears to be quite rare. Harper (1961), who reviewed the earlier literature which indicated that the species was abundant throughout the area, obtained reports from only a few localities in 1953 and considered the wolverine extremely rare. Doutt (1961), in a paper on the mammals of the east coast of Hudson Bay and the interior of Ungava, states that "although the animal was well known to the Indians, they had not seen any in recent years." A field party from the National Museum of Natural Sciences did not find any evidence of the wolverine's presence in two widely separated areas of northern Quebec, along the Korok River and around Upper Seal Lake, during a 6-week period in the summer of 1973. A wolverine was seen by Miller (1972) in Gatineau Park far to the south of its normal range.

The number of pelts produced in the Province of Quebec (Figure 1) confirms the rareness of the species there. Numbers of pelts were low in the 1920s and gradually declined to very low numbers. A slight increase is apparent in recent years.

In Ontario the changes in abundance are very similar to those in Quebec (Figure 2). Recent records are available only from the Patricia portion of the Kenora District (Peterson 1966). Wolverines are now caught mostly in the Sachigo Hills near the Manitoba border (Novak, personal communication 1971) and should be considered rare in Ontario.

Status in the Prairie Provinces

The past and present distribution of the wolverine in Manitoba was reviewed and analyzed by van Zyll de Jong (1972). In that province, distribution of the species, once extending south into the aspen parklands, is now confined to the north of the province with the center of abundance in the extreme northwest corner of the province north of the settlement of Brochet. From this area of greatest abundance there is a rather sharp decrease in the frequency of occurrence and in the number of pelts produced toward the south and east. In the Brochet registered trapline district the frequency of occurrence in the catch in 16 trapping seasons from 1955–56 to 1970–71 was 100% and the average annual catch was 11.1 animals. In four districts along the Ontario border the frequency of occurrence was only 6 to 19% and average annual catch 0.2 animals or less. The number of wolverines has declined considerably in Manitoba since the 1920s (Figure 3), although there appears to be an upward trend in the last few years.

The present distribution in Saskatchewan and Alberta is not well known. In Saskatchewan the species is reported to occur at present in the extreme northern portion of the province (Beck 1958; Dodds, personal communication 1971), and in Alberta in the north and in the mountains along its western border (Scheffler, personal communication 1971; Banfield 1958; Soper 1964, 1970, 1973). Extralimital occurrences and sightings are occasionally reported (e.g., Hewson 1973; Santy 1963; Scotter 1964); they probably represent dispersing young and should not be given undue weight in determining the southern boundary of the wolverine's geographic range.

The changes in the number of wolverine pelts produced followed similar patterns in the three prairie provinces (Figures 3–5). The generally high level of the 1920s was followed by a decline in the late 1920s and early 1930s. Production has continued at a much lower level since then, with a slight suggestion of an increase in the last few years.

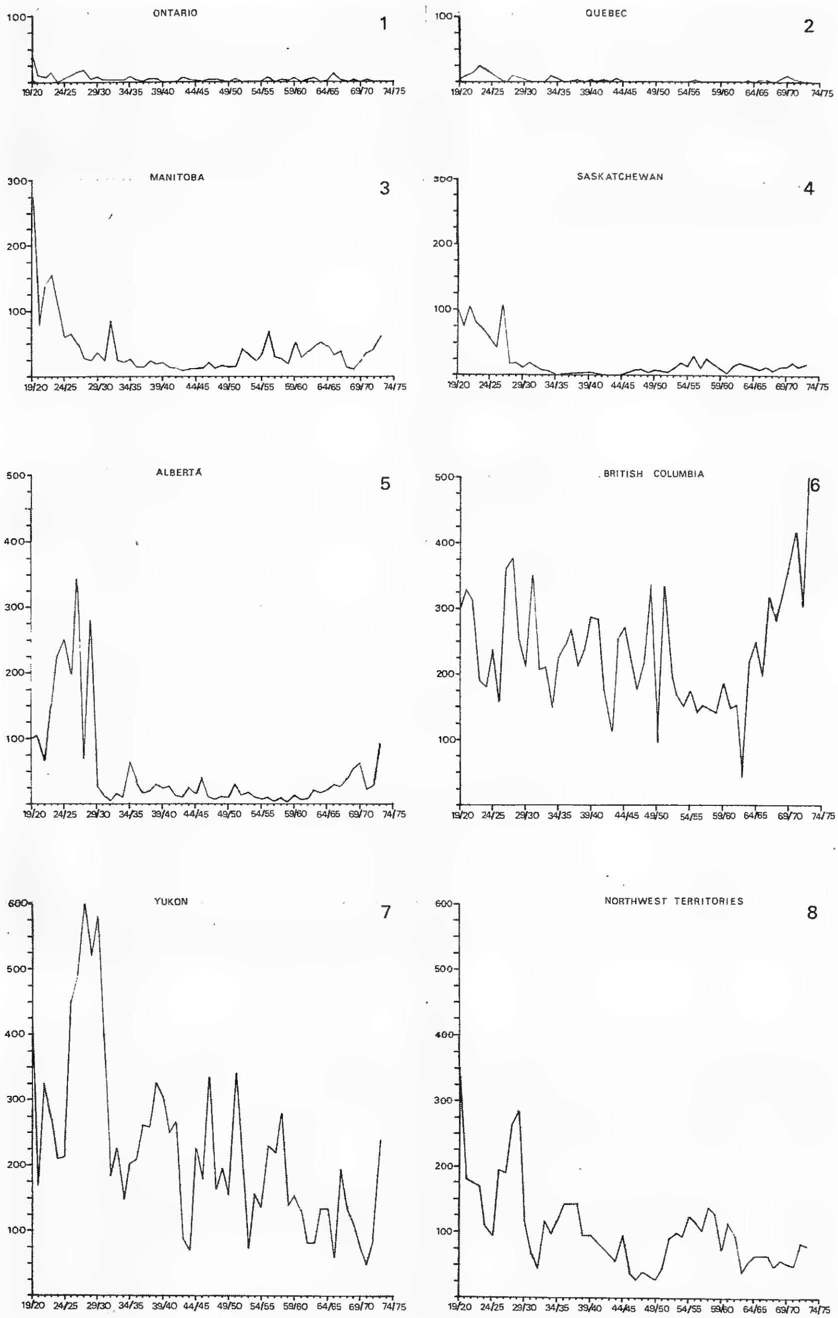
Status in British Columbia

The changes in abundance in British Columbia are much less pronounced than in any of the other provinces (Figure 6). Although there appears to have been a gentle downward trend with progressively lower peaks and troughs over most of the period considered, production remained generally high, and within the last 10 years a definite upward trend has been noticeable. The distribution, as far as can be determined, has remained virtually unchanged since the turn of the century (cf., Seton 1909; Cowan and Guiguet 1965). No current information on the status of the Vancouver Island form, *G. g. vancouverensis,* could be obtained.

Status in the Yukon and Northwest Territories

In the two territories, decline in numbers is evident (Figures 7 and 8), but as in British Columbia it is less marked than in the prairie provinces and eastern Canada. Changes in number of pelts produced in the Yukon are similar to those in British Columbia, although the decline from the 1920s to 1970–71 appears to have occurred at a somewhat faster rate. An increase is evident during the last two years and the status of the wolverine in the Yukon is reported to be secure at the moment (Rausch and Pearson 1972).

In the Northwest Territories the center of abundance lies on the mainland, but wolverines have also been reported from Banks Island (Manning and Macpherson 1958), Victoria Island (Hall and Kelson 1959), Melville Island (Preble 1908), Baffin Island (Anderson 1937; Seton 1929), Ellesmere Island (Anderson 1946), and Little Cornwallis Island (Tener 1963). The infrequent



FIGURES 1–8. The number of wolverine pelts produced in Canadian provinces and territories in the seasons 1919–20 to 1972–73.

reports and small numbers of specimens from the arctic islands suggests that the species is rare and may not have permanent resident populations in the archipelago.

Summary and Discussion

The changes in distribution and abundance of the wolverine in Canada in this century may be summarized as follows. In eastern Canada, where the species was apparently less abundant than in the western part of the country, the species has become quite rare and restricted in distribution. In the prairie provinces numbers decreased sharply and the southern limits of the species' distribution receded to the northern and western fringes of the region.

In British Columbia and the two territories, distribution seems to have changed little if any, although there appears to have been a slight reduction in numbers in these areas as well. There are indications of increases in British Columbia and the Yukon in recent years.

An approximation of the present distribution based on the available information and an earlier distribution based on Seton (1909) are shown in Figure 9.

In order to attempt a probable explanation of the observed changes in the wolverine's distribution and abundance, we must consider some of the factors that may have affected the species' chances to survive and multiply. Climate and habitat remained either unchanged or changed so slightly during the period under consideration that they may be dismissed as possible causes. Of the biotic factors in the wolverine's environment, predation by humans appears to be the most likely factor to have affected the number of wolverines. Direct evidence of negative effects of human exploitation on wolverine populations is not available, but indirect evidence from declining production of wolverine pelts and the disappearance of the species from areas with relatively dense human populations strongly suggests that exploitation by man contributed to the decline. The comparatively stable and denser populations in mountainous areas (British Columbia and Yukon) or in the more remote and sparsely populated areas (Northwest Territories) could be explained as resulting from the availability of natural refuges created by the relative inaccessibility, especially in winter, of the former and the low density of human predators in the latter.

The frequency of field observations of the animals or their sign, and evidence from fur production records strongly suggest that wolverines normally occur at relatively lower densities than other carnivores of comparable size. Data on wolverine densities are not easily obtained, but Krott (1959) provides estimates for Scandinavia varying from 1 wolverine per 200 km^2 (approximately 77 mi^2) to 1 wolverine per 500 km^2 (approximately 193 mi^2). For comparison, estimates of wolf (*Canis lupus*) densities in North America (Mech 1970) vary from 1 wolf per 26 km^2 (10 mi^2) for high density areas to 1 wolf per 259–518 km^2 (100–200 mi^2).

If these estimates are correct, they indicate that wolverines tend to be less abundant than wolves even in optimum habitats. Figures on the numbers of wolverines and wolves killed at poisoned bait stations in northern Canada appear to support the contention that wolverines occur at lower densities than wolves. In the Northwest Territories, with a probably better-than-average wolverine population, figures for 3 years of a predator control program (Kelsall 1968) give ratios of 8.5, 6.3, and 10.6 wolves per wolverine or an average of 8.5 wolves per wolverine. In Manitoba, with a much lower wolverine population, similar ratios for the period 1954–1961 average 139.7 wolves per wolverine. The low density relative to that of other similar-sized boreal carnivores is coupled with a comparatively smaller litter size (Krott 1959; Rausch and Pearson 1972; Asdell 1964). Natural predation is probably insignificant as a mortality factor in wolverine populations, although wolverines apparently are occasionally killed by wolves (Burkholder 1962). It seems likely, therefore, that there was selection for a low intrinsic rate of natural increase (r_m) resulting in a reduced ability to compensate for losses due to human exploitation.

The availability of food is another factor that probably contributed to the observed changes in abundance and distribution. In the

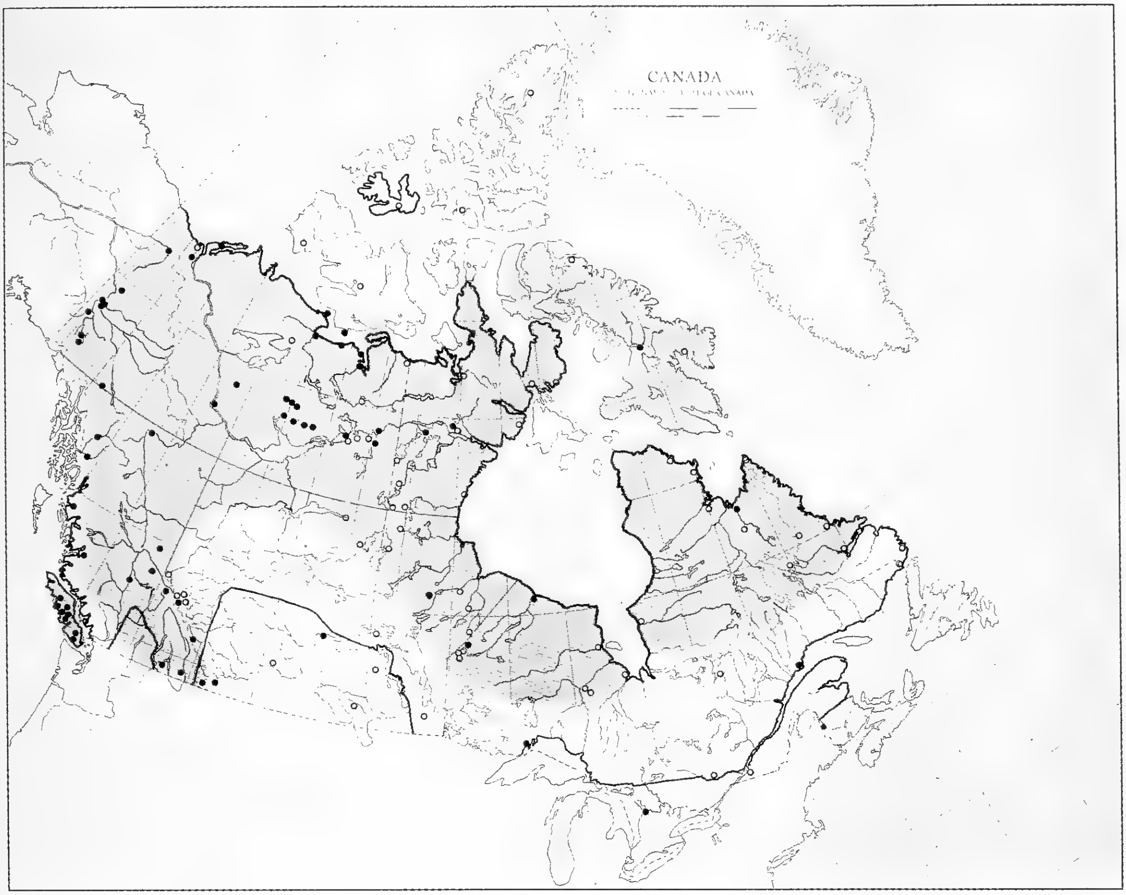


FIGURE 9. Approximate past (solid line; based on Seton 1909) and present distribution of the wolverine in Canada (shaded area). Peripheral and extralimital records are indicated by solid circles.

food webs of the boreal and arctic ecosystems the wolverine is part of the predator component. Field observations (Krott 1959; Haglund 1966), however, have revealed that the wolverine is not an efficient hunter. It has neither the stealth nor the speed that characterizes the efficient hunters among the Felidae and Canidae. The wolverine's attack is direct and consists of a shorter or longer chase (Haglund 1966). On a firm substrate the chase of healthy prey is rarely successful. Deep snow gives the wolverine with its low weight load (27–35 g/cm², Novikov 1962) an advantage over its prey and it appears to be more successful under those circumstances.

Studies of food habits have shown the wolverine to be an omnivore in summer (Krott 1959), feeding on a large variety of food including carrion, small mammals, insect larvae, eggs, and berries and, despite its shortcomings as a hunter, a meat-eater in winter. Large herbivores, especially reindeer and caribou (*Rangifer tarandus*), the most numerous large herbivore over most of the wolverine's range, are the most important food in winter (Haglund 1966; Krott 1959; Rausch and Pearson 1972). Most of the large herbivores eaten are thought to be carrion, resulting from predation by other carnivores or death from other causes. Haglund (1966) reported that only 15 out of 50 domestic reindeer carcasses fed upon by wolverines were killed by wolverines. The proportion of animals killed by wolverines in a wild population would undoubtedly be even lower, as wild animals are, in general, less vulnerable to predation than their domestic counterparts. Morphological and behavioral characteristics also point to adaptations for a scavenging way of life. The dentition, in particular the carnassials, is massive and the extreme posterior projection of the sagittal crest is indicative of the great size and power of the temporalis muscle. This powerful jaw mechanism allows the wolverine to feed on solid-frozen meat and to crush large bones, thus enabling it to utilize frozen carcasses and the remains of kills (Haglund 1966). The animal's propensity for wandering far and wide, which increases its chances of finding widely scattered and immobile food, as well as its well-developed food-caching behavior can also be interpreted as adaptations to the scavenger role.

The wolverine may thus be regarded as a seasonal scavenger on the fringe of the main links of the food web. The wolverine's niche explains the relative rareness of the species in the community compared to the efficient hunters among carnivores that act as providers, and it implies a direct relationship between the biomass and turnover of large herbivore populations and the abundance and distribution of wolverines. Circumstantial evidence seems to support this view. For example, Elton (1942) noted the concomitant decline in caribou, wolf, and wolverine pelts traded at the Moravian Missions in Labrador in the latter half of the last and the early part of this century; caribou populations in other parts of eastern Canada declined markedly in the last 50 years (de Vos and Peterson 1951; Banfield and Tener 1958); during the same period wolverine populations also declined. The distribution and abundance of wolverines in Manitoba was found to coincide largely with that of the barren-ground caribou in winter (van Zyll de Jong 1972). In the mountain ranges of Alberta, British Columbia, and the Yukon, where wolverines are still common, large and diverse ungulate populations occur. The available evidence suggests therefore, that the changes in distribution of the wolverine may be attributable to predation by humans, decline of caribou populations, and possibly also indirectly to wolf control.

Acknowledgments

For supplying information on the status of the wolverine in their province or territory, I am indebted to S. F. Manuel, Newfoundland Wildlife Service; M. Novak, Ontario Department of Lands and Forests; E. Dodds, Fur Unit, Fisheries and Wildlife Branch, Saskatchewan; E. G. Scheffler, Alberta Department of Lands and Forest; W. A. McKay, Department of Recreation and Conservation, British Columbia; J. B. Fitzgerald, Yukon Game Branch; and R. B. Hall, Northwest Territories. The fur production statistics used (Figures 1–8) were supplied by J. H. Dickson, Livestock and Animal Productions Section, Statistics Canada.

Literature Cited

Anderson, R. M. 1937. Mammals and birds of the western Arctic district, Northwest Territories, Canada. Canada's Western Northland 1937, July: 97–122.

Anderson, R. M. 1946. Catalogue of Canadian Recent mammals. National Museum of Canada Bulletin 102, Biological Series 31. 230 pp.

Asdell, S. A. 1964. Patterns of mammalian reproduction. Cornell University Press, Ithaca, New York. 670 pp.

Banfield, A. W. F. 1958. The mammals of Banff National Park, Alberta. National Museum of Canada Bulletin 159, Biological Series 57. 53 pp.

Banfield, A. W. F. and **J. S. Tener.** 1958. A preliminary study of the Ungava caribou. Journal of Mammalogy 39(4): 560–573.

Beck, W. H. 1958. A guide to Saskatchewan mammals. Saskatchewan Natural History Society Special Publication 1. 52 pp.

Burkholder, B. L. 1962. Observations concerning wolverine. Journal of Mammalogy 43(2): 263–264.

Cowan, I. McT. and **C. J. Guiguet.** 1965. The mammals of British Columbia. British Columbia Provincial Museum, Handbook II. 414 pp.

de Vos, A. and **R. L. Peterson.** 1951. A review of the status of the woodland caribou (*Rangifer caribou*) in Ontario. Journal of Mammalogy 32(3): 329–337.

Doutt, J. K. 1961. Observations on mammals along the east coast of Hudson Bay and the interior of Ungava. Annals of the Carnegie Museum 33: 235–249.

Elton, C. S. 1942. Voles, mice and lemmings. Oxford University Press. 496 pp.
Haglund, B. 1966. De stora rovdjurens vintervanor, I. Viltrevy (Stockholm) 4(3). 299 pp.
Hall, E. R. and **K. R. Kelson.** 1959. The mammals of North America. The Ronald Press Company, New York. 1083 pp.
Harper, F. 1961. Land and fresh-water mammals of the Ungava Peninsula. University of Kansas, Miscellaneous Publication 27. 178 pp.
Hewson, G. M. 1973. Wolverine. Blue Jay 30(4): 261.
Kelsall, J. P. 1968. The migratory barren-ground caribou of Canada. Canadian Wildlife Service, Ottawa. 340 pp.
Krott, P. 1959. Der Vielfrass. Monographien der wild Sangetiere. Band XIII. Gustav Fischer Verlag, Jena. 159 pp.
Kurtén, B. and **R. Rausch.** 1959. Biometric comparisons between North American and European mammals. Acta Arctica XI. 44 pp.
Manning, T. H. and **A. H. Macpherson.** 1958. The mammals of Banks Island. Arctic Institute of North America. Technical Paper 2. 74 pp.
Mech, L. D. 1970. The wolf: the ecology and behavior of an endangered species. The Natural History Press, New York. 384 pp.
Miller, F. L. 1972. Wolverine in Gatineau Park, Quebec. Canadian Field-Naturalist 86(4): 390.
Novikov, G. A. 1962. Carnivorous mammals of the fauna of the USSR. Israel Program for Scientific Translations No. 62. 284 pp.
Peterson, R. L. 1966. The mammals of eastern Canada. Oxford University Press, Toronto. 465 pp.
Preble, E. A. 1908. A biological investigation of the Athabasca-Mackenzie Region. North American Fauna 27: 1–574.
Rausch, R. A. and **A. M. Pearson.** 1972. Notes on the wolverine in Alaska and the Yukon territory. Journal of Wildlife Management 36(2): 249–268.
Santy, D. 1963. Bear and wolverine near Beechy, Saskatchewan. Blue Jay 21(3): 119.
Scotter, G. W. 1964. Occurrence of a wolverine in southwestern Alberta. Journal of Mammalogy 45(4): 629.
Seton, E. T. 1909. Life histories of northern animals. Volume 2. Scribner's Sons, New York. 1267 pp.
Seton, E. T. 1929. Lives of game animals. Volume 2. Doubleday and Co., Garden City, New York. 746 pp.
Soper, J. D. 1964. The mammals of Alberta. Government of Alberta. 402 pp.
Soper, J. D. 1970. The mammals of Jasper National Park, Alberta. Canadian Wildlife Service Report, Series 10. 80 pp.
Soper, J. D. 1973. The mammals of Waterton Lakes National Park, Alberta. Canadian Wildlife Service Report, Series 23. 57 pp.
Tener, J. S. 1963. Queen Elizabeth Islands Game Survey, 1961. Canadian Wildlife Service Occasional Paper 4. 50 pp.
van Zyll de Jong, C. G. 1972. The status of the wolverine in Manitoba. Manitoba Department of Mines, Resources and Environmental Management, Research Branch Manuscript Report 72-2. 17 pp.
Wright, P. L. 1963. Delayed implantation. *In* Variations in reproductive cycles in North American mustelids. *Edited by* M. A. C. Enders. University of Chicago Press, Chicago. pp. 77–97.
Wright, P. L. and **R. Rausch.** 1955. Reproduction in the wolverine, *Gulo gulo*. Journal of Mammalogy 36(3): 346–355.

Received 18 February 1975
Accepted 14 May 1975

Bald Eagle Nesting Attempts in Southern Ontario in 1974

FLORENCE M. WEEKES

#305–2233 Bowker Avenue, Victoria, British Columbia V8R 2E3

Weekes, Florence M. 1975. Bald Eagle nesting attempts in southern Ontario in 1974. Canadian Field-Naturalist 89(4): 438–444

Abstract. My search for active nests of the Bald Eagle (*Haliaeetus leucocephalus*) in southern Ontario was continued in 1974, and nesting results were noted. Active nests in the southwestern sector showed reproductive success at three of six nests (average of one nest in two); this is a better success rate than five nests of 25 (average of one nest in five) during the five seasons 1969–1973. The southwestern sector near Lake Erie continued to show more active nests (six compared to one) and more successful fledgings (three compared to none) than the eastern sector. One successful 1974 nest had been inactive since the fledging of one young and the shooting of one adult in 1970; the surviving adult appeared to have mated in 1974 with the bird fledged from the nest in 1970. Another nest had its third successful fledging in 4 years after at least 11 (possibly 18) barren seasons. The question is raised as to a possible correlation between improved 1974 nesting success of the Bald Eagle in southwestern Ontario and the restrictions of DDT use in the province as of 1970. Some nest histories are included with the 1974 observations.

A study of nesting attempts of the Bald Eagle (*Haliaeetus leucocephalus*), carried out in southern Ontario since 1969 (Weekes 1974), was continued in 1974. Because the Lake Erie survey continued to show more nests than the Lake Ontario – Ottawa Valley survey, search for re-activated nests in the eastern sector was intensified.

Methods

I searched by air or on foot or both at the following sites:

(1) nine of the 10 sites that I had found active at any time from 1969–1973;

(2) one southeastern nest discovered to have been active in 1971 but not previously included in this study;

(3) one southeastern site where recent but not current activity had been reported in 1971 but about which I had previously made only enquiries;

(4) six (five southeast, one southwest) still wooded sites (used 1950s or early 1960s) which I had searched with negative results during the 1969–1973 period;

(5) six other such southeastern sites about which I had previously made only enquiries, and one southeastern area new to this study where a possible Bald Eagle nest had been reported as of 1972.

(6) One southwestern nest which I did not check in 1974 is included in this report as a result of information received in 1975.

(7) Enquiries regarding possible nest reactivation were repeated in southwestern Ontario areas which had at least 17 Bald Eagle nests about 1950, but where searches had revealed no active nests in the 1969–1972 period. These latter areas still had reasonable amounts of cover.*

The area covered in this study included, insofar as possible, that part of Ontario south of a line that might be drawn from Owen Sound eastward to the Ottawa River south of Pembroke, but including the Bruce Peninsula (Weekes 1974). Initially east and west sectors were divided by a line drawn north–south at about Toronto. By 1974 the search for active nests had been narrowed down, with the southwestern sites checked in 1974 being all in the vicinity of Lake Erie and the southeastern sites being all in an area north of a line extending from about Trenton to about Brockville.

At first the 1974 checks of all eastern sites took the form of aerial circumnavigation of lake areas where nests had been noted or reported. In the western section I used aircraft mainly when looking for replacements for nests inactivated during the 1969–1973 period. I investigated at least once from the ground

* No search was made for one southeastern nest that I had found active but unsuccessful in 1971. I found neither the nest nor a replacement for it in aerial searches in 1972 or 1973, nor had I received further reports of Bald Eagle nests in the district.

all nests found standing in 1974. Where activity was noted, I continued checks until outcome (nest abandoned or young fledged) was established. I climbed no nests, and where necessary used binoculars (7× or 12×) or telescope (15×, 30×, 45×, or 60×). It was possible to reach all 1974 nests on foot, following travel by car, or car and boat. Field observations were supplemented where possible by enquiries among local residents.

Observations

Both nesting attempts and nesting success remained higher in southwestern than in southeastern Ontario (Table 1). Seven nests were active, six in the southwest and one in the southeast. Of the southwestern nests, three produced one young each, two were unsuccessful, and result at one is unknown. The southeastern nest was unsuccessful. All fledgings were less than 2½ mi from Lake Erie. The known southwestern Ontario success rate of at least three nests of six, or 50%, compares to an average of five of 25, or 20%, during the five preceding years, and the three eaglets fledged compare to a total of six during the five preceding seasons (Table 2).

TABLE 1 — Comparison of nestings of Bald Eagles in southwestern and southeastern Ontario 1971–1974

	Southwest nests		Southeast nests	
Year	Active	Successful	Active	Successful
1971	6	2	2	1
1972	5	0	1	0
1973	3	1	0	0
1974	6	3	1	0

TABLE 2 — Results of nesting activity at southwestern Ontario Bald Eagle nests 1969–1974

Year	Active nestings	Successful nestings	Young fledged
1969	5	1	1
1970	6	1	1
1971	6	2	3
1972	5	0	0
1973	3	1	1
1969 to 1973	25	5	6
1974	6	3	3

The following nest data for 1974 and previous years is listed for the areas checked in the order outlined under Methods.

(1) *Nests Active from 1969–1973*

a) Southwestern Ontario

1) 1974: one young (new nest from 1972).
1973: nest from 1972 unused; other nesting undetermined.
1972: unsuccessful nesting attempt.
1971: two young fledged.
1970–1962: one young on nest in 1964 (E. W. Keith, Field Observer, Bald Eagle Research, Canadian Audubon Society, personal communication); other years no known young (Keith, S. Postupalsky, personal communications).
Pre-1962: reports do not refer to only one nest, but deal with an area of about 18 mi^2 that contained three or four active nests in 1956 and only one by 1961 (R. D. Ussher, Ontario Department of Lands and Forests report to Canadian Audubon Society, 6 February 1962); one young in 1952; two on one nest 1958. Ussher's records number nests for identification up to number 20. Most of these were not in use by 1956, and some were possibly supernumerary. Reynolds (1960) reports that "a few years" prior to 1960 there were about six Bald Eagle nests in this area.

2) 1974: one young.
1973–1971: nest inactive. One adult and one immature Bald Eagle in vicinity. Area residents reported the younger bird, new in 1970, appeared to develop considerable white plumage by late 1973, looked quite adult by 1974, and was seen performing nuptial-type cartwheeling flights with the older bird as early as 1972. The younger bird was reported to be somewhat smaller.
1970: two young hatched; one disappeared and one fledged successfully. This was the only eaglet known fledged in southwestern Ontario in 1970 (Table 2). On 19 December 1970, the day after what a local resident referred to

as "the rabbit hunt," one of the adult birds was found shot (one of the shootings among mated pairs noted by Weekes (1974)). The surviving adult and an immature remained in the area. This nest was located in 1970 by the author with the assistance of local residents.

Pre-1970: no record could be found of last previous successful nesting. No nests or activity had been noted during checks in the early 1960s (Keith, Postupalsky, personal communications). This general area had at least 3 pairs of Bald Eagles nesting in it in 1948 (Reynolds 1954), and probably more earlier according to residents, with earlier nests producing young regularly.

3) 1974: one young. New nest less than 1 mi from nest used in 1973 and earlier. The new nest was near the edge of a wooded area and somewhat closer to the birds' feeding grounds.

1973: one young.

1972: unsuccessful nesting attempt.

1971: one young. At this time the author noted a second smaller nest, like a shallow platform, about where the 1974 nest was subsequently built.

Pre-1971: nest active but unsuccessful back to at least 1960 (Postupalsky, Keith, personal communications). Landowner's last recollection of young on nest was 1952. Bald Eagles were remembered as nesting earlier, generally successfully, as far back as could be recalled by a former landowner who had been raised in the area and who died 2 March 1974 at age 78.

4) 1974: unsuccessful nesting attempt. Adult appeared to be incubating 14 March, 28 April, and 2 May. On 11 June there were no eagles around and a raccoon was sleeping on the nest.

1973–1971: the nest was found by the author and Ontario Department of Lands and Forests personnel on 5 April 1971. It was active in 1971, 1972, and 1973, but unsuccessful.

Pre-1971: nest had been known in area, sometimes successful, in 1950s and early 1960s, but in 1969 there had been no reports of recent nesting (M. F. Field, personal communication).

5) 1974: pair of adults repaired the nest, but whether they had an otherwise-viable egg or eggs was undetermined because the complete nest was found scattered on the ground in mud and water in mid-March. No supporting branches had been broken, and there had been no unusually stormy weather since the nest had last been noted standing. This particular nest structure had been built in 1963. The adult eagles stayed in the area after the nest went down in 1974 but did not rebuild. On 19 June 1974 one of them was found shot.

Pre-1974: annual nesting attempts had been made but the only known hatching since at least 1961 was in 1963. That eaglet was shot off the nest 1 June 1963 (noted by Weekes 1974). The landowner recalled Bald Eagles reported nesting in the immediate area since at least 1919, with three or four nests talked of then in the vicinity, all generally producing young.

6) 1974: one adult seen near river where birds had been earlier known to feed. Old nest standing unused. No new nest found.

Pre-1974: one young fledged 1969; otherwise unsuccessful nestings noted regularly in area from 1973 at least as far back as 1961. One young hatched in 1962 was shot off the nest before it could fly (noted by Weekes 1974).

7) 1974–1971: no nest found in annual checks.

1971: local resident reported he last saw the adult eagles in a woodlot with a rabbit carcass on 5 January 1971, when he was checking the area prior to a township "fox and wolf hunt."

1970: the eagles appeared to be using a long-standing nest when a storm broke a supporting branch and the nest fell, on or about 8 April 1970. Within a month they built a smaller nest, little more than a platform, about 2 mi away, near the edge of a woodlot and nearer their feeding grounds. They did not attempt further incubation. This small nest was felled in the winter of 1970–71 when the land was cleared for crops (Weekes 1974).

1969: unsuccessful nesting attempt. A neighboring farmer reported the adults left the nest for several days following 20 April 1969, when he noted a large group of people congregated noisily under the tree in what appeared to be a picnic or birdwatching outing. A check by the author 4 May showed the nest unattended.

Pre-1969: no young known on the nest during the 1960s (Keith, Postupalsky, personal communications).

8) 1974: no nest or eagles found.

Pre-1974: no nest or eagles found 1973, 1972. In 1971 there was an unsuccessful attempt by a pair of Bald Eagles. An area resident reported to the author that an adult Bald Eagle was shot late in 1971 over a nearby duck-hunting area. The nest had been inactive since the shooting of an adult in 1966 (Postupalsky, personal communication). There had been no known young since at least 1961 (Postupalsky, Keith, personal communications).

b) Southeastern Ontario

1974: nest unused and no eagles seen during aerial survey 8 May and ground check 26 May.

Pre-1974: nest unrepaired and no eagles seen 1973. Unsuccessful nesting noted 1972. Prior to 1972 there had been occasional sightings of Bald Eagles in the general area, and possibly nestings, but no young known fledged since the late 1950s (Helen Quilliam, Kingston Field Naturalists' reports, personal communication).

(2) *Nest (Southeast) Active in 1971 but Not Previously Included in Study*

1974: unsuccessful nesting attempt. An aerial check 8 May 1974 showed the nest to have a light-colored upper surface of fresh material and to contain a spray of green pine. No eggs or eagles were seen. A ground check 26 May showed the nest apparently deserted. Local residents told the author eagles were there earlier in the season but not there recently as of 26 May.

Pre-1974: local residents reported there was no apparent nesting in 1973 or 1972. Two young were raised in 1971 (George K. Peck, Ontario Nest Record Scheme, personal communication). Prior history is unknown, although this area is circled on an old map used to mark nests during the Canadian Audubon Society's 1960–1965 Bald Eagle survey.

(3) *Nest (Southeast) Active before 1971*

1974: no nest or eagles found.

Pre-1974: Alden Strong (personal communication), who worked with Charles Broley on area Bald Eagle bandings in the 1950s, had had reports in 1971 of recent but not current activity at this site. Broley banded two young at this nest in 1955 (Quilliam 1965).

(4) *Nests (Five Southeast, One Southwest) Active 1950s and 1960s*

1974: no nests or eagles found in aerial surveys over southeastern lake area where five active nests were reported in records covering 1955–1960 (Quilliam 1973; Quilliam, Kingston Field Naturalists, personal communication). No nests or eagles found in aerial survey over southwestern river area where earlier nest had been reported by local residents. These areas had all been searched at least once during the 1969–1973 period, with negative results.

(5) *Nests (Southeast) not Searched for prior to 1974*

1974: no nests or eagles found in aerial surveys of six former nesting areas about which I had made enquiries during 1969–1973, with negative results. Nests had existed in the 1950s or 1960s (Quilliam, Kingston Field Naturalists, personal communication).

1974: an active Osprey nest was found where a possible 1972 Bald Eagle nesting had been reported to a Canadian Wildlife Service biologist (Laurie Wight, personal communication).

(6) *Southwestern Nest not Checked in 1974 but Later Reported*

1974: nest reported in active use by a pair of Bald Eagles (G. R. Austin, Ontario Ministry of Natural Resources, 17 March 1975, personal communication). Nesting results unknown.

Pre-1974: I found one adult and one immature Bald Eagle in this area in 1971 and 1972, but no active nesting. An adult pair may have attempted nesting in 1969 (Holroyd and Wasserfall 1969). George K. Peck (personal communication) reported an occupied nest in 1963, and three active nests in the general area in 1962 (report to Canadian Audubon Society, 22 January 1963). No young are noted in any report from at least 1961. About eight nests were still known in the general area by the end of the 1950s (Reynolds 1960).

(7) *Nests (Southwest) Active 1950s*

1974: no eagles, or reports of them, could be found.

Discussion

Factors cited earlier (Weekes 1974) as affecting the decline of southern Ontario's Bald Eagles were still apparently operating in 1974, although there was an increase in the birds' reproductive rate near Lake Erie and an apparent change in hunter attitude in at least one locality. One might wonder about a possible correlation between the phasing out of DDT use in Ontario as of 1970 and the improved reproductive success at remaining nests. The 1974 success rate at active nests was substantially higher than the forerunning average. One 1974 nest had its third success in four years following at least 11 (and possibly 18) years during which unsuccessful nesting attempts had been routine. The sample surviving for study, however, is too small to be statistically significant; follow-up over more seasons would be needed to determine whether the improvement is chance or trend. A more complete picture would also require finding and study of any nests that might have been missed in this survey and any that are subsequently put into re-use. It was previously suggested (Weekes 1974) that more intensified search might reveal a few more nests in southern Ontario; re-activation of former sites, as at two 1974 nests, could enhance the possibility of such findings. Comprehensive analysis of food, egg-shells, unhatched eggs, and available autopsy specimens might also help clarify any role played by environmental toxicants, although it might be difficult to obtain sufficient samples for historical comparisons.

A further consideration in the increased success among remaining nests might be a heightened public awareness of the species' situation. When a Bald Eagle was shot near one southwestern Ontario nest in 1971 few people knew about it and a later appeal for its carcass brought no results. When another was shot there in 1974 naturalists were called immediately; steps were taken to save the injured bird, and the local newspaper reported the matter in considerable detail.

It has earlier been noted (Weekes 1974) that in recent years the shooting of an adult Bald Eagle in southern Ontario has usually been followed by prolonged or complete inactivation of a nest. This problem was apparently resolved at one nest in 1974 by the successful mating of a surviving adult with a bird that was probably its own offspring of 1970. In 1970 the author found that many residents of this area seemed to think Bald Eagles were common. One man said he had shot "lots of eagles." By 1974 the one remaining nest had become a minor *cause célèbre*. Even in the local school, the author was told, the children were learning about the eagles and importance of not molesting them. Hunter tolerance of the two remaining birds during the 1970–1974 period would be a positive factor in the successful 1974 nesting.

The raccoon noted on a nest in June 1974 was probably taking advantage of a ready-made bed, but it might also have eaten any abandoned egg or eggs. Two raccoons were seen on another abandoned southwestern Ontario Bald Eagle nest 5 April 1971, although it could not be established if there had been a nesting attempt. Starlings and grackles appeared to clean up food remains from a 1973 Bald Eagle nest after the eagles had left (Weekes 1975). In 1972 at another southwestern Ontario Bald Eagle nest there arose a question as to whether a Turkey Vulture might have eaten either food remains or a dead or abandoned eaglet. During overflights by the author 11 April and 21 April 1972, a whitish object was seen beside the adult on the nest. The nest was later abandoned with no young raised. The landowner reported the adults were at the nest the night of 14 May, but gone 15 May, and that on 15 May a big black bird was seen feeding for a few minutes on something on the nest. From the description given, the bird could have been a Turkey Vulture, fairly common in the district.

Bald Eagle nests noted in this study tended to remain in place, possibly disintegrating slowly over a period of years unless a storm or other factor felled the tree or unless (and sometimes even if) a storm broke one or more supporting branches. Only one nest was recorded as falling completely without apparent external factors. In the cases of nine other nests known by the author to have fallen entire rather than piece-meal, two of the trees were felled by people (once to make room for crops; once because the tree was dead); three trees fell because of erosion of lake or river banks; two trees went down in storms; and two nests were blown out of trees when storms broke supporting branches.

Of these last four storm-felled nests, two fell in the spring and two in the autumn. One nest tree that fell was a beech, one a dead elm, and both nests that went down with supporting branches were in dead elms. Seven of the nests noted to fall entire were active at the time they went down; two were probably active and status of one was unknown. Broley (1951) noted that southern Ontario Bald Eagle nests were mainly in elm trees. Many of the nests located at the beginning of this study in 1969 were in dead or dying elms. Death of these trees from Dutch elm disease probably hastened the loss of many nests.

One 1974 nest fell after standing in constant repair in a sycamore tree for 11 years. Of the other five active 1974 nests, two were newly found that season; one had stood for 3 years in an elm; one for 4 years in a maple; and one for 10 years in an oak.

Of the four inactive nests noted standing in 1974, one in a maple had stood at least 3 years; one in a hickory at least 6 years; and another in an oak for a reputed 44 years. It was not usually possible to find records of initiation or abandonment of old nests, and those considered abandoned were not always watched by the author until they disappeared entirely. In addition to the above-listed, however, 19 nests found in not-new condition during the 1969–1973 period had stood for the following minimum lengths of time (some probably much longer): nine, 1 year; three, 2 years; four, 3 years; one, 6 years; two, 8 years.

Broley (1947) reported that poorly constructed Bald Eagle nests seldom lasted more than 1 year, going down in the first heavy wind. He records better nests going down in a particular hurricane in 1944, when 18 nests were blown right over and many nests "blown out of trees." He does not specify whether these latter were accompanied by broken or supporting branches. Run-of-the-mill hurricanes apparently did little damage to established nests in the area where Broley worked (Broley 1952).

My observations suggest that aerial surveys might be useful in establishing whether Bald Eagle nests are active even when they are abandoned early in the season. Fresh linings appear much lighter and show up well from the air, compared with the weathered tops of old nests which blend with the surrounding branches. Sprays of green pine, one of which was noted during an overflight, were found in active Bald Eagle nests by both Bent (1961) and Herrick (1933), and were cited by Howell (1958) as indicators, along with eagle down, of current or imminent nest occupancy.

A problem encountered frequently during the 6 years of this survey was the finding of other large birds of prey when possibility of Bald Eagle nesting had been reported or rumored. Three possible Bald Eagle nests reported in 1972 in southeastern Ontario turned out to be Osprey nests. Of two reported in 1969 in southwestern Ontario, one was a Red-tailed Hawk nest and the other a mere gathering of Turkey Vultures. Two "possible eaglets" found by boys near Lake Huron in 1971 proved to be downy Red-tailed Hawks. A southwestern Ontario report in 1973 checked out to be a pair of wintering Golden Eagles. Several nests reported as those of Osprey or Red-tailed Hawk proved to have been correctly identified, although one potential Osprey nest in 1974 turned out to be that of a Marsh Hawk. Most of the rumors of Bald Eagle nests came from areas where earlier nests had been definitely known, and since Bald Eagles were indeed sometimes found, a complete survey would require that all rumors and reports be checked to source and/or that the areas be searched.

Literature Cited

Bent, A. C. 1961. Life histories of North American birds of prey. Part 1. Dover Publications, New York. 398 pp.

Broley, C. 1947. Migration and nesting of Florida Bald Eagles. Wilson Bulletin 59(1): 3–20.

Broley, C. 1951. Bald Eagle nesting failures continue. Audubon 53(4): 208.

Broley, C. 1952. Eagle man. Pellegrini and Cudahy, New York. 210 pp.

Herrick, F. 1933. Daily life of the American Eagle: early phase (concluded). Auk 50(1): 35–53.

Holroyd, G. and **A. Wasserfall.** 1969. The status of the Bald Eagle at Long Point. Long Point Bird Observatory Newsletter 1(3): 7–9.

Howell, J. C. 1958. Further history of some Bald Eagle nest sites in East-central Florida. Auk 75(1): 96–98.

Quilliam, H. R. 1965. History of the birds of Kingston, Ontario. Privately printed, Kingston, Ontario. 210 pp.

Quilliam, H. R. 1973. History of the birds of Kingston, Ontario. Kingston Field Naturalists, Kingston, Ontario. 209 pp.

Reynolds, J. K. 1954. Mostly birds. London Free Press, London, Ontario, November 6, 1954.

Reynolds, J. K. 1960. Mostly birds. London Free Press, London, Ontario, February 6, 1960.

Weekes, F. M. 1974. A survey of Bald Eagle nesting attempts in southern Ontario 1969–1973. Canadian Field-Naturalist 88(4): 415–419.

Weekes, F. M. 1975. Behavior of a young Bald Eagle at a southern Ontario nest. Canadian Field-Naturalist 89(1): 35–40.

Received 26 July 1974
Accepted 13 June 1975

Notes

The King Eider in Ontario

The King Eider, *Somateria spectabilis* L., occurs regularly but in small numbers in Ontario. The species was probably never common along the Hudson and James Bay coast, as few of the early Hudson's Bay Company employees reported the birds. Breeding has occurred at McConnell River and South Twin Island, Northwest Territories and at Stupart Bay and Kogaluk River, Quebec (Godfrey 1966). Hearne (1958) reported the species as common in the vicinity of Churchill, Manitoba, about 1770.

Northern Ontario Records

This eider probably does not breed commonly in Ontario and no nests have been found. Two females and five young from their broods were collected in July 1947 at Cape Henrietta Maria (Manning 1952), but the specimens have since been lost. An adult female with a brood patch was collected on 5 July 1957 near Walrus Island; the specimen is in the Royal Ontario Museum (ROM specimen 92319). There are additional specimens which are not valid as breeding evidence. An immature (sex unknown), capable of flight, was shot by a hunter at Long Point Shoal (51°20′ N, 80°30′ W) on 22 September 1974. One wing from this specimen is in the collection of the Ontario Ministry of Natural Resources at Toronto. In June 1932 a male was shot at Fort Severn by Hugh Conn but this specimen has been lost. A female (age unknown) was collected on 2 August 1944 on Cape Henrietta Maria (ROM 71442) and an adult male was taken on 14 July 1957 near Neskamamige on Cape Henrietta Maria (ROM 92315). There are several sight records, mostly adult males, from the Hudson Bay Coast, primarily Cape Henrietta Maria. I estimate that there are at present no more than 200 breeding pairs from Cape Henrietta Maria to the Manitoba border.

Southern Ontario Records

The status of the species in southern Ontario has been variously recorded. McIlwraith (1886) gave no direct evidence of the species. Delacour (1959) and Bent (1925) reported the bird as a frequent winter resident on the Great Lakes whereas Godfrey (1966) described the species as being a rare resident in winter on the St. Lawrence River and the Great Lakes. Currently, the bird is an irregular migrant and rare winter resident. Although there are no Ontario band recoveries, it is probable that many of those individuals that do occur in southern Ontario originate on breeding grounds located outside the province. Many of these birds migrate to wintering grounds along the Atlantic coast of North America although it is likely that a few winter in leads in the ice near the Belcher Islands and elsewhere in Hudson Bay. Specimen evidence and observations recorded by Bent (1925) indicate an overland north–south migration route possibly from the south end of James Bay.

The first recorded occurrence of this species in Ontario consists of bones from the Inverhuron excavations, Bruce County, dated at about 1150 B.C. (Dr. H. Savage, ROM, personal communication). As many as 18 were reportedly taken in Lake Erie near Buffalo in November 1879 and two individuals, of unknown origin, were sent from Toronto to a Paris exhibition in 1867 (McIlwraith 1886). Whereas about 1900 flocks numbering as many as 75 individuals occurred in southern Ontario (Eifrig 1910), most recent reports are of pairs or individuals. In addition to numerous sight records, primarily in the vicinity of Lake Ontario, there are seven Ontario specimens in the National Museum of Canada and 50 in the Royal Ontario Museum (Figure 1). Wings from five individuals that are included as records in Figure 1 were taken by hunters near Brighton; these wings, and one from Moosonee, have been retained by the Ontario Ministry of Natural Resources. A specimen shot near Little Current in the fall of 1971 is currently in the collection at Laurentian University. Among the southern Ontario specimens, five were obtained in the vicinity of Ottawa, 15 near Belleville, Brighton, and Cobourg, 12 in the Whitby-Toronto-Hamilton area, and 18 on the Niagara River. Twelve were taken elsewhere. On 2 December 1960, 10 were collected in Ontario by A. Muma near the Niagara River; six of those were given to the U.S. Fish and Wildlife Service and the four remaining were retained by the Royal Ontario Museum. Only two specimens have been obtained in areas not directly associated with the Great Lakes or Ottawa River. One of these was collected 1 November 1926 at Little Lake, near Barrie and the other was collected on 1 November

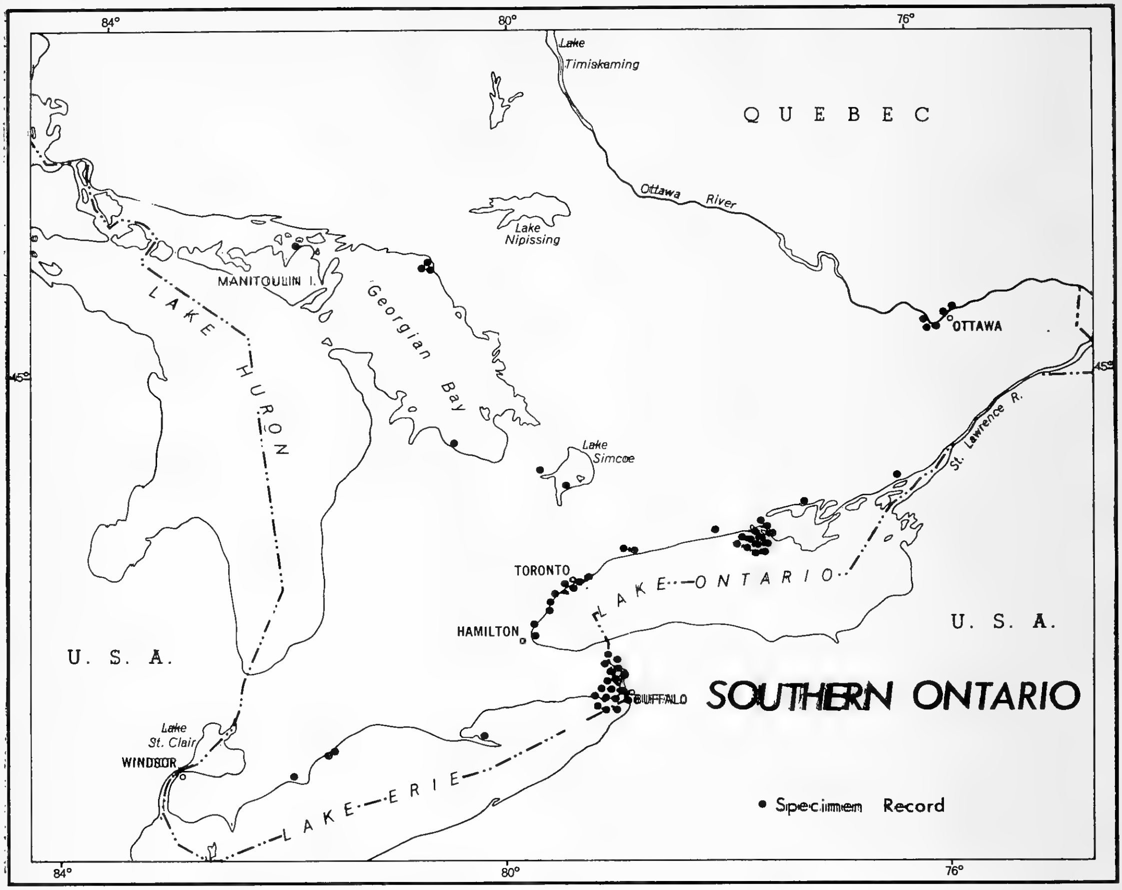


FIGURE 1. Specimen records of King Eider, *Somateria spectabilis* L., in southern Ontario from Royal Ontario Museum, National Museum of Natural Sciences, and Ontario Ministry of Natural Resources.

1969 on Lake Simcoe.

Observations and additional evidence are similarly clustered. According to the records of the Toronto Ornithological Club, the Buffalo Ornithological Society, and the Hamilton Field Naturalists, significant sightings occurred in 1879, 1936, 1948 (all on the Niagara River), 1956 (Hamilton, Port Hope, and Long Branch), 1958 (Oshawa and Clarkson), 1969 (Prince Edward Point and Toronto), and 1970 (Hamilton, Wheatley, and Toronto). A record number of individuals was sighted during the winter of 1966–67 (25 in the Niagara River, 5 at Toronto, and 1 at Sarnia) in southern Ontario, although there were no specimens taken that year. The species was also more common than usual in the autumns of 1959 (15 on the Niagara River), 1972 (5 on the Niagara River), and 1973 (1 at Amherst Island, 5 at Hamilton, and 1 at Kettle Point). On 10 December 1948 two were observed at Loughborough Lake near Kingston and one was collected (specimen lost) in December 1896 at the Thousand Islands (Quilliam 1973). In 1967, 1972, and 1973 a total of four wings of this species was received by the Canadian Wildlife Service during routine harvest surveys. All of these individuals were taken on Lake Ontario. Furthermore, there is no positive correlation between the numbers of sight records and specimens taken annually.

Sight records and specimen evidence suggest November and December are the months of greatest abundance. Thus the arrival of this species in southern Ontario occurs about 1 month after the scoters, *Melanitta* sp., *Oidemia nigra,* and 2 weeks before the Oldsquaws, *Clangula hyemalis*. Furthermore the numbers moving into southern Ontario vary significantly, the species being virtually absent in many years. There are specimen records of occurrences in southern Ontario in 29 of the years since 1889 although more specimens were obtained in 1936, 1957, 1960, and 1974 than in other years. It is suggested that larger numbers of these birds wander into southern Ontario in years when arctic breeding conditions are more favorable and the birds reproduce more successfully. No specimens positively determined as adults have been taken in southern Ontario. Thus fluctuations in abundance may be related to the size of the King Eider population rather than to changes in migration routes or annual weather variations. If the occurrences of this species in Ontario are a result of weather-induced changes in migration routes, then it is unlikely that the birds would repeatedly occur at the same locations.

Literature Cited

Bent, A. C. 1925. Life histories of North American wild fowl. Part II. United States National Museum Bulletin 130. pp. 107–119.

Delacour, J. 1959. The waterfowl of the world (III). Country Life Ltd., London. pp. 38–42.

Eifrig, C. W. G. 1910. The birds of Ottawa. Ottawa Naturalist 24: 152–163.

Godfrey, W. E. 1966. The birds of Canada. National Museum of Canada Bulletin 203. 428 pp.

Hearne, S. 1958. Journey from Prince of Wales Fort in Hudson's Bay to the Northern Ocean, 1769, 1770, 1771, 1772. *Edited by* R. Glover. MacMillan Co., Toronto.

Manning, T. H. 1952. Birds of the west James Bay and southern Hudson Bay coasts. National Museum of Canada Bulletin 125. 114 pp.

McIlwraith, T. 1886. Birds of Ontario. Lawson and Co., Hamilton Association, Hamilton. pp. 65–70.

Quilliam, H. R. 1973. History of the birds of Kingston, Ontario. Kingston Field Naturalists. 216 pp.

R. M. ALISON

Wildlife Management Section, Wildlife Branch
Ontario Ministry of Natural Resources
Queen's Park Crescent
Toronto, Ontario M7A 1W3

Received 4 February 1975
Accepted 28 April 1975

Further New Localities for Certain Coldwater Fishes in Eastern Ontario and Western Quebec

Abstract. The fishes *Cottus ricei, Pungitius pungitius,* and *Percopsis omiscomaycus* are reported in 36 new localities in eastern Canada. A total of 235 localities are now known for these fishes in fresh waters of eastern Ontario and western Quebec. The smelt, *Osmerus mordax,* is reported from 17 new localities in the Gatineau River Valley, Quebec. These new locality records indicate further that the dispersal of these fishes is closely associated with the maximum extent of the large, interconnected, post-Wisconsin glacial lakes, their outlet channels, and areas inundated by postglacial marine waters.

During 1971 and 1972, 242 lakes (in addition to those reported earlier (see Dadswell 1972, 1974)) in eastern Ontario and western Quebec were sampled using a small otter trawl, before termination of a project on the zoogeography of coldwater crustaceans and fishes. One or more of the fishes *Cottus ricei, Pungitius pungitius,* and *Percopsis omiscomaycus* were found in an additional 36 new localities (Table 1). A further 10 published or unpublished records from various sources, that were unknown to me before my previous publication on these fishes (Dadswell 1972), are also listed. This brings to 235 the number of localities known for these species and *Myoxocephalus quadricornis* in the areas of eastern North America influenced by the post-Wisconsin glacial Great Lakes.

These further records continue to show the association of the present day occurrences of these fishes to areas in and around post-Wisconsin glacial lakes and marine inundations (Figure 1; Dadswell 1972). Of the 274 lakes sampled (this paper; Dadswell 1972), considered to be within the glacial-lake – marine boundaries, 162 (59%) were found to contain one or more of these fishes. Conversely, these species were found in only 35 (10%) of 359 lakes sampled which are considered to be outside the boundaries.

The smelt, *Osmerus mordax,* is present in the Ottawa Valley of eastern Ontario and western Quebec as a relict of the post-glacial invasion of the Champlain Sea (Dymond 1939; Delisle and Veilleux 1969). Like the other four fishes it is susceptible to capture by otter trawling, and in the course of our work it was found in 17 new

TABLE 1 — Localities in which one or more of the coldwater fishes were found. Number of locality follows in order after Dadswell (1972). Plus sign (+) indicates presence of species. Sources of records are as follows: new records (n. rec.); Service de la Faune de Quebec (SFQ); Ontario Ministry of Environment (OME); literature record (author's name and date of publication). Unless otherwise specified all localities refer to lakes

Number	Locality	Lat.	Long.	*Cottus ricei*	*Pungitius pungitius*	*Percopsis omiscomaycus*	Source of record
190.	Assinica	50° 35′	75° 20′	—	+	—	SFQ
191.	Vimont	49° 43′	73° 57′	—	—	+	n. rec
192.	Jim	49° 00′	72° 46′	+	+	+	SFQ
193.	la Treve	49° 45′	75° 33′	+	—	+	n. rec.
194.	Goeland	49° 45′	76° 50′	+	—	—	"
195.	Mattagami	50° 00′	73° 30′	+	—	+	"
196.	Bachelor	49° 33′	76° 05′	+	—	+	"
197.	Pustimica	49° 20′	76° 24′	—	—	+	"
198.	Maude	48° 20′	76° 45′	—	—	+	"
199.	Faillon	48° 25′	76° 45′	—	—	+	"
200.	Chicobi	48° 50′	78° 30′	—	—	+	"
201.	Castagnier	48° 45′	77° 46′	—	—	+	"
202.	Lois	48° 34′	78° 45′	—	—	+	"
203.	Malarctic	48° 15′	78° 05′	—	—	+	"
204.	Mourier-Lemoine	48° 00′	78° 10′	+	—	+	"
205.	Kenogamissi	48° 13′	81° 33′	—	—	+	"
206.	St. Anthony	47° 58′	79° 43′	+	—	—	"
207.	Kinogami	47° 49′	80° 08′	—	—	+	"
208.	Mountain	47° 38′	80° 12′	—	—	+	"
209.	Longpoint	47° 42′	80° 37′	—	+	+	"
210.	Mendelssohn	47° 33′	80° 13′	+	—	—	"
211.	Lady Evelyn	47° 20′	80° 12′	+	—	—	"
212.	Wakimika	47° 08′	80° 20′	—	+	—	"
213.	Descelles	47° 45′	78° 14′	—	—	+	"
214.	Bernard	45° 45′	79° 23′	—	—	+	OME
215.	Pickerel	45° 41′	79° 18′	+	—	—	n. rec.
216.	Wauquimakog	45° 50′	80° 00′	—	—	+	"
217.	Wahwashkesh	45° 45′	80° 03′	+	—	—	"
218.	Manitouwabing	45° 30′	79° 55′	+	—	—	"
219.	Lake of Bays	45° 15′	79° 00′	—	—	+	OME
220.	Little Hawk	45° 09′	78° 43′	—	+	—	OME
221.	Wensley	45° 03′	78° 04′	+	—	—	n. rec.
222.	Calabogie	45° 16′	76° 45′	—	—	+	"
223.	Nottawissi	47° 07′	75° 30′	—	+	+	"
224.	Marguerite	47° 02′	75° 48′	—	+	—	"
225.	Petawaga	47° 00′	75° 55′	—	+	+	"
226.	Piscatosine	46° 55′	75° 37′	—	—	+	"
227.	Green	46° 05′	75° 58′	—	+	—	"
228.	Ramsey Creek	45° 25′	75° 30′	—	—	+	"
229.	Labelle	46° 12′	74° 50′	—	+	—	"
230.	à Beauce	47° 18′	72° 46′	+	—	—	"
231.	Simon	48° 10′	69° 02′	—	+	—	"
232.	Rivière Etchemin	46° 35′	71° 00′	—	—	+	SFQ
233.	Rivière Chaudière	46° 30′	71° 00′	—	—	+	SFQ
234.	Massaquoi River	45° 04′	72° 30′	—	—	+	Richardson (1935)
235.	Keuka	42° 30′	77° 10′	—	+	—	Royce (1951)

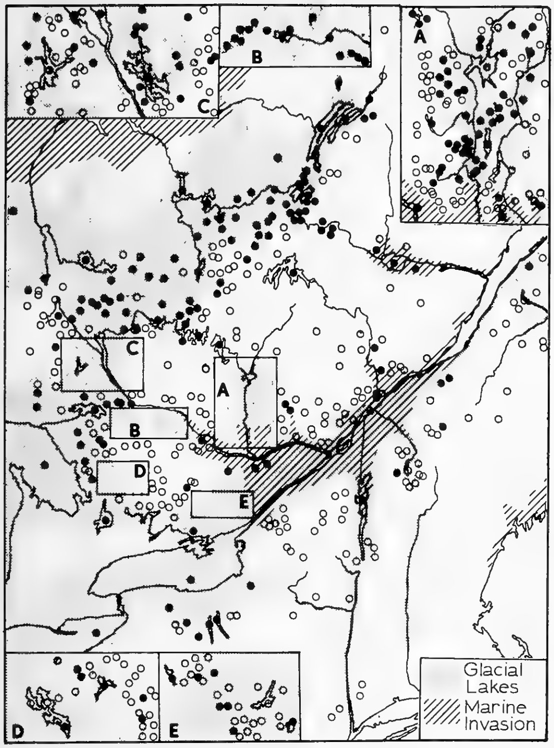


FIGURE 1. Known distribution of coldwater fishes in eastern North America. Closed circles (●) are localities in which one or more of the species are known; open circles (o), none have been found. Maximum extent of late-Wisconsin glacial lakes and marine transgressions are after Prest et al. (1968) and Dadswell (1974).

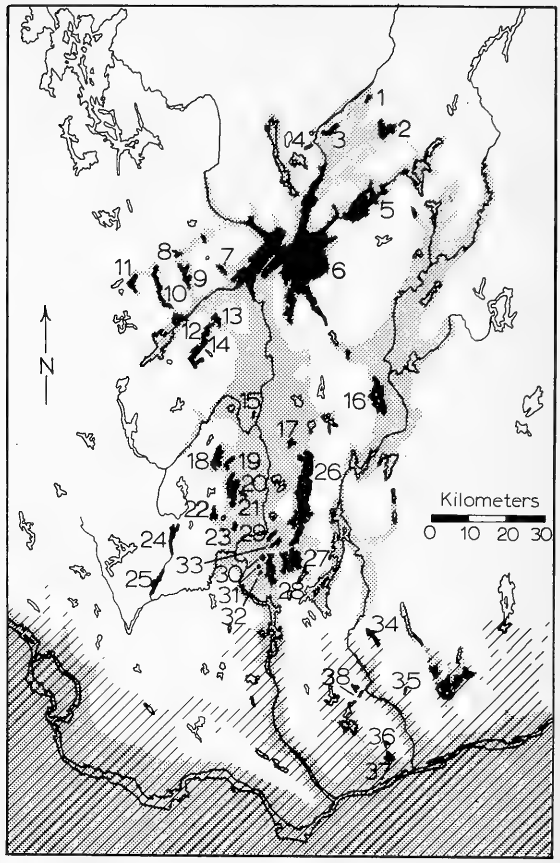


FIGURE 2. Localities (solid lakes and numbers) in which smelt have been found in the Gatineau and Lievre Valleys, Quebec. Numbers refer to localities in Table 2. Open lakes are those sampled in which no smelt were found. Maximum extent of Champlain Sea (crosshatching) is after Prest et al. (1968); glacial Lake Gatineau and later Champlain Sea (shading) is after Dadswell (1974).

localities in the Gatineau Valley region of Quebec (Figure 2). This brings to 38 the number of localities in this region where the smelt is known (Table 2).

Delisle and Veilleux (1969) consider the smelt's presence in the Gatineau Valley lakes to be due to the inundation of the region by the Champlain Sea. This is not strictly true since the sea waters only covered the lower portion of the valley (Figure 2; Gadd 1971) and most of the occurrences are north of this. Apparently the bulk of dispersal to these lakes occurred through the later stages of glacial Lake Gatineau, which was directly connected to the Champlain Sea during its early phases (Figure 2; Dadswell 1974). Smelt dispersal seems to be limited mainly to standing water, as only 2 of the 33 known localities in the Gatineau Valley are outside the bounds of glacial-lake and/or marine-inundated areas.

The distribution patterns of these five small coldwater fishes indicate the following: (1) their primary means of dispersal are standing fresh or marine waters; (2) upstream dispersal is limited; (3) most of their dispersal took place during the time of the large post-glacial water bodies (before 6000 years ago); (4) their distribution patterns have remained relatively static since that time.

Series of fish specimens from all locations have been deposited at the National Museum of Natural Sciences, Ottawa, and the Royal Ontario Museum, Toronto.

This work was supported by the National

TABLE 2 — Localities in which natural-occurring smelt are known in the Gatineau and Lievre River Valleys, Quebec. Number of locality indicates position of record in Figure 2. Sources of records are as follows: new records (n. rec.); Delisle and Veilleux (1969) (D. & V.); Service de la Faune de Quebec (SFQ). All localities refer to lakes

Number	Locality	Source
1.	l'Esturgeon	n. rec.
2.	Nottawissi	"
3.	Crevier	"
4.	Cobble	"
5.	Piscatosine	"
6.	Baskatong	"
7.	Quinn	"
8.	Serpent	"
9.	de la Vieille	"
10.	Tomasine	"
11.	Savary*	D. & V.
12.	Rond	n. rec.
13.	Lytton	"
14.	Bras Coupé*	D. & V.
15.	Gilmore	n. rec.
16.	des Iles	D. & V.
17.	Bois Franc	n. rec.
18.	Grand Cèdres*	D. & V.
19.	Petit Cèdres*	"
20.	Blue Sea*	D. & V.
21.	Grant	"
22.	des Iles*	"
23.	Paquin	n. rec.
24.	Cayamant*	D. & V.
25.	Petit Cayamant	n. rec.
26.	Thirty-one Mile	D. & V.
27.	Pemichangan	"
28.	Heney*	"
29.	Bitobi	n. rec.
30.	Desormeaux	D. & V.
31.	Noir	"
32.	Green*	"
33.	St. Laurent	"
34.	Clay*	"
35.	Cole	"
36.	Plumbago	SFQ
37.	Donaldson	D. & V.
38.	Dodds	SFQ

* Presence confirmed by my sampling.

Museum of Natural Sciences, The Canadian National Sportsmen's Show, The Royal Ontario Museum, and National Research Council of Canada grants to E. L. Bousfield and H. F. Howden. Don Moxley assisted in the field.

Literature Cited

Dadswell, M. J. 1972. Postglacial dispersal of four deepwater fishes on the basis of new distribution records in eastern Ontario and western Quebec. Journal of the Fisheries Research Board of Canada 29: 545–553.

Dadswell, M. J. 1974. Distribution, ecology, and postglacial dispersal of certain crustaceans and fishes in Eastern North America. National Museums of Canada Publications in Zoology 11. 110 pp.

Delisle, C. and **C. Veilleux.** 1969. Répartition géographique de l'éperlan Arc-en-ciel *Osmerus eperlanus mordax* et de *Glugea hertwigi* (Sporozoa : Microsporidia) en eau douce, au Québec. Naturaliste Canadien 96: 337–358.

Dymond, J. R. 1939. The fishes of the Ottawa region. Contributions of the Royal Ontario Museum in Zoology 15: 1–43.

Gadd, N. R. 1971. Marine deposits, Gatineau Valley, Quebec. Geological Survey of Canada, Annual Report 71: 156–157.

Prest, V. K., D. R. Grant, and **V. N. Rampton.** 1968. Glacial map of Canada. Geological Survey of Canada, Department of Energy, Mines and Resources, Map 1253A.

Richardson, L. R. 1935. The freshwater fish of southeastern Quebec. Ph.D. thesis, McGill University, Montreal, Quebec. 196 pp.

Royce, W. F. 1951. Breeding habits of lake trout in New York. United States Fish and Wildlife Service, Bulletin 59, Volume 52: 59–76.

MICHAEL J. DADSWELL[1]

Department of Biology
Carleton University
Ottawa, Ontario K1S 5B6

[1]Present address: Huntsman Marine Laboratory
St. Andrews, New Brunswick

Received 16 April 1975
Accepted 13 June 1975

Red Fox Attack on Beaver

At 1400 hours, 28 January 1970, we observed a live adult female beaver (*Castor canadensis*) in 30–45 cm snow on a bog near the southern shore of the Avalon Peninsula, Newfoundland. The observation was unusual since at that time of year Newfoundland beaver normally are confined to lodges, dependent on food on the browse pile stored beneath the ice. The day was clear with no wind, and the temperature was about −5°C. It had been −18°C the previous night.

We left, but returned 2 h later and flushed a red fox (*Vulpes vulpes*) away from the beaver.

The beaver was still in the same place with about 3 m^2 of snow beaten down around it. The skin on the beaver's head was torn from the eyes to the nose, with profuse bleeding. The rear half of the tail was broken off and fur had been pulled out in places. Although alive, the beaver was unable to move about, and a trapper killed it. The legs and tail were frozen.

The beaver had dug through the snow to the ground and had been feeding on the stems of dwarf juniper (*Juniperus communis*) and Labrador tea (*Ledum groenlandicum*) at the attack site. These plants usually are not eaten by beaver, but little else was available at the site. Snow had fallen the previous day, but the beaver's tracks could be followed about 100 m back. There it apparently had dug a hole in the snow, probably to feed on dwarf juniper and Labrador tea. There were no visible tracks beyond the hole. The closest open water was a river 0.5 km away. The river ice was about 1 m thick, and all ponds were frozen.

This apparently is the first reported incident of a fox attacking a beaver. F. M. Packard (1940, Journal of Mammalogy 21(3): 359–360) described a situation in which a coyote (*Canis latrans*) killed an adult beaver 0.5 km from its emergence hole through the ice. Packard suggested that the beaver's emergence may have resulted from an overpopulation of beaver in that area. The same could hold for the red fox attack on the beaver.

The beaver's stomach was relatively empty compared to those of other beaver trapped in the area during this time of year. There was limited beaver food in the bog and barren-ground country surrounding where this beaver was found. Moreover, the beaver's old age (16.5 yr), determined from cementum annuli, may have produced a weakened condition, perhaps to the extent that she was unable to store adequate food in the fall. Other possibilities are that she was excluded from a colony through competition for a food supply too low to support all members, or shallow ponds of marginal beaver habitat may have frozen solid, leaving the beaver with no access to the stored browse pile. In any case, it seemed evident the beaver would have starved or frozen to death had she not been attacked by the fox.

NEIL F. PAYNE[1] and CON FINLAY

Newfoundland Wildlife Division
Building 810, Pleasantville
St. John's, Newfoundland

[1] Present Address: College of Forest Resources
University of Wisconsin – Stevens Point
Stevens Point, Wisconsin 54481

Received 25 October 1974
Accepted 21 May 1975

Additions to the Adventive Flora of Vancouver Island, British Columbia

Introduced plants form a considerable portion of the flora of any populated area. In British Columbia they represent one fifth to one third of the total flora (cf., Calder and Taylor 1968; Szczawinski and Harrison 1973).

There are three major types of introduced plants (Holub and Jirasek 1967). The first type, ephemerophytes, cannot establish in the new environment, surviving only for a limited period of time (e.g., *Sedum acre* L. in our area). The second type, epoecophytes, consists of species which occupy areas under relatively strong human influence. This is the largest group of introduced species, represented by ruderal and weedy plants (e.g., *Conium maculatum* L., *Chenopodium* ssp., etc.). The last type, neoindigenophytes, represents plants which spread easily in undisturbed vegetation types, become unwanted dominants, and change the physiognomy and structure of indigenous vegetation. *Cytisus scoparius* (L.) Link has spread successfully throughout rock outcrops, light Garry oak forests, and dry Douglas fir forests on Vancouver Island. The grasses *Anthoxanthum odoratum* L., *Cynosurus echinatus* L., and *Aira praecox* L. have also become well established in natural outcrop vegetation and open Garry oak forests.

It is difficult to predict the future behavior of newly introduced plants. The present paper focuses on some introduced species on Vancouver Island and establishes a basis for monitoring their distribution. Most of them have not been reported from British Columbia.

Juncus canadensis J. Gay

This species, native to Eastern North America, is well established on Vancouver Island in the Long Beach area (Ucluelet, Tofino, Kennedy Lake), growing in wet disturbed places. There are several collections in local herbaria (UBC, UVIC, V) collected since 1963 and mostly misidentified as *Juncus acuminatus* Michx: Ucluelet, boggy ground, *T. M. C. Taylor 6730*, 19 August 1963 (UBC, V); Long Beach, common in wet ditches in camp site, *M. Bell s.n.*, 15 August 1965 (UBC); Long Beach, bog on Wickanninish Inn Road, *A. Ceska 465*, 30 November 1969 (UVIC); Long Beach, bog at start of Wickanninish Inn Rd., *A. Harcombe & B. Wille 81807*, 18 August 1971 (UVIC).

Juncus canadensis is similar to *Juncus acuminatus*. Both have septate leaves, three stamens, and acute capsules; but in *J. canadensis* the seeds have appendages and the inner perianth segments are distinctly longer than the outer ones, while in *J. acuminatus* the seeds lack appendages and all the perianth segments are of the same length.

Juncus canadensis belongs to an aggregate of related taxa with complicated taxonomy and nomenclature. One of these, *Juncus brevicaudatus* (Englm.) Fernald, was reported from Ucluelet by Carter and Newcombe (1921) and mentioned in "Excluded species" by Eastham (1947) and by Boivin (1967). It is very probable that Carter and Newcombe's *J. brevicaudatus* in fact refers to our species. This would suggest its early introduction, possibly with cultivated cranberries, *Oxycoccus macrocarpos* (Ait.) Pursh (cf. Boivin 1967).

Mentha pulegium L.

Abundant on the public beach on the northern shore of Shawnigan Lake (*Ceska s.n.*, 13 August 1970, UVIC; *E. Dunn s.n.*, 1 October 1970, UVIC). This European species became established in California (Munz 1959) and in the Willamette and Umpqua Valleys of Oregon (Peck 1941). It can be distinguished from *Mentha arvensis* L. by its smaller size, prostrate stolons, and small leaves which have only about three pairs of veins.

Saxifraga tridactylites L.

Saxifraga tridactylites, a European species with a subatlantic-submediterranean distribution, grows on rock outcrops and fortifications on Fort Rodd Hill near Victoria (*O.&A. Ceska s.n.*, 11 May 1974, UVIC). Fort Rodd Hill was used as a military fortress from 1896 to 1956 on the Belmont Farm site (dating about 1850). *Saxifraga tridactylites* may have been introduced long ago with livestock and hay from England. I have not found any previous report of this species from North America.

Saxifraga tridactylites is a lowland annual with basal leaves which do not persist to the fruiting stage, stem that is branched from the lower half, and pedicels that are longer than the flowers (see Figure 1); whereas the similar native species, *S. adscendens* L., is an alpine biennial with a rosette of basal leaves which persist until fruiting time, branches in the upper half, and pedicels that are shorter than the flowers.

Trifolium fragiferum L.

This species has been reported from Washington, Oregon, Idaho, and California. In British Columbia it has been collected by *V. J. Krajina* (Cawston/Similkameen, 20 August 1950, DAO) and listed from southwestern British Columbia, with a question mark, by Boivin (1966). It grows in farmlands in the Saanich Peninsula south of Victoria International Airport (farms between the airport & McTavish Road, *Ceska s.n.*, August 1974, UVIC). This species, native to Europe, is easily recognized by its calyces which are inflated after anthesis. Our plants belong to *Trifolium fragiferum* subsp. *bonannii* (C. Presl) Soják (= *T. neglectum* C. A. Meyer).

Trifolium subterraneum L.

Trifolium subterraneum, a European species with a subatlantic-submediterranean distribution, was introduced to the United States and became established in California, Oregon, and Washington. From our area it was reported from the Saanich Peninsula north of Victoria by Szczawinski and Harrison (1973) from one collection (Deep Cove, *J. R. Shestone*, 1941). It was recently recollected in the same area (old farm on Queenswood Development area, North Saanich, *Bell, Bonell & Roemer s.n.*, 22 May 1970, UVIC). *Trifolium subterraneum* is common in pastures northwest of Victoria in the Rocky Point, Becher Bay, and East Sooke Park areas (Edye Point, *S. Mitchell 428*, 16 May 1974; Creyke Point, *O.&A. Ceska s.n.*, 19 May 1974; Aldridge Point, *O.&A. Ceska s.n.*, 19 May 1974, UVIC).

Trifolium subterraneum can be easily distinguished from other clovers of the area. The outer flowers of the head are fertile with a distinct purplish coloration of the calyces and long filiform calyx lobes. The inner flowers consist of sterile calyces. Fruiting heads are pressed into the soil by recurved peduncles and the fruits ripen underground.

I thank my wife for preparing the illustration and for her invaluable assistance in the field, and W. J. Cody and R. L. Taylor for their comments on the manuscript.

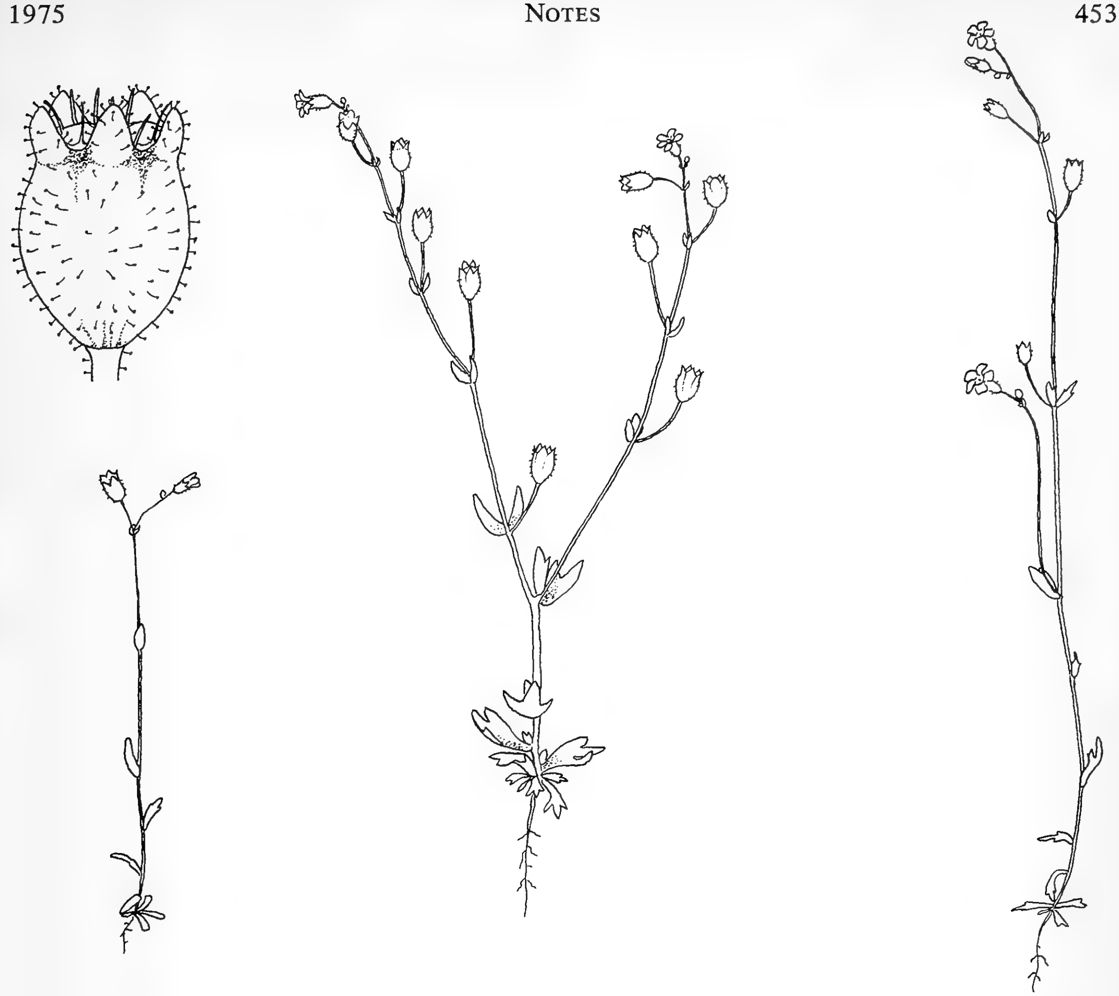


FIGURE 1. *Saxifraga tridactylites* L. Orig. O. Češka

Literature Cited

Boivin, B. 1966. Enumération des plantes du Canada. II, Lignidées. Naturaliste Canadien 93: 371–437.

Boivin, B. 1967. Enumération des plantes du Canada. VII, Résumé statistique et régiones adjacentes. Naturaliste Canadien 94: 625–655.

Calder, J. A. and **R. L. Taylor.** 1968. Flora of the Queen Charlotte Islands. Part 1, Systematics of the vascular plants. Canada Department of Agriculture. 659 pp.

Carter, W. R. and **C. F. Newcombe.** 1921. A preliminary catalogue of the flora of Vancouver and Queen Charlotte Islands. Provincial Museum of Natural History, Victoria. 86 pp.

Eastham, J. W. 1947. Supplement to Flora of Southern British Columbia (J. K. Henry). British Columbia Provincial Museum, Special Publication Number 1. 119 pp.

Holub, J. and **V. Jirasek.** 1967. Zur Vereinheitlichung der Terminologie in der Phytogeographie. Folia Geobotanica et Phytotaxonomica 2: 69–113.

Munz, P. A. 1959. A California flora. University of California Press, Berkeley & Los Angeles. 1681 pp.

Peck, M. E. 1941. A manual of the higher plants of Oregon. Binfords & Mort Publishers, Portland, Oregon. 866 pp.

Szczawinski, A. F. and **A. S. Harrison.** 1973. Flora of the Saanich Peninsula. Annotated list of vascular plants. British Columbia Provincial Museum, Occasional Papers Number 16. 114 pp.

ADOLF ČEŠKA

Department of Biology
University of Victoria
Victoria, British Columbia V8W 2Y2

Received 19 April 1975
Accepted 4 June 1975

Nesting of Purple Martins in Natural Cavities and in Man-made Structures in Alberta

Prior to the white man's arrival in North America, the Purple Martin (*Progne subis*), our largest swallow, primarily nested in cavities that had been made and then abandoned by various species of woodpeckers (Allen and Nice 1952).

In Alberta, according to K. Wood (personal communication) the settlers of the 1890s in the central part of the province reported martins being well established in tree cavities at Pine, Sylvan, and Honeymoon Lakes and near Buffalo and Gull Lakes. T. E. Randall (personal communication) noted for Alberta that martins occurred ". . . in the extensive muskeg north and west of Westlock. All through that region, where the poplar ridges, which intersect the muskeg, have been burned over, leaving tall stumps in abundance, the martins are at home, nesting in old woodpecker nest holes." In the 1920s and 1930s martins nested in tree cavities along the shores of South Cooking Lake (A. Allan, personal communication). Allan further claims that in the 1930s Purple Martins were commonly seen in the nesting season in the area between Leduc and Cooking Lake, south of Edmonton. H. Burns (personal communication) writes that "old timers have informed me of black swallows nesting a few miles east of Leduc as early as 1910. These small colonies remained until an elderly resident (Mr. Saunders) erected a few nesting boxes in town (Leduc) and succeeded in getting them established on his property. By the time of his death in the late 1920s this was a very large colony." In recent years Burns has observed these birds occupying cavities in trees west of Warburg. North of Edmonton, R. Lister (personal communication) reported martins occupying cavities in trees at Big Lake, near St. Albert, in 1955. H. M. Laing (personal communication) reported a few pairs nesting in tree cavities near Lac la Nonne in 1926. D. Sterling (personal communication) located two or three pairs of martins nesting in tall snags south of Calling Lake in 1948. A. J. Erskine (personal communication) noted martins ". . . on 14 of 40 days, with a maximum day count of 6, in the heavily forested area north of Lesser Slave Lake." In addition Erskine found Purple Martins to be fairly common along the Atikameg road, north of Lesser Slave Lake in June–July 1964 (Sadler and Myres, *in press*). It appears from these records that the Purple Martin probably has always nested in natural cavities in small numbers in central Alberta.

K. Wood writes (personal communication) that the first man-made martin nest boxes in Red Deer were erected around 1920, and Farley reported the first pair nesting in boxes at Camrose in 1918 (Bent 1942, p. 498). T. E. Randall, while a warden at Elk Island National Park, attracted the park's first martins to man-made boxes in 1937. Before 1939 martins nested at Kavanaugh in man-made boxes (Allan, personal communication).

In Edmonton, the first martins to be interested in a man-made box appeared in a yard in the Garneau district (M. Fisher, personal communication). Her first bird house was erected in 1935 and was visited that summer by three birds, but no nesting occurred. In 1937, a pair (the male was immature) built a nest and six eggs were laid. This clutch was later destroyed by a wren! The birds were not reported nesting again in Edmonton until 1946. In that year a pair once again appeared in the Fisher yard and nested, and a second pair nested in a house erected by A. Allan. These two large nest boxes, each holding 12–16 pairs, prospered until today there are about 2000 pairs of Purple Martins nesting in municipal Edmonton (Finlay 1971).

The Purple Martin is being assisted by man to extend its nesting range to the south. Bird and Bird (1971) reported that the first direct evidence of nesting in Calgary was in 1971, however, with the lack of success probably due to starlings breaking the martins' eggs. A recent band return of a bird marked at Edmonton and recovered in an outhouse that had a hole cut in the top, which presumably simulated a cavity, at Manyberries in southeast Alberta in May, indicates either that martins may be looking for new nest areas out on the plains or migrating across them. It is suggested, therefore, that a southern extension of their nesting range may be limited only by insufficient nest cavities.

My banding returns indicate that there is a mixing of the gene pool in the Edmonton area. A bird fledged in Edmonton nested at Sylvan Lake, 85 mi to the south, and an Elk Island National Park bird banded as a nestling was recovered a year later 25 mi to the west at Sherwood Park, a community adjacent to Edmonton. Limited returns from banding also indicate that Edmonton birds migrate east past Battleford, Saskatoon and then southeast until south of Winnipeg, Manitoba; it appears that they follow the old tree contact between prairie and aspen parkland.

It is interesting to note the similarity between the history of the nesting habits of Purple Martins and the Common Swift (*Apus apus*) of Europe. The swift now nests primarily in man-made structures (under roofs, in castle walls, church steeples, etc.). In Scandinavia, however, the swift still nests in trees (Peterson et al. 1954) and in Russia where "with the growth of towns it is extending its range, e.g., in the Urals it formerly was only found in wooded areas but now nests in towns in treeless localities (Harber 1955, p. 224). Montbeillard (1793, 1797) thought that, in eastern France at the end of the 18th century, urban-dwelling Common Swifts spent the night in the woods where non-urban swifts were then breeding. Harber (1955) also stated on the same page that in the Soviet Union "The Swift (*Apus apus*) when nesting in forests (as it frequently does) makes use not only of old woodpeckers' holes but of any suitable cavity in trees." Size for size, it is almost as though the Purple Martin replaces the Common Swift—one a passerine, and the other an apodi form—in North America in nesting habits and in making the switch from natural cavities to man-made structures.

I thank A. J. Erskine and M. T. Meyers for comments on this note.

Literature Cited

Allen, R. A. and **M. M. Nice.** 1952. A study of the breeding biology of the Purple Martin (*Progne subis*). American Midland Naturalist 47: 606–665.

Bird, C. D. and **A. Bird.** 1971. The status of the Purple Martin in the Calgary area. Calgary Field Naturalist 3: 48–49.

Bent, A. C. 1942. Life histories of North American flycatchers, larks, swallows and their allies. Smithsonian Institute, United States National Museum Bulletin 179: 489–509.

Finlay, J. C. 1971. Breeding biology of Purple Martins at the northern limit of their range. Wilson Bulletin 83: 255–269.

Harber, D. D. 1955. Special reviews. The birds of the Soviet Union. Under the general editorship of G. P. Dementiev and N. A. Gladkov. British Birds 48: 218–224.

Montbeillard, P. G. de. 1793. The Swift. *In* Natural history of birds. Volume 6. Count de Buffan (*From the French*). London. pp. 534–547.

Montbeillard, P. G. de. 1797. Le Martinet Noir. *In* Histoire naturelle des oiseaux. Volume 6. Count de Buffan. Blusse et fils, Dordrecht. pp. 327–335.

Peterson, R., G. Mountfort, and **P. A. D. Hollom.** 1954. A field guide to the birds of Britain and Europe. Collins, London.

Sadler, T. S. and **M. T. Myers.** Alberta birds, 1961–1970. Provincial Museum of Alberta, Edmonton. pp. 138–139.

J. Campbell Finlay

Site 9, R.R. 2
Sherwood Park, Alberta T8A 3K2

Received 26 March 1975
Accepted 18 May 1975

Bald Eagle and River Otter

The wardens of Terra Nova National Park, Newfoundland, report that a bald eagle (*Haliaeetus leucocephalus*) and a river otter (*Lutra canadensis*) had a fatal encounter in the park during January 1975. The eagle, although unmarked, apparently was a permanent resident which had been observed regularly by park officials and residents of the Eastport Peninsula during the last three or four years. It was commonly seen both winter and summer on a small island directly beside the causeway which links the peninsula and the park. Beginning during the summer of 1974 three river otters became regular inhabitants of the salt-water inlet which surrounds the causeway. On 6 January, the eagle, one of the otters, and an unidentified fish were found dead on the ice of the inlet. Both of the eagle's wings were broken, and the otter's body showed wounds which appear to have been caused by the eagle's talons. Both bodies were examined in detail; there was no evidence of gunshot or any other such wounds. The wardens speculate that the mutually fateful encounter surrounded possession of the fish.

I thank Terra Nova National Park warden Jim Matchim for details on the eagle.

Michael Rosen

831–100th Avenue
Laval, Quebec

Received 12 March 1974
Accepted 25 April 1975

New Data on the Distribution of the Moss *Schistostega pennata* in Alberta

During the summer of 1974, while conducting studies of the effects of natural gas-processing plant emissions on epiphytic lichens in west-central Alberta, I made four collections of *Schistostega pennata* (Hedw.) Hook. & Tayl. This moss is characteristically found in caves associated with sandstone rocks but also occurs in other dark recesses (Crum 1973). *Schistostega pennata* has a unique protonema which has earned it the common names of goblin's gold and luminous moss. The persistent protonema is frequently evinced *in situ* by a yellow-green luminescence produced when light is reflected from chains of spherical vesiculose cells. Each of these cells contains a few chloroplasts on the side of the cell away from the incident light. The parallel rays of light reaching the cells are refracted so as to form a cone of light illuminating the green chloroplasts. Any light not absorbed by the chloroplasts is reflected and produces the luminous appearance, looking as if innumerable tiny emeralds had been scattered over the deeply shaded soil. If these treasures, like the legendary goblin's gold, are removed to the light, however, the luminescence disappears leaving only damp earth.

Schistostega pennata is known from Europe, mainland Asia, and Japan, and in North America from British Columbia, Washington, and Alberta in the west, to Newfoundland and Rhode Island in the east. This species is primarily one of coniferous forest areas and is fairly widely distributed although it is rarely found or reported. The new locations reported here are from the northern limit of the species' range in North America.

The species has been found in six places in Alberta. My observations were made on four collections at three different locations (Figure 1), where it was growing in recesses under upturned roots of toppled trees in moist, rich, mature stands. The height of sterile gametophytes was about 7.0 mm. The green gametophytes of fertile plants were about 4.5 mm tall and each bore a green sporophyte about 6.5 mm long. The seta was soft, green, mostly erect, bearing a small (0.4–0.5 mm high) capsule lacking an annulus and peristome. Figure 2 shows a sterile gametophyte, a female gametophyte with sporophyte, and a mature male gametophyte.

My first collection was made on 27 June, 2 miles south of Smoke Lake, 50°20′ N, 116°55′ W. The plants were found growing under the rootpan of a toppled lodgepole pine tree in lodgepole pine – white spruce – balsam poplar woods at an elevation of about 2850 feet above sea-level.

The second and third collections were made on 28 July, 2 miles north of Highway 43 on the Heavy Sound Forestry Road, 8 miles north of Windfall (54°19′ N, 116°15′ W). These were found in recesses under the rootpans of toppled white spruce trees, in lodgepole pine – white

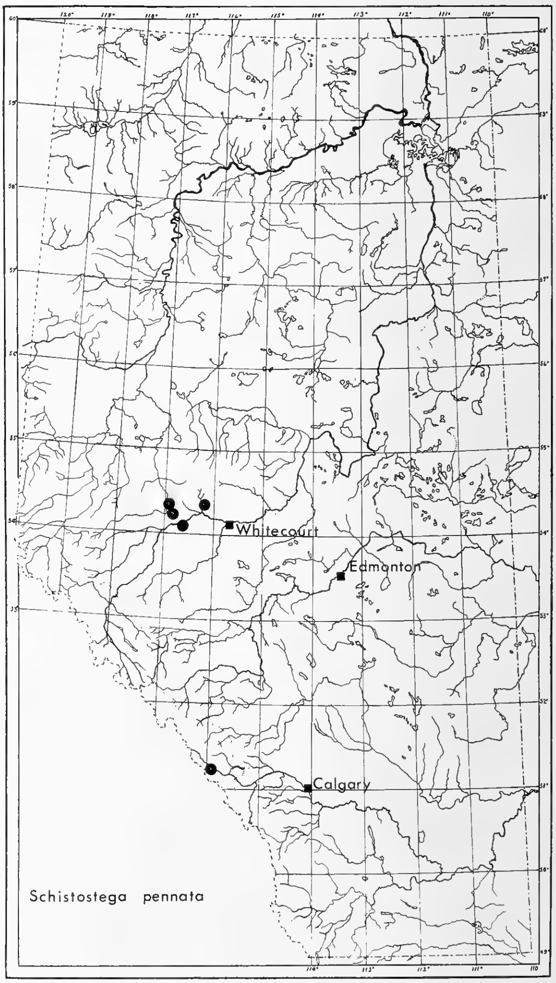


FIGURE 1. Location of *Schistostega pennata* collection sites in Alberta.

FIGURE 2. Habit of *Schistostega pennata*: (A) mature sterile gametophyte; (B) mature sporophyte on female gametophyte; (C) mature male gametophyte. Drawing by C. N. Crack.

spruce woods, at an elevation of about 3250 feet.

The fourth collection was made on 10 August, in lodgepole pine – white spruce – balsam fir woods, 26 miles south of Fox Creek (54°05′ N, 116°37′ W), at an elevation of about 3300 feet. Again, the plants were found under the rootpan of a toppled white spruce tree.

In Alberta, the species has been reported previously by Macoun (1892) from Castle Mountain (now Mount Eisenhower) in the Rocky Mountains (54°15′ N, 115°55′ W). Lawton (1971) reported it from Alberta but gave no location. It seems likely that she was referring to the Macoun collection just mentioned. An unreported collection was made by C. D. Bird (7229, personal communication) in 1961, 0.5 mile southeast of Pass Creek Tower, south of Fox Creek (54°14′ N, 116°50′ W) (Figure 1).

Voucher specimens have been deposited in the Herbaria of the University of Calgary (UAC) and the University of Alberta (ALTA).

Literature Cited

Crum, H. 1973. Mosses of the Great Lakes Forest. University Herbarium, University of Michigan, Ann Arbor, Michigan. 404 pp.

Lawton, E. 1971. Moss flora of the Pacific Northwest. The Hattori Botanical Laboratory, Nichinan, Japan. 362 pp., 195 plates.

Macoun, P. 1892. Catalogue of Canadian plants. Part VI. Musci. Printed for the Government of Canada by William Foster Brown & Co., Publishers, Montreal. 295 pp.

JAMES W. CASE

Department of Biology
University of Calgary
Calgary, Alberta T2N 1N4

Received 28 February 1975
Accepted 9 April 1975

Nest-sites of Birds in Residential Areas of Vancouver, British Columbia

Abstract. A total of 185 nests of 10 species of birds was found in 1968 and 1969 in residential areas of Vancouver, British Columbia. Crested Mynas had the greatest mean nesting height, and American Robins and Barn Swallows the lowest. Most nests were in buildings; of the common species, only the American Robin nested mainly in trees. Ground nesters were virtually absent, probably as a result of disturbance by humans and domestic animals. Low-nesting populations of arboreal species like the American Robin may also be eliminated by disturbance.

Nest-sites of birds in Vancouver, British Columbia were studied in 1968 and 1969 during an investigation of urban bird ecology (Weber 1972). Nest-site data, particularly nest heights, for the urban bird community are compared here with similar data from other urban and non-urban habitats.

Study Area

Residential districts of Vancouver were arbitrarily divided into three types. The first, "typical residential," covers approximately 75% of the residential areas. It is characterized by one-storey and occasionally two-storey frame houses, usually on small lots (33 ft by 125 ft). There are relatively few trees (10 to 15 per acre), most of which are less than 30 feet tall, and little shrubbery. Lawns and buildings each cover about one-third of the area.

The second type, "well-wooded residential," occupies about 15% of the residential area. It consists of single-dwelling areas (usually high-income areas) with large one- and two-storey frame houses. Lots are large (about 75 ft by 125–200 ft), with numerous large trees (about 30 to 40 per acre), often including many conifers, and dense shrubbery. Lawns cover a third of the area, but buildings only about 15%.

The third or "apartment" type is the least extensive of the three (about 10% of total residential area). It includes multiple-dwelling areas which may retain some old two-storey houses as well as low-rise and high-rise apartment blocks. Trees are few (less than 10 per acre); buildings cover much of the area (30% to 40%), and lawns relatively little (about 20%).

Methods

A census plot of about 40 acres (16 ha) was established in each of the three habitat types. Plots were visited at bi-weekly intervals during the 1968 breeding season, and weekly in 1969. Most nests were found incidental to work on bird populations and foraging ecology; few special nest-searches were carried out. Because most nests belonged to hole-nesting species, nest contents could rarely be seen. The presence of a nest was assumed if nestlings were seen or heard, adults were seen carrying food to a suspected nest-site, or adults were seen carrying nesting material to a site. In most instances, nests were located by tracing the calls of nestlings to their source. For each nest, position and height were recorded. Heights were visually estimated to the nearest foot.

Results

A total of 185 nests of 10 species (54 nests in 1968, 131 in 1969) was found on the study plots and in similar nearby habitats. Of these, 53% were in typical residential habitat, 29% in apartment habitat, and 18% in well-wooded residential habitat; 62% of the total were on the study plots. A report on the distribution of birds by habitats is in preparation. The height distribution of the nests is summarized in Table 1, and their sites are categorized in Table 2. The disparity in number of nests found in different habitats partly reflects nest-finding effort, since breeding bird densities were similar on all plots (Weber 1972); it also reflects the fact that nests of hole-nesters like Starlings (*Sturnus vulgaris*) were more easily found than those of open nesters like the American Robin (*Turdus migratorius*), which made up over a third of the breeding avifauna of the well-wooded plot.

The scarcity of bird nests near ground level is clearly demonstrated in Table 1. No nests were found below 5 ft, and no species had a mean nesting height of less than 10 ft. The Crested Myna (*Acridotheres cristatellus*) had the greatest mean nesting height, 26.5 ft (8.1 m); the American Robin and Barn Swallow (*Hirundo rustica*) had the lowest, 12.5 ft (3.8 m) and 14.1 ft (4.3 m), respectively. The importance of buildings as nest-sites is apparent in Table 2; 89% of the nests were in buildings. Although nests in trees are admittedly much harder to find than those in buildings, only one numerous species, the American Robin, nested more often in trees.

Tree nests (all species of birds combined) accounted for 24% of the total in well-wooded residential habitat, but less than 10% in the other two types where trees were scarcer. Mean nest height was 22.0 ft (6.7 m) in apartment habitat, 17.5 ft (5.3 m) in typical residential, and 16.2 ft (4.9 m) in well-wooded residential. The presence of multi-storey buildings in the apartment habitat increases the availability of high nest-sites there.

Discussion

Urban avifaunas tend to be dominated by hole-nesting species (cf., Walter and Demartis 1972). On the Vancouver study plots, 7 out of 17 breeding species, accounting for 61% of individual birds, were hole-nesters; this compares with 12 out of 49 species, accounting for 14% of individuals, in a Pennsylvania bird sanctuary composed chiefly of oak-hickory forest and brushy old fields, where Preston and Norris (1947) carried out a detailed nesting study. Interspecific competition for nest-sites is often severe among hole-nesting birds (von Haartman 1957). In Vancouver, despite an apparent abundance of potential nest-sites, such competition is evident between two members of the family Sturnidae, the recently-arrived Starling (a common breeder only since 1960) and the long-established Crested Myna; but it may be reduced by the tendency of mynas to nest at greater heights (Table 1).

The rarity of nests on or near the ground has been documented for other urban areas—in Butler, Pennsylvania (Preston and Norris 1947) and

TABLE 1 — Height distribution of nests (all measurements are in feet)

Species	Number of nests in each height category								Mean
	0–5	5–10	10–15	15–20	20–25	25–30	30+	Total	height
Rock Dove, *Columba livia*	—	—	—	2	5	—	2	9	22.1
Violet-green Swallow, *Tachycineta thalassina*	—	—	5	2	1	3	—	11	17.5
Barn Swallow, *Hirundo rustica*	—	—	9	4	—	1	—	14	14.1
Red-breasted Nuthatch, *Sitta canadensis*	—	—	—	1	—	—	—	1	18.0
American Robin, *Turdus migratorius*	—	2	8	5	—	—	—	15	12.5
Starling, *Sturnus vulgaris*	—	2	10	13	25	14	1	65	20.4
Crested Myna, *Acridotheres cristatellus*	—	—	1	1	—	7	3	12	26.5
House Sparrow, *Passer domesticus*	—	1	24	12	15	3	1	56	16.8
House Finch, *Carpodacus mexicanus*	—	—	1	—	—	—	—	1	13.0
American Goldfinch, *Spinus tristis*	—	—	—	—	1	—	—	1	20.0
Total	—	5	58	40	47	28	7	185	18.4

TABLE 2 — Site distribution of nests

Species	Number of nests in each site category				
	Deciduous trees, vines[1]	Evergreen trees	Bird boxes	Buildings[2]	Total
Rock Dove				9	9
Violet-green Swallow				11	11
Barn Swallow				14	14
Red-breasted Nuthatch	1				1
American Robin	8	3		4	15
Starling	2		1	62	65
Crested Myna				12	12
House Sparrow	2		3	51	56
House Finch				1	1
American Goldfinch	1				1
Total	14	3	4	164	185

[1] Nuthatch and Starling nests in trees were in cavities: all other species nesting in trees and vines built open nests among branches.

[2] Robin and House Finch nests on buildings were on ledges; those of Barn Swallows were on walls, usually under eaves; all other species nesting in buildings used crevices or semi-enclosed spaces.

London, England (Simms 1962). In contrast, half of all nests were at heights of 3 ft (0.9 m) or less in the sanctuary studied by Preston and Norris (1947). In an area of mixed habitats in Louisiana, including a university campus, cemeteries, a farm, and deciduous forest, nest heights were intermediate between these two extremes; 18% of nests were 3 ft or less above ground (Taylor 1965).

Preston and Norris (1947) found that the distribution of nest heights in their sanctuary study area could be approximated by a simple mathematical equation which states, in effect, that the number of nests per foot of height decreases in logarithmic fashion with increasing height. Nest height distribution in their residential study area could be approximated by adding to this equation a term to represent an "attrition factor" which operated strongly at ground level but had no effect at heights of more than 5 or 10 ft. This attrition factor probably results mainly from accidental or intentional disturbance of birds by humans, and predation by cats and other domestic animals. Cats in particular may exert a great effect on urban birds, as suggested by the reports of McMurry and Sperry (1941), Matheson (1944), and Evenden (1957).

Open-nesting species are likely to be greatly affected by disturbance. Assuming that a bird's preference for a certain range of nest heights is at least partly inherited, disturbance could result in selective elimination of ground-nesting species (this is the most important potential effect), elimination of low-nesting populations of arboreal species, or possibly even individual birds' learning to increase their nesting height because of constant harassment. In Arizona, Emlen (1974) concluded that two ground-nesting birds, the Gambel's Quail (*Lophortyx gambeli*) and Roadrunner (*Geococcyx californianus*) were eliminated by disturbance from an urban area. In Vancouver the only ground nester breeding on my study plots was the Song Sparrow (*Melospiza melodia*), and it bred only on the well-wooded plot where disturbance would be least.

The importance of buildings as nest-sites is confirmed by other studies, especially that of Kelleher (1963), who studied nest-sites of birds in a residential area of Hope, British Columbia, a town of about 3000 people, located 100 miles east of Vancouver. Of 44 House Sparrow (*Passer domesticus*) nests found by Kelleher, 38 were in buildings, 5 in bird boxes, and 1 in an old Cliff Swallow (*Petrochelidon pyrrhonota*) nest; of 34 Starling nests, 30 were in buildings and 2 each in bird boxes and tree cavities; and of 26 Violet-green Swallow (*Tachycineta thalassina*) nests, 25 were in buildings and 1 in a bird box. Simms (1962) also reported that 92% of Starling nests he found in London, England were in buildings, and only 8% in tree cavities.

Kemper (1972), studying American Robin nests on the University of British Columbia campus in Vancouver (a habitat somewhat resembling well-wooded residential but much more open), found a mean nest height for 72 nests of 10.7 ft (3.3 m), close to the 12.5 ft (3.8 m) I found. Some of her nests were as low as 1.5 ft, while I found none lower than 7 ft. Young (1955), who investigated robin breeding biology in an arboretum and cemetery in Wisconsin, found 202 nests, 77% of which were 8 ft or less above ground. The divergence between these data and mine suggests selection against low nesters in residential areas. It certainly does not result from a lack of low potential nest-sites in urban areas, since all my study plots contained numerous evergreen shrubs with dense foliage extending to the ground.

Preston and Norris (1947) noted that in the 1930s, robins in their sanctuary study area seemed to nest only at heights of 4 ft or less, whereas the mean height of 122 nests in 1944 and 1945 was more than 10 ft. This change could possibly have been caused by increasingly strong selection against low-nesting birds in the dense robin populations of expanding residential areas. Eventually, through dispersal of birds to other habitats, this selective force could have influenced the nest height preference of robins in all habitats in the region.

Acknowledgments

I particularly thank Rudolf H. Drent, my M.Sc. thesis supervisor at the University of British Columbia, as he provided patient guidance and helpful criticism throughout this part of my study. Valuable advice and comments were also given to me by Peter A. Larkin and Stephen R. Johnson. Anthony J. Erskine and Miklos D. F. Udvardy kindly reviewed an earlier draft of the manuscript. Financial support from the National Research Council of Canada is gratefully acknowledged.

Literature Cited

Emlen, J. T. 1974. An urban bird community in Tucson, Arizona: derivation, structure, regulation. Condor 76: 184–197.

Evenden, F. G. 1957. Observations on the nesting behavior of the House Finch. Condor 59: 112–117.

Haartman, L. von. 1957. Adaptation in hole-nesting birds. Evolution 11: 339–347.

Kelleher, K. E. 1963. A study of the hole-nesting avifauna of southwestern British Columbia. M.Sc. thesis, University of British Columbia, Vancouver. 169 pp.

Kemper, D. L. 1972. The breeding biology of the American Robin (*Turdus migratorius*) in southwestern British Columbia. M.Sc. thesis, University of British Columbia, Vancouver. 67 pp.

McMurry, F. B. and **C. C. Sperry.** 1941. Food of feral House Cats in Oklahoma, a progress report. Journal of Mammalogy 22: 185–190.

Matheson, C. 1944. The domestic cat as a factor in urban ecology. Journal of Animal Ecology 13: 130–133.

Preston, F. W. and **R. T. Norris.** 1947. Nesting heights of breeding birds. Ecology 28: 241–273.

Simms, E. 1962. A study of suburban bird-life at Dollis Hill. British Birds 55: 1–36.

Taylor, W. K. 1965. Nesting heights of Louisiana birds. Wilson Bulletin 77: 146–150.

Walter, H. and **A. M. Demartis.** 1972. Brutdichte und ökologische Nische sardischer Stadtvögel. Journal für Ornithologie 113: 391–406.

Weber, W. C. 1972. Birds in cities: a study of populations, foraging ecology, and nest-sities of urban birds. M.Sc. thesis, University of British Columbia, Vancouver. 269 pp.

Young, H. 1955. Breeding behavior and nesting of the Eastern Robin. American Midland Naturalist 53: 329–352.

WAYNE C. WEBER

Department of Zoology
University of British Columbia
Vancouver, British Columbia V6T 1W5

Present Address: Department of Zoology
P.O. Drawer Z
Mississippi State University
Mississippi State, Mississippi 39762

Received 24 February 1975
Accepted 5 May 1975

Arboreal Mating Behavior in the Red-sided Garter Snake

The spring emergence and mating behavior of red-sided garter snakes (*Thamnophis sirtalis parietalis*) at large communal dens or hibernacula in the Interlake region of Manitoba have been described in some detail by Gregory (1974) and Aleksiuk and Gregory (1974). Mating in these populations generally takes the form of mating "balls" (i.e., many males per female) in the den area and is most intense on warm sunny days in mid-May. At such times, males are extremely active in courting females and mating may sometimes take place in unusual situations. An especially interesting case is the occasional formation of mating balls in trees and bushes, mentioned by Aleksiuk and Gregory (1974). The purpose of this note is to describe one such instance of arboreal mating activity and to present pictorial evidence of its occurrence.

On 8 May 1972, while collecting a sample of snakes for a mark-recapture program at a large den ("Den One" in Aleksiuk and Gregory 1974)) near Inwood, Manitoba, I observed a large snake move a short distance across the ground and rapidly climb to the top of a small bush about 1 m high. This snake was closely pursued all the way by a large group (about 10–15) of smaller snakes. When the snakes all reached the top of the bush, there was a flurry of activity, consisting largely of the mass writhing characteristic of mating balls on the ground (Figure 1). This activity lasted approximately 3–5 min. Following this, snakes began breaking away from the group (Figure 2), and rapidly descended from the bush and intermingled with the hundreds of snakes engaged in intense mating activity on the ground. The general pattern of this activity was suggestive of a mating aggregation but I did not see actual copulation take place nor was I able to capture the large snake which the others had been chasing. It seems likely, however, that this large snake was a female and the smaller ones males, since adult females are generally larger than males. Also, odor appears to be very important in attracting males to females (Fitch 1965); it is not unusual for males to follow the trail of a female during the breeding season. It seems likely, therefore, that this represents an instance of arboreal mating in this species. To my knowledge, this has not been observed before.

Females appear to play a passive role in courtship (Fitch 1965) and must be stimulated by the male for mating to take place. During the early stages of courtship, females often appear to ignore and perhaps actively avoid males; males often chase females. Males also appear to be more highly stimulated to mate on warm sunny

FIGURE 1. Apparent mating group of snakes in bush.

FIGURE 2. Break-up of aggregation of snakes in bush.

days and are more likely to chase females under such conditions. May 8 1972 was an exceptionally warm and sunny day. The only other occasion on which I have observed similar activity was on 10 September 1971 when I observed a young male apparently courting a young female on a tree branch at the same den. (Mating occasionally takes place in fall.) The weather again was warm and sunny. Perhaps as a result of these factors, occasional arboreal mating is not surprising.

While *Thamnophis sirtalis* is not generally noted for arboreal habits, it is not unknown for individuals to climb into small bushes and trees. Nestlings of bird species which usually nest somewhat above ground have been reported as occasional food (Carpenter 1952; Fitch 1965; Gregory and Stewart 1975). Carpenter (1952) recorded this species climbing to a maximum height of 4 ft (about 1.2 m) in small bushes; he suggested that such behavior may be of some value in avoiding high ground-temperatures in hot weather. In the Interlake region, individual snakes have occasionally been seen climbing in small trees (mainly willow) surrounding Den One. On one occasion (6 May 1970), at about 11:30 p.m., I observed a large number of snakes (possibly in excess of 100) resting or climbing at various heights in these trees. Although it had been a warm sunny day, the air temperature at the time of this observation was only about 12–14°C. The reason for this unusual behavior is not known.

Literature Cited

Aleksiuk, M. and **P. T. Gregory.** 1974 Regulation of seasonal mating behavior in *Thamnophis sirtalis parietalis.* Copeia 1974(3): 681–689.

Carpenter, C. C. 1952. Comparative ecology of the common garter snake (*Thamnophis s. sirtalis*), the ribbon snake (*Thamnophis s. sauritus*), and Butler's garter snake (*Thamnophis butleri*) in mixed populations. Ecological Monographs 22(4): 235–258.

Fitch, H. S. 1965. An ecological study of the garter snake *Thamnophis sirtalis.* University of Kansas Publications, Museum of National History 13(4): 85–288.

Gregory, P. T. 1974. Patterns of spring emergence of the red-sided garter snake (*Thamnophis sirtalis parietalis*) in the Interlake region of Manitoba. Canadian Journal of Zoology 52(8): 1063–1069.

Gregory, P. T. and **K. W. Stewart.** 1975. Long-distance dispersal and feeding strategy of the red-sided garter snake (*Thamnophis sirtalis parietalis*) in the Interlake of Manitoba. Canadian Journal of Zoology 53: 238–245.

PATRICK T. GREGORY

Department of Zoology
University of Manitoba
Winnipeg Manitoba R3T 2N2
Present Address: Department of Biology
University of Victoria
Victoria, British Columbia V8W 2Y2

Received 16 April 1975
Accepted 18 June 1975

Fulmar from Southern James Bay in December

A Northern Fulmar, *Fulmarus glacialis minor,* apparently the first for southern Hudson or James Bays, was taken under unusual circumstances near Moosonee, Ontario (51°15′ N, 80°39′ W). On 8 December 1974 three Moosonee residents were cutting a snowmobile trail through a thick stand of black spruce (*Picea mariana*) approximately 15 km south of the village when their attention was engaged by a large, pale slim-winged bird laboring in the snow. The bird did not attempt to take flight and showed no fear of the men. It was easily approached and captured. Many trails through the 30-cm-deep snow marked the wanderings of the bird since snow had stopped falling the preceding night. In the evening the men brought their "strange-looking sea gull" back to the village and notified the District Office of the Ontario Ministry of Natural Resources.

The Fulmar was kept alive until next day; it appeared lively and alert and readily ate canned dog food. No injuries or other anomalies were found when the skin was being prepared.

The bird was a light-phased female (category LL *after* Fisher 1952). Judging by the absence of any yellowish tinge on the head and neck the Fulmar was probably a juvenile (see Snyder 1957). It weighed 539 g and appeared in good physical condition, showing little subdermal fat but moderate amounts of intestinal fat. The ovary measured 12 × 6 mm and the bill length was 34.9 mm. The specimen is now number 60759 in the National Museum of Natural Sciences.

Snowfall throughout the day of 7 December could have caused the Fulmar to become disoriented and come down in the forest; however, there are no apparent reasons, such as a storm with high winds in the Moosonee area in the preceding several days, to suggest why the Fulmar came to James Bay. Once on the ground the lack of a sufficiently long open area due to the close spacing of the spruces, together with the light fluffy snow on the ground, likely prevented the Fulmar from taking off.

Fulmars breed at several locations in the eastern arctic archipelago and winter in the north Atlantic but they do not normally enter Hudson Bay (Godfrey 1966). Four other specimens have been taken in Ontario: two from the Ottawa River, one from southern Georgian Bay, and one near the north shore of Lake Superior. It is perhaps probable that the Lake Superior and Georgian Bay birds in particular were wanderers that had originally entered James Bay; the Moosonee specimen was taken 35 km south of the James Bay coast. Alternatively, they could have come from the Gulf of St. Lawrence where the occurrence of Fulmars is regular in November (Godfrey 1966). In any case, the apparent scarcity of sea-birds in winter in the few areas of open water in James Bay suggests that Fulmars are accidental in the area.

I thank Reg Zanelli of Moosonee for contacting the Ministry of Natural Resources about this bird.

Literature Cited

Fisher, J. 1952. The fulmar. Collins, London. pp. 266–268.

Godfrey, W. E. 1966. The birds of Canada. National Museum of Canada Bulletin 203. 428 pp.

Snyder, L. L. 1957. Arctic birds of Canada. University of Toronto Press, Toronto.

J. P. PREVETT

Ontario Ministry of Natural Resources
Box 190
Moosonee, Ontario P0L 1Y0

Received 30 January 1975
Accepted 9 April 1975

Bartonia virginica (L.) BSP in Perth County, Ontario

During the course of a survey of the flora of Perth County, a number of plants of *Bartonia virginica* were discovered by David Weber, a graduate student, and the author in October 1972. The author had no knowledge of the occurrence of this species elsewhere in southern Ontario; as well, James H. Soper (personal communication, June 1973) thought at that time that it was no longer existent in southern Ontario since its disappearance some decades ago from a site near the western end of Lake Erie.

A specimen sent from the Perth County site to the National Herbarium was acknowledged by John M. Gillett, who had revised the genus *Bartonia* in 1959 (A revision of *Bartonia* and *Obolaria* (Gentianaceae). Rhodora 61: 43–62). As of that date he had no record of active stations for the species in Ontario and suggested that our discovery should be reported.

The site in Perth County is in a dry bog located at approximately 43°28′ N, 80°57′ W. The dry bog extends over an area of some 2 mi^2. Part of this area has been planted with coniferous trees, but *Bartonia* occurs mainly in the unforested open area with mosses and low vegetation. This open area has not developed a natural forest cover, although some scattered and poorly developed individuals of *Populus tremuloides* occur.

The substratum is mainly of deep organic material with the water table at a depth of 50 to 80 cm below the present surface. It is thought that the water table has been lowered as a result of the extensive installation of drains throughout the surrounding agricultural terrain.

The subject area is controlled by the Upper Thames River Conservation Authority. After pointing out certain unique features of the site to the Authority, we have been assured that the unforested portion will be retained in its natural state. This area includes the principal habitat of *Bartonia virginica*.

Specimens currently on file in the Herbarium of Wilfrid Laurier University include collections made on 1 October 1972 (Herbarium Number 8256), on 30 July 1973 (Numbers 8571, 8820, 9082), and on 3 September 1973 (Number 9372).

ARNOLD A. WELLWOOD

Department of Biology
Wilfrid Laurier University
Waterloo, Ontario N2L 3C5

Received 14 February 1975
Accepted 7 April 1975

Long-distance Movement of an Arctic Fox in Newfoundland

On 9 April 1973 a male arctic fox (*Alopex lagopus* (L.)) was captured alive on a small island just offshore from the settlement of Cavendish, Trinity Bay, Newfoundland (Figure 1). The animal was ear-tagged and released by helicopter on sea ice on 11 April some 16 km north of New World Island. Eleven months later, on 15 March 1974, the fox was collected by a trapper 10 km south of Gander Lake, 107 km from the point of release, and possibly more than 1500 km from its point of entry onto the ice. The 11-month sojourn of this fox on insular Newfoundland represents the longest known period of survival in the wild for this species on the island.

Macpherson (1969) suggests that the breeding range of the arctic fox in North America extends over the entire arctic tundra zone, including all of northern Labrador and the coastal areas of southern Labrador. Where this fox first joined the sea ice is pure conjecture. But fox populations do occur in northern Labrador and in the land bordering Hudson Strait (Figure 2); and Schwartz (1966) has shown by tag returns that arctic foxes may disperse several hundred kilometres from their breeding grounds. Polar bear populations in this same area take to the sea ice in the spring to seek seals. In coastal areas seal remains (from polar bear kills) form a high proportion of arctic fox food (Macpherson 1969).

The winter and spring of 1973 saw cold temperatures and severe ice conditions. Deep snow on land forced foxes out into the ice. The pack ice was very dense near land. Because of heavy ice conditions polar bears had to travel out

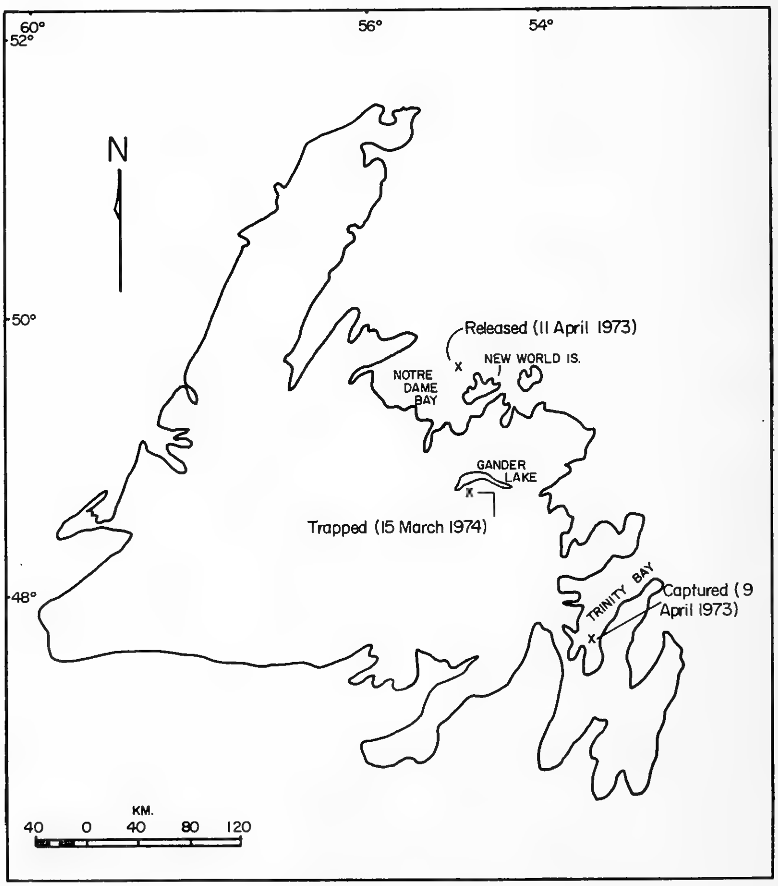


FIGURE 1. Map of Newfoundland showing capture and release locations of an arctic fox.

FIGURE 2. Map showing possible movement of arctic fox on sea ice.

onto the ice and southward farther than normal to find the ice edge since open water is necessary for good seal hunting. As spring advanced, the bears and the attendant scavenging foxes continued southward on the heavy ice. Sealers, RCMP detachments in northern Newfoundland, and the ice patrol reported more bears and arctic foxes on the island and in the surrounding sea ice, in the spring of 1973 than at any time in recent years.

In March of most years the pack ice reaches its most southerly extent and envelops all of Newfoundland except the south coast (Hare 1952). Trinity Bay is ice-filled for most of March and April. Notre Dame Bay is normally ice-filled from February to early May, some years until June. Personal communication with Ice Forecasting Central, Environment Canada, Ottawa, reveals that the rate of drift of the ice, southward, is about 10 km a day. At this rate it would take about 3 months for ice to drift from Hudson Strait to Newfoundland.

A number of vessels were engaged in the spring seal hunt close to the area where the fox was released on 11 April. The fox would have had an ample supply of seal-carcass food provided for it if it remained on the ice in that area. How long it remained there is, of course, not known but it would have had to journey southward to the island sometime before the ice disintegrated in late May. Macpherson (1968), reporting on another long-distance movement of an arctic fox, suggests that this species may possess navigational ability and a homing instinct. The present observation may provide evidence for the former, but not the latter ability.

Once on land, the spring snow crusts made travelling easy. By late May or early June all snow would have disappeared. Survival during the summer would not have been difficult. But winter, with its 1 m of soft snow accumulation in January-February (average annual snowfall for this region of the province is 3.8 m (Hare 1952)) would provide difficult travel conditions for the arctic fox, whose foot weighting is too great. Formozov (1946) observes that the Canidae, being digitigrade and with quite compact and relatively narrow paws, sink deeply into snow. He calculates the load on the supporting surface of the feet of the red fox as 40–42.5g/cm^2. The foot weighting for arctic foxes is not given but is reported as being greater than that of the red fox. This should be compared with 8–12 g/cm^2 for the snowshoe hare. Formozov further notes that 40–50 cm of snow will hinder the movement of arctic foxes.

The captured fox was trapped. In some years, one or two are taken in like manner. In all the period of time that arctic foxes have been brought to insular Newfoundland by sea ice a breeding population has not become established. Snow conditions plus the random chance arrival of individuals in this "pioneering" situation point to a low probability of this happening.

Literature Cited

Formozov, A. N. 1946. Snow cover as an integral factor of the environment and its importance in the ecology of mammals and birds. (English translation from Russian.) University of Alberta, Edmonton. Boreal Institute Occasional Paper 1. 197 pp.

Hare, F. K. 1952. The climate of the island of Newfoundland: a geographical review. Geographical Bulletin 2: 36–88.

Macpherson, A. H. 1968. Apparent recovery of translocated arctic fox. Canadian Field-Naturalist 82: 287–289.

Macpherson, A. H. 1969. The dynamics of Canadian arctic fox populations. Canadian Wildlife Service Report Series, Report Number 8. 52 pp.

Schwartz, S. S. 1966. Biological foundations of the hunting and trapping industries. (In Russian.) Problemy Severa 11, USSR.

TOM NORTHCOTT

Wildlife Division
Building 810, Pleasantville
St. John's, Newfoundland

Received 25 April 1975
Accepted 3 June 1975

Poplar Bud in the Subcutaneous Tissue of a Northern Flying Squirrel

On 3 January 1975 an adult male northern flying squirrel (*Glaucomys sabrinus*) was collected by a trapper, Jack Clemmons, in mixed forest about 1 mi north and 1 mi west of Gypsumville, Manitoba (51°46′N, 98°38′W). The specimen was obtained by John Prosser who donated it to the Manitoba Museum of Man and Nature (No. 6020).

On preparation of the specimen, an assistant, Janice Morier, found an encapsulated structure in the subcutaneous connective tissue of the lower chest area, just left of the median line. Dissection of this material showed it to be a perfectly preserved winter terminal bud of a balsam poplar (*Populus balsamifera*).

The flying squirrel must have glided into a branch of a balsam poplar tree, whereupon the slender and sharply-pointed terminal bud penetrated the loose thin skin and lodged itself along the rib cage. This large piece of foreign matter (17×4 mm) might have been expected to form an abscess, resulting eventually in its expulsion from the body, much as a thorn is worked out. The bud had, however, become completely surrounded by connective tissue and no sign of inflammation was apparent. The winter bud probably entered the body during the autumn, or possibly even during the previous winter.

Buds of the balsam poplar, also known as Balm of Gilead Buds, are saturated with a fragrant sticky resin which has been extracted (as a product called Tacomahaca) and used as a soothing ointment for bruises and cutaneous diseases (M. Grieve. 1967. A modern herbal. Hafner Publishing Company, New York. Vol 2, p. 79). This balsamic resin was likely involved in the preservation of the bud and may also have helped the wound from becoming infected.

ROBERT E. WRIGLEY

Manitoba Museum of Man and Nature
190 Rupert Avenue
Winnipeg, Manitoba R3B 0N2

Received 15 April 1975
Accepted 14 May 1975

Locomotion of a "Three-legged" Porcupine

A porcupine (*Erethizon dorsatum*) observed on the north side of Forest Road 2195, Chippewa National Forest, Beltrami County, north-central Minnesota, 17 October 1972 is the subject of the following observations.

This porcupine was feeding on the ground when first seen. While walking, it was observed to fall partially over on its side momentarily, but immediately righted itself and continued feeding. Cautious approach to within 3 m showed that the animal's left hind leg was pulled up tightly to the side of the abdomen and that the foot was compressed laterally with the toes curled very sharply downward. When the animal moved, this leg remained tightly drawn up and did not touch the ground. The legs were moved in the sequence normally observed in all four-legged animals when walking slowly, that is, alternately. The only difference was that when the left hind leg should have made a stride, there was a slight pause before the next step. The strides were shorter than those of a porcupine less than 6 months old observed in 1971. The tail was kept firmly pressed to the ground at all times and was dragged quite heavily while the animal was walking. In this respect, the tail functioned effectively as a "fourth" leg. When the left foreleg was moved, the animal's center of gravity was too far to the left for perfect balance with every step. In the loose leaf litter, it fell over on its side on the average every fifth step with the left foreleg. On harder surfaces, such as grass and bare soil, the porcupine did not lose its balance.

Observed from a distance of 30–100 cm, the animal was plainly seen using the right forefoot to push aside the leaf litter. The disturbed area was investigated with the nose, and food was apparently located by scent alone. As it moved about the forest floor, I followed and observed it feeding exclusively on acorns (*Quercus* spp.) for 1.5 h. After this time, I touched the porcupine gently on the back and it immediately struck upward with the tail and erected its quills. When it moved its tail, however, it lost its balance, falling as before. Further stimulation of the back could not elicit a similar response. Instead, it moved away and eventually climbed a small aspen (*Populus tremuloides*). The behavior while climbing could be differentiated from that of a normal porcupine only by the slowness of the ascent which resulted from the short "steps" that were taken with each foreleg. When last seen, the animal was asleep, 8 m above the ground in this tree.

Three other porcupines observed during the month were also feeding exclusively on acorns, and one road-killed animal had eight acorns mixed in with approximately half a cup of unidentifiable vegetable matter in the stomach. The observed three-legged animal appeared to be feeding normally for this season of the year. I could not age or sex the animal, but it appeared to be of a normal size for first-year porcupines in north-central Minnesota.

Other reports of injured porcupines could not be found. Taylor (1935) found few injured animals in extensive collection efforts. There are some reports of survival of seemingly seriously incapacitated small mammals of other species. Yeager and Woloch (1962) found a juvenile female skunk (*Mephitis mephitis*) in good condition with only three legs. Loss of the leg was attributed to contact with a hay mower weeks or months prior to the time of capture. In a more severe case, Sunquist et al. (1969) followed the movements of a blind raccoon (*Procyon lotor*) for three months and found no functionally significant differences between the blind and normal raccoons in activity patterns, travel rates, length of movement periods, and minimum size of home range. In cold areas with heavy snowfall, it is presumed that the survival potential of a porcupine that could not climb into the treetops for food would be very low. This animal could still climb, but its reactions to disturbances were limited by its impaired mobility. It is assumed that increased susceptibility to predation and the chance that winter storms could dislodge a three-footed grasp normally would eliminate such an animal from a northern Minnesota population.

These observations were made while the author was conducting research supported by NIH training Grant Number 5 TO1 GMO1779, awarded to Dr. John R. Tester.

Literature Cited

Sunquist, M. E., G. G. Montgomery, and **G. L. Storm.** 1969. Movements of a blind raccoon. Journal of Mammalogy 50(1): 145–147.

Taylor, W. P. 1935. Ecology and life history of the porcupine (*Erethizon epixanthum*) as related to the forests of Arizona and the southwestern United States. University of Arizona Bulletin VI(5), Biological Sciences Bulletin 3. 177 pp.

Yeager, L. E. and **J. P. Woloch.** 1962. Striped skunk with three legs. Journal of Mammalogy 43(3): 420–421.

RONALD E. KIRBY

Department of Ecology and Behavioral Biology
University of Minnesota
St. Paul, Minnesota 55108

Received 11 March 1975
Accepted 4 April 1975

Red-breasted Nuthatches Breeding in Nest Boxes in Pine Plantations on the North Shore of Lake Erie [1]

Two pairs of Red-breasted Nuthatches (*Sitta canadensis*) bred successfully in 1974 at the St. Williams Forestry Station (42°41′ N, 80°26′ W), 1.5 mi N of St. Williams, and 17 mi SW of Simcoe, Ontario. This constitutes the southernmost breeding record for Canada, with the nearest previously recorded nesting near Erindale, about 80 mi NE of the present record, 25 years ago (according to records at the Royal Ontario Museum).

The nests were in 2 of about 100 boxes designed for Black-capped Chickadees (*Parus atricapillus*) and hung by the authors in mixed white and red pine plantations (*Pinus strobus* and *P. resinosa*). All subsequent observations were made by Howkins and Cartar. In a nest-box check on 3 May 1974, there was no sign of nuthatch nests; but on 6 June, two small fiber nests were found, with five eggs in the first and six in the second. The nest-box entrances were heavily daubed with pine pitch, as is characteristic of Red-breasted Nuthatches in natural nest-sites (A. C. Bent. 1948. United States National Museum Bulletin 195: 23–25). Adult females were present at both nests. On 12 June all nestlings had hatched and the four adult birds were trapped and banded. The surviving young were banded on 22 June: three in the first nest and five in the second. Nest record cards have been submitted to the Ontario Nest Records Scheme.

Red-breasted Nuthatches are known to breed farther south in the United States, and there are nearby records from northwestern Pennsylvania and Cleveland, Ohio (Audubon Field Notes 17: 460, 1963; and 19: 552, 1965, respectively). The lack of records for southern Ontario is probably related to a historical lack of suitable habitat, but with reforestation in recent years, further nestings are likely to be discovered.

We thank the students at Valley Heights and South Walsingham Schools who made the nest boxes, and R. E. Laupert, Superintendent of the St. Williams Forestry Station, for co-operation in hanging the boxes.

ERICA H. DUNN
HEATHER F. HOWKINS
RALPH V. CARTAR

Long Point Bird Observatory
Box 160
Port Rowan, Ontario N0E 1M0

Received 23 January 1975
Accepted 25 June 1975

---

[1] A publication of the Long Point Bird Observatory

American Wigeon Steals Food from Muskrats

On 9 November 1974, the author and Terry Van Meer watched a female American Wigeon (*Anas americana*) stealing food from muskrats (*Ondatra zibethicus*). This occurred approximately 3 km (2 mi) west of Elk Island National Park, Alberta, on a slough kept partly open by muskrat activity.

The moment a muskrat rose to the surface with a mouthful of aquatic vegetation, the wigeon swam directly towards it. When the muskrat climbed up on the edge of the ice and began feeding, the wigeon immediately struck at the muskrat with its bill. Leaving its food cache, the muskrat then retreated into the water. The wigeon climbed onto the ice and devoured the remaining vegetation. This interaction occurred four consecutive times, within 15 min, and involved two different muskrats. Two larger muskrats were eating aquatic vegetation on the edge of the ice at the same time, but during the observation period of 1 h, the wigeon stole food only from the two smaller muskrats.

American Wigeon are known for their notorious habit of stealing food from diving ducks, especially Canvasbacks (*Aythya valisineria*), Redheads (*Aythya americana*), and scaups (*Aythya* spp.) (Bent, A. C. 1951. Life histories of North American wild fowl (Order Anseres). *In* Ducks, geese and swans. New York Dover Publications, New York. Two volumes; Kortright, F. H. 1967. The ducks, geese and swans of North America. The Stackpole Company, Harrisburg, Pennsylvania. 474 pp.), but they have not previously been recorded doing so from muskrats.

My thanks to A. J. Erskine for his comments during the preparation of this manuscript.

BOB M. FISHER

425 – 22 Avenue N.E.
Calgary, Alberta T2E 1T8

Received 22 April 1975
Accepted 14 June 1975

News and Comment

Reference List of Birds

The Department of Ornithology of the American Museum of Natural History has just completed compilation of a "Reference List of the Birds of the World." The list (compiled by Dr. John Morony, Jr.; Dr. Walter J. Bock; and Dr. John Farrand, Jr.) will be used as the basis of the avian species inventory system under the the International Species Inventory System (ISIS).

The avian inventory system is under the direction of Dr. U. S. Seal for the American Association of Zoological Parks and Aquariums (AAZPA).

Copies of the "Reference List of Birds of the World" are available (at cost) for $6.00 postpaid from: Dr. Walter Bock, Department of Ornithology, American Museum of Natural History, New York, New York, U.S.A. 10024.

Canadian Arctic Resources Committee (CARC)

CARC is a citizens' organization concerned about the future of the North. Since CARC was formed in 1971, it has attempted to encourage Canadians to think about northern development. "The Arctic is much more than the land of the midnight sun. To the wildlife and native people it is their only home. To southern Canadians, it is part of our national heritage, to be passed on to our descendants. Yet if all goes according to plan, the Arctic as we know it will disappear in our lifetime."

CARC is now fully engaged in several projects of vital importance. Most important among these is the major role it is playing in the Mackenzie Valley Pipeline Inquiry—the "Berger Hearings." At the Berger Hearings CARC's intent is not to stop the pipeline, but to ensure that the long-term social, economic, and environmental consequences of a gas pipeline are brought to light and carefully considered by the Canadian public. CARC has coordinated the assessment research and, on behalf of five major Canadian groups, is shouldering the responsibility for environmental evidence at the Inquiry. This role will cost in the neighborhood of $90 000.

Owing to the urgency of making a full presentation to the Berger Hearings and to the increased costs of regular services, CARC is now asking for financial support. All donors will receive free of charge, regular monthly issues of *Northern Perspectives,* a monthly report that provides challenging analysis of development issues in the Canadian North. Donations are tax-deductible and should be sent to Canadian Arctic Resources Committee, 46 Elgin Street, Room 20, Ottawa, Ontario K1P 5K6.

CanaColl Foundation: New Endowment for Collections

The CanaColl Foundation is a newly formed, non-profit, tax exempt organization devoted to the development and curation of the Canadian National Collection of insects and related arthropods. The name "CanaColl" is derived from the first letters in *Cana*dian *Na*tional *Coll*ection.

The Canadian National Collection consists of over 7 million specimens and is the responsibility of the Biosystematics Research Institute of Agriculture Canada. The CanaColl Foundation has established an endowment to grant funds for research and curatorial studies that cannot be financed by Agriculture Canada—to develop segments of the collections that have received little or no attention; to improve the base for the National Identification Service; and to support travelling expenses and honoraria for visiting specialists. As more money becomes available and as the needs arise, CanaColl may support other activities related to the development of the collection.

Operating expenses for CanaColl are paid from membership fees. All donations to the endowment fund will be appreciated and receipts provided for income tax purposes. For more information write: The CanaColl Foundation, K. W. Neatby Building, Rm. 4058, 1010 Carling Avenue, Ottawa, Canada K1A 0C6.

Karsh photograph of Rowley Frith

ROWLEY CAMPBELL FRITH, 1897–1974

There is something about a field naturalist that sets him apart from the rest of men. Along with other humans he shares the daily problems of existence and personal relations. But this experience is greatly expanded by contacts with things outside his personal relations—the rocks, the landscape, the plants, the animals—these broaden horizons and inspire him to echo Wordsworth's stanza:

> For I have learned to look on nature
> Not as in the days of thoughtless youth,
> But hearing oft' times
> The still sad music of humanity.

The nature-lover develops a sense of wonder that impels him, without counting the cost, to explore nature and his place in it. This promotes a degree of knowledge that imposes humility. And, in turn, this inspires a sense of religion, of awe. He realizes the need for a ritual expression of dependence on something outside himself.

Then there develops a sense of unity with all humanity and with the rest of nature. Hence a desire to communicate with other humans: by material cooperation, by communication of ideas, and by friendship. From this, in turn, develops a sense of the unity of all things, which leads the naturalist to rejoin Wordsworth in expressing belief in

> A motion and a spirit that impels
> All thinking things, all objects of all thought
> And rolls through all things.

These are amongst the first thoughts that occur to me as I accept the responsibility of writing this tribute to Rowley Frith.

A man who was destined to wear many hats during his 77 years, Rowley Campbell Frith was born in Ottawa in 1897, of Alexander Neil Frith and Christine Imlach. His father, a minister in the Baptist Church, held pastorates in western Canada before returning to Ottawa at the time that his son was about to enter high school; so Rowley was able to attend the celebrated Lisgar. He worked summers at the Central Experimental Farm where he came under the influence of such renowned botanists as Gussow and Macoun.

He naturally gravitated to Ontario Agricultural College, now the University of Guelph. The record shows that during his sojourn there the amiable nature that always inspired his relations with his fellow man expressed itself in his great popularity as Dean of Students. His versatility was indicated by the fact that the college appointed him, a biologist, a part-time instructor in English.

He planned to attend Cornell University. But this project fell through when he was offered the opportunity to acquire a group of greenhouses in the Beechwood section of Ottawa. That was in 1924 and he was to remain in business for 34 years.

During these years he became what one might call the universal naturalist. While horticulture was his primary concern, there was no aspect of natural history that did not interest him. Trees, insects, birds, mammals, even geology—nothing of this kind escaped his attention. He was a member of every concerned society, including The Ottawa Field-Naturalists' Club, and to all of them he gave the benefit of his administrative ability.

He abandoned his greenhouses in 1958 partly because of health reasons. In the long years I knew him I never suspected that often he suffered much physical pain. I now wonder whether anyone except his good wife and his physician suspected it either—such was his equanimity.

His freedom now gave him time to travel and to write. He attended many natural history conferences. Hoyes Lloyd, our Ottawa dean of ornithologists, told me that on expeditions he always wanted Rowley to be along. Lloyd called Rowley his "bird-dog."

With his vast knowledge and friendly nature he was the very man the National Parks Service needed to serve the visiting public as seasonal park naturalist at Point Pelee National Park, Ontario. He most successfully filled this role during the summers of 1961 to 1963, and when he retired there were many public expressions of appreciation and regret. When he was prevailed upon to come out of retirement again, the return of "Mr. Pelee" to the park for the summer of 1965 was widely acclaimed.

There is so much to say about this man of many interests. He was an avid reader and collector of rare books. He devoured poetry, especially that of nature poets like Whitman. He was fascinated by the writings of Sir William Osler. His minister told me that he never allowed a quotation from literature in a sermon to pass without asking for the reference so he could study it.

With Rowley's death, Canada has lost one of the most interested and interesting of her citizens. Those of us who knew him personally mourn the loss of a gentleman, a scholar, and a friend.

FARRELL E. BANIM

Additional Note

Rowley Frith was first elected to the Council of the Ottawa Field-Naturalists' Club in 1943 and served for many years. During the 1952–1954 years he presided as President and throughout his long term on Council was Chairman or an active member of such committees as Excursions and Lectures, Special Lectures, Reserve Fund, and FON Affairs. As Chairman of the Special Lectures Committee he was responsible in large part for the success of the Audubon Screen tours for adults and for the afternoon school performances.

Publications

1958 Observations of a Short-tailed Weasel Capturing a Chipmunk. Canadian Field-Naturalist 72(3): 144–145.

1958 Observations of the Mocking-bird [sic] in Eastern Ontario. Canadian Field-Naturalist 72(3): 145.

1960 Country Hours. By Clark Locke. Reviewed in The Canadian Field-Naturalist 74(3): 168.

1961 A Probable First Record Nesting of the Common Raven in the Ottawa District. Canadian Field-Naturalist 75(3): 168–169.

1964 Point Pelee National Park. Ontario Naturalist 2(1): 10–17.

1971 A Brief History of The Ottawa Field-Naturalists' Club. Trail and Landscape 5(2): 36–37.

Reviewing Policy of *The Canadian Field-Naturalist*

Manuscripts submitted to *The Canadian Field-Naturalist* are normally sent to an Associate Editor and at least one other reviewer. If their comments concerning the scientific merit and suitability of the manuscript for publication are widely divergent or if an original referee's field of competence does not cover the entire contents of the manuscript, one or two additional referees are asked to review it. Referees are requested to complete their reviews within three weeks or to return the manuscript immediately and suggest an alternate reviewer. Reviews offering a general appraisal of the manuscript followed by specific comments and recommendations for revision are most useful to the Editor and author.

Most manuscripts with a content suitable for *The Canadian Field-Naturalist* must undergo revision — sometimes extensive revision. After resubmission, manuscripts that required major revision are usually returned to the original referees for re-evaluation. Some manuscripts must be rejected if they are scientifically unsound, unimportant (i.e. they do not contribute any worthwhile information), or are otherwise unsuitable for publication. The Editor makes the final decision on whether a manuscript is acceptable for publication and in so doing aims to maintain the scientific quality and overall high standards of the journal.

Book Reviews

Zoology

Grouse and Quails of North America

By Paul A. Johnsgard. 1973. University of Nebraska Press, Lincoln, Nebraska. 553 pp., 140 plates. $25.

This is a handsome and scholarly monograph in which the author presents detailed and interesting accounts of the biology and behavior of the nine species of grouse and the 14 quails that occur in North America from the Arctic to Guatemala. He also includes the introduced Gray and Chukar Partridges because of their interesting comparisons with native species. Johnsgard modestly states in his preface that very little in this book represents new and original information, and that nearly all the findings are those of others. Nevertheless, the assemblage and evaluation of the enormous body of literature (34 pages of source material are listed) is a great undertaking. Johnsgard is in a good position to evaluate the literature at his disposal, having "observed in life all of the nine species of grouse, both of the introduced partridges, and all but two of the fourteen species of quails."

The book is organized into two parts: Comparative Biology, and Accounts of Individual Species. There are also keys to identification, name derivations, source list, and an index to the occurrence of both vernacular and scientific names of species mentioned in the text. In the introduction he presents a framework for his discussion of the zoogeographical relationships and the evolutionary radiation of grouse and quails. He lists fossil grouse and quails of this continent and speculates that since Oligocene and Miocene forms share a number of common characteristics, both groups may have been derived from cracid-like ancestors during mid-Tertiary times. Johnsgard regards North America as the evolutionary center of the grouse since it has more total genera and more endemic genera than does Eurasia. He regards *Centrocercus* (Sage Grouse) and *Tympanuchus* (Prairie Chicken) to be the most highly specialized of the extant genera and presumes that both of them evolved independently from forest-dwelling forms as arid habitats expanded during the late Tertiary times. He regards *Dendragapus* (Blue Grouse) and *Lagopus* (Ptarmigan) to be nearest the ancestral types in general morphology, with the tundra-dwelling adaptations of *Lagopus* representing a more recent development than the forest-habitat and adaptations of *Dendragapus*. Regarding the quails, he considers that since Central and South America exhibit the largest number of endemic quail species, the New World quails originated in Middle America and the primitive, tree-dwelling *Dendrortyx* (Tree Quail), which exhibits a large number of generalized traits, is nearest the hypothesized ancestral quail type.

The section on physical characteristics is both interesting and useful to both the scientifically oriented, and the hunting fraternity. He includes the adult weights of males and females of all the grouse and quails as well as egg characteristics and incubation periods. Within the first section Johnsgard continuously focuses attention on the living bird in its natural environment and the adaptive value of specific characteristics. Although grouse and quails present specific and frustrating problems when reared in captivity, this book contains an eight-page section on their aviculture and propagation. A quick perusal of the section on hunting, recreation, and conservation attests to the great importance of grouse and quails as game birds. During the open season in 1970, the estimated annual kill in United States and Canada totalled 49 380 000 grouse and quail with the Ruffed Grouse and Bobwhite being the favorites. Non-hunters will probably recoil in horror at such statistics, but Johnsgard points out that regulated hunting has a scant impact on these species, which have a relatively high reproductive rate, and emphasizes that under most circumstances hunting cannot measurably alter the mortality rate of the species. The real threat to their survival is loss of habitat through depredation by man's activity. This threat, along with the insidious environmental pollutants, is the true specter which overshadows all of nature.

In Part II, Accounts of Individual Species, many readers are to have their first detailed look at species which may not have previously attracted them because they believed them drab and uninteresting. All aspects of the life histories are included; the elaborate courtship displays and the unusual and colorful display structures are pictured in most species' accounts.

This book is profusely illustrated both in color, and in black and white. Often there is a series of photographs showing different attitudes of the species depicted. This is not entirely successful in all cases since there is, unfortunately, a strong similarity between several pictures in some series. Nevertheless, the effect is pleasing and they do show in good detail some of the beautiful courtship postures which only the most fortunate can see in the wild. Most of the color plates are excellent photographs, but the works of four artists are included. Plates by C. G. Prichard have special value since they feature downy young, which are seldom illustrated. Dexter Landau and John O'Neill, as well as Prichard, all beautifully reproduce the mottled, cryptic patterns of the plumages. The reproduction of the superb plate of the hybrid between Scaled and Gambel's Quail by Louis Agassiz Fuertes is poor in comparison with its original at the Cornell Laboratory of Ornithology.

All in all, *Grouse and Quails of North America* is a comprehensive scholarly monograph that should be attractive to professional biologists, bird watchers, and hunters.

S. D. MACDONALD

Vertebrate Ethology
National Museums of Canada
Ottawa K1A 0M8

Mind in the Waters. A book to celebrate the consciousness of whales and dolphins

Assembled by Joan McIntyre. 1974. McClelland and Stewart, Toronto. 240 pp. (including 16 pp. colored photographs). $14.95.

This is a successful book, as a collection of poems, essays, articles, illustrations and like material celebrating the consciousness of cetaceans. Any book that helps to increase more widely the appreciation of whales as the interesting and complex animals they are in the wild is to be commended. The illustrations are an important part of the book's message. A nice feature is the portfolio of color photographs showing Right whales apparently off Patagonia, feeding humpback whales, and a jumping striped dolphin. Interesting too, but of relatively poor quality in reproduction, are a number of black-and-white photographs from the technical literature. It is surprising, in an undertaking of this magnitude, that more original material was not included—it certainly exists.

The layout and design are slightly confusing, perhaps purposefully so, with constant intercalation of philosophy with fact. Perhaps this is meant to open the reader's mind.

The book is at its best when presenting original findings. The mutual aid in False Killer Whales and Common Dolphins is good original information and is gripping, unlike Spong's derivative information and speculations.

In a field such as whale conservation, emotion-laden, it is important to get the facts correct. This is a major attempt to synthesize and make simple a tremendous body of information and thought. Taxonomists will quibble about the species recognized in the descriptions of species. The essay on the evolution of cetacean intelligence by Bunnell does not quite get all the facts straight about the evolution of cetaceans, and never really gets around to the question of the definition of intelligence or whether and how cetaceans are intelligent. The two companion articles, however, by Jacobs and by Morgane on the brain's input and behavior, and the anatomical basis of intelligence, are both readable and up to professional standards. Warshall gives an account of the biological characteristics of cetaceans that is marred by minor and some major errors. More than one illustration is misidentified as to species or anatomical exactitude. The strange ventral color pattern of the orca is illustrated—the underside shown is actually that of a pilot whale. The porpoise melon is represented more clearly than it perhaps exists in the porpoise. Strange whale, too, the blue whale which "survived, as far as we know, by digesting her own blubber."

After arousing the reader's interest, few references are given to additional information. The chapter on Greek dolphin mythology by Doria is an exception. Morgane's article cites the literature, but the list is not appended—too dry, I suppose. A bibliography or reading list would have been a useful addition to the book. Identification of sources and credits for illustrations are not consistent, when given.

One quibble I have is that much cetological scuttlebutt has found its way into this book. Whether it is justifiable, I find character assassination of deceased cetologists distasteful, as in the poem "To the Apologist, Defender, and Stooge of the Whaling Industry: EJS," presumably the late Professor E. J. Slijper. And quotes meant to be insulting such as that attributed to Ray Gambell should at least spell his name correctly.

As a call to action, I am sure that it will be successful and raise public consciousness. Getting to the crux of the problem, as to where that action should presumably be directed, editor McIntyre has helped the focusing process by concluding with two essays by Scheffer and Talbot. Scheffer presents moral, biological, and technological arguments for the case for a world moratorium on whaling. The essay is interesting and on some points persuasive, but Scheffer misses the point entirely in stating that "within the IWC [International Whaling Commission], the voting power of industry has dominated the voting power of the Scientific Committee." If the scientific findings are valid, they need not be subjected to vote; also, the Scientific Committee acts in an advisory capacity and neither votes internally or externally within the IWC. Talbot's indictment of the IWC precedes his calling for a new or revised mechanism to regulate whale populations, an increased data base, and abandonment of the MSY (Maximum Sustainable Yield) concept in whale management.

There is more right than wrong in this book, and it is worth the low price just to have around to argue over.

EDWARD MITCHELL

Arctic Biological Station
Ste. Anne de Bellevue, Quebec

The Whale Problem, A Status Report

Edited by William E. Schevill, with consulting editors G. Carleton Ray and Kenneth S. Norris. 1974. Harvard University Press, Cambridge. 419 pp. $12.50.

Although I am one of the contributors to this volume, the editors of *The Canadian Field-Naturalist* have asked me to review the book. I offer instead comments on its present importance.

The volume originated from papers presented at "The International Conference on the Biology of Whales," held 10–12 June 1971 in Shenandoah National Park, immediately preceding the meeting of the Scientific Committee of the International Whaling Commission. The meeting was called to examine the existing data base, of what was then known of the biology of whales as necessary for the management of whale populations. The papers fall broadly into four categories, the current status of populations, their biology, management and conservation, and field methods. They represent a useful compendium of what was known in 1971, and is still pertinent today.

The dissatisfaction with the record of the International Whaling Commission, partly the reason this symposium was called, subsequently became the focal point for an active anti-whaling campaign by many conservation and protection organizations. Recently, the Food and Agriculture Organization of the United Nations has become active in setting up its ACMRR Working Party on Marine Mammals. This group is currently holding meetings and compiling data preparatory to another international symposium on marine mammals, to be held in 1976. But this does not detract from the importance of the Shenandoah volume.

The volume itself is poorly produced, and in my opinion does not measure up to the standards expected by some of the invited participants. The text is unjustified typescript, the binding is poor, and photographs were not solicited from participants although some excellent photos have been inserted by the editors. My major criticism is the lengthy period between the time of the conference and the date of publication. This, however, makes the book easier to review, as it is now a historical document more than an essay on the current status of whales and knowledge of whales.

Since 1971, many new developments have taken place. Most of the recommendations of one of the working groups (useful essays resulting from sessions of the participants) related to seven items then important in the management of the large whales. Nearly every item as it was then framed has been acted upon or implemented in some way, and in some cases resolved.

Considering the ignorance of some conservationists and protectionists, I think that this book should be obligatory reading for all who espouse a "position" on the issue of whale management. Particularly the chapters on methods of analysis of Antarctic whale populations should be read by all. Chapman concluded that the management of the Antarctic whales "has had the benefit of as much scientific information as any large managed natural animal population in the world."

So here we have an entire book, slightly out of date but full of useful details on the biology, history of exploitation, and present status of whales. "The Whale Problem," however, has yet to be succinctly defined. As is often true, the answer will not be recognized until the problem is precisely defined. Actually, I think that "The Whale Problem" was inadvertently summarized by McVay, who stated regarding Antarctic fin and sei whales that "only three parties are currently scrutinizing these data on a part-time basis, and their interpretations vary widely." According to the convenors, "the present scientific manpower and resources devoted to whale research are inadequate and should be expanded."

In a digest by the convenors and others, of the major conclusions resulting from the conference, eight points are listed ranging over issues from statements of stock reduction to details of new methods of study. It is difficult to formulate a single phrase that describes the whale problem, since the problems range from the logistics of data collection and the difficulties of quantifying continuous variables in biological systems, to methods of analyzing scientific, economic, technological, and political data and keeping these various data, interpretations, and conclusions separate from each other and from the resulting recommendations. McVay stated that "in one sense we are 'beyond data,' since a resolution of the whale problem is now more in the domain of politics and economics than science."

Whatever the resolution of the problem, this inexpensive volume will become one of the important milestones in the definition of the biological data base.

EDWARD MITCHELL

Arctic Biological Station
Ste. Anne de Bellevue, Quebec

Wasps. An account of the biology and natural history of solitary and social wasps

By J. Philip Spradbery. 1973. University of Washington Press, Seattle. 408 pp. $17.50.

Although it could be applied in a general sense to most of the families of the order Hymenoptera, the word "wasp" probably elicits from most people the image of a big ovoid hornets' nest hanging from the branch of a tree. It is the hornets and the other smaller social species comprising the family Vespidae, and their closest non-social relatives, the Eumenidae, which are the subject of this book.

Some 60% of the contents is divided about equally amongst chapters and appendices concerning vespoid taxonomy and morphology; natural history of the eumenids (especially the 22 British species); natural history, distribution, and evolution of the Vespidae; the taxonomy and distribution of the 29 vespoid species in Britain; methods of study and control; and other front- and back-matter. The remainder deals in depth with the natural history of the yellow jackets and hornets and is the main strength of the book. For the most part it is very thorough and up to date, and includes much unpublished material from various doctoral dissertations, including the author's own work on the exocrine glands, antennal sensillae, and fat body depletion.

Substantive errors are few. The number of segments in the antenna is attributed to the flagellum alone in the text, although the figures are correctly labelled. In the diagram of the sting apparatus, however, the anterior process of the oblong plate is labelled as part of the quadrate. The plates were bound incorrectly, necessitating the tipping in of some supplementary captions and causing some inconvenience in their consultation.

Though perhaps not the sort of stuff to entertain the general reader, nor, perhaps, to inspire an undergraduate, this book is an invaluable tool for the serious student since it includes not only the extensive citations and author, species, and subject indexes lacking in more popular books, but also detailed directions on methods of study ranging from the location and collection of large underground nests to preparation and microphotography of male genitalia.

Nevertheless there is here an abundance of curiosities from natural history. A solitary wasp may fly a few hundred kilometres to fetch the several hundred pellets of mud required to shelter her growing grubs; little wonder that through the cumulative efforts of a multitude of such dedicated laborers, a yellow-jacket colony at its maturity can produce a few thousand virgin queens; nor that in New Zealand, where some colonies persist into a second season, nests may grow to nearly 200 combs of 3 to 4 million brood-filled cells weighting half a ton. Not only have wasps invented clay pottery and paper, but one species of *Eumenes*, having combined these two traditional vespoid architectural styles, seems to have been the originator of wallpaper. The all-female work force of a yellow-jacket colony may keep the lawn neatly mowed around the entrance to their underground nest. Of no comfort to feminists of whatever gender, however, is the fate of an equally conscientious householder, the female eumenid wasp, who thoroughly cleans out the debris in her cell before pupation and therefore usually makes her debut free from ectoparasitic mites, only to be contaminated venereally by her less fastidious suitors. Presumably both sexes are subject to that weakness for fermented sap that leads many a foraging wasp to "die a drunken death." But one must admire at least the sober diligence, if not the good judgment, of the *Ancistrocerus antilope* who built her nest in a French commuter train.

Because of Spradbery's emphasis on the depauperate temperate insular fauna of Britain, the beginner will still need Evans & Eberhard's *The Wasps* for a balanced overview of basic wasp biology and evolution, while Wilson's definitive *The Insect Societies* will be required for an introduction to Polistine taxonomy as well as a comprehensive account of social evolution in wasps, a primarily tropical phenomenon whose rich variety we have only begun to explore.

Despite a few deficiencies and a certain degree of parochialism, this current, highly readable and scholarly book will be most useful to students of behavioral ecology. It brings under one cover the scattered and diverse world literature of this interesting group of organisms, greatly facilitating the entry of new workers into this field of study. And the wasps need all the friends they can get among mankind; for, despite the abundant good these creatures do us in the biological control of pests, man (along with a few other undiscriminating omnivores such as the badger and the skunk) is the prime enemy of mature wasp colonies, having gone so far as to place bounties on them when their nuisance value, real or imagined, has reinforced their already undeservedly bad reputation. Yet the greatest threat to many species, solitary as well as social, is habitat attrition. At a time when a list of endangered species of butterflies is being prepared and the world honeybee population is in decline, it is " 'only those who have learned to love wasps' " who will notice, like Mr. Spradbery, that the hornets' papery spheroid is disappearing from our increasingly urbanized land.

MICHAEL WONIO

2407 Olympia Drive
Bettendorf, Iowa 52722

Flies and Disease

By Bernard Greenberg. 1971. Princeton University Press, Princeton. Vol. 1. 856 pp.; 1973. Vol. 2. 447 pp. Set $42.50.

These two volumes are written mainly for epidemiologists, medical entomologists, microbiologists, parasitologists, and others concerned with public health. The flies concerned are the synanthropic flies—those living in association with man or his domestic animals. Biting flies, with the exception of stable flies (*Stomoxys*) and others, such as *Haematobia*, are not dealt with.

Volume 1 is devoted to ecology, classification, and biotic associations of synanthropic flies. In addition to the introduction and a discussion on synanthropy, there is a chapter on the bionomics of flies, dealing with 96 of the more important species. Fifteen species are illustrated in as many excellent full-page color plates. Chapter 4 includes keys to the common adult flies of the Palaearctic region, covering 17 families. There are keys to the world species of *Musca* and a key to the most common species of *Drosophila*. One hundred and fifty-five figures illustrate the terminology used in the keys. Chapter 5 consists of a key to the larvae of Palaearctic and cosmopolitan species and is illustrated by 70 figures.

The bulk of this volume, 558 pages, is devoted to Chapter 6 and 7. Chapter 6 presents a systematic list of flies associated with other organisms, including 346 species (29 families), followed by a classification of flies and their associated organisms. In Chapter 7 a list of organism – fly associations is presented.

Volume 1 is well-documented, with a bibliography of 84 pages. A convenient feature of the index is that page numbers referring to a graph or drawing are marked. In addition to the author there are six other contributors to this volume.

Whereas Volume 1 serves as a detailed reference work Volume 2 is integrative in nature, dealing with biology and disease transmission. Greenberg, the sole author in this case, looks at flies through history, the biology of flies, and the fly as a host. Chapters 4 and 5, dealing with flies and human diseases and flies and animal diseases respectively, contribute the major portion of this volume. There is an 84-page bibliography and an index. Fifty-four figures, consisting of graphs, line drawings, and photographs, illustrate Volume 2. In addition there are six tables.

Although this is not the work a general naturalist or perhaps even a general entomologist would purchase, I would recommend these two volumes to anyone interested in flies or disease. Volume 2 is of special interest to researchers as the author has tried to point out specific research needs. It is the author's stated hope that this book will serve as a stimulus and guide to further research. I believe his hope will be fulfilled.

WILLIAM B. PRESTON

Manitoba Museum of Man and Nature
190 Rupert Avenue
Winnipeg, Manitoba

The Deer and the Tiger: A Study of Wildlife in India

By George B. Schaller. 1967. University of Chicago Press, Chicago. 360 pp. New paperback 1974 edition $6.95.

"In one hundred years the combination of land clearing, uncontrolled slaughter, habitat destruction by livestock, and disease have reduced one of the world's great wildlife populations to a small remnant." Compounding this problem is the limited information available regarding the life histories of these species. Schaller's text, *The Deer and the Tiger: A Study of Wildlife in India,* is an attempt to establish a basic information source for wildlife managers facing these problems.

Owing to time constraints, Schaller selected a study area providing maximum exposure to a wide variety of species, the Kanha National Park in central India. "Of the ten wild species of hoofed animals in Kanha Park, only the chital (*Axis axis*), sambar (*Cervus unicolor*), and gaur (*Bos gaurus*), were fairly abundant. The barasingha (*Cervus duvauceli*) and blackbuck (*Antilope cervicapra*) though conspicuous, were rare in actual number." Schaller was unable to collect much information on other species of wild hoofed animals: nilgai (*Boselaphus tragocamelus*), four-horned antelope (*Tetracercus quadricornis*), barking deer (*Muntiacus muntjak*), wild pig (*Sus scrofa*).

Each of the five most commonly observed species is treated separately with consideration given to distribution, reproduction, mortality, and behavior; behavioral characteristics are treated in the greatest detail. This is the largest section of the book and contains a great deal of first-hand data supplemented by the available literature and numerous references to comparable species in North America.

Following a specific treatment of each species, Schaller attempts to summarize similarities and differences between the different animals. "Although the large ungulate species in Kanha Park occupy essentially the same environment, each one is adapted to certain habitat conditions which separate it to some extent ecologically from the others." This section acts as a convenient brief summary before consideration of the predator species. A discrepancy occurs when the text suggests chital feed on grasses and the inserted table on page 203 suggests otherwise.

The second section of Schaller's book considers the predators of Kanha Park. "Although a number of different kinds of large carnivores occur in Kanha National Park, the tiger is by far the most important as a predator on the populations of hoofed animals." Unfortunately the predator section lacks the 'first-hand' data characteristic of the prey section. Schaller, however, recognizes the weakness: "Although there were more tigers at Kanha than in any other area of similar size that was visited, the population was too small to provide much data on its dynamics during the year of study." Information from captive specimens (zoos) and the literature were used to supplement his data.

The final chapter of *The Deer and the Tiger: A Study of Wildlife in India* attempts to summarize the predator–prey interactions within Kanha Park. Probably because of the limiting predator data Schaller was able to collect, its contribution to the overall text is slight.

The greatest value of this book lies within the sections dealing with the ungulate species. Whereas these sections have definite limitations (i.e., very little disease and parasitological information) they point out the apparent end-product of morphologically similar species co-existing in harmony. "The striking differences in the annual reproductive cycle between the species at Kanha make it obvious that no single environmental factor or combination of factors influence all animals equally."

Schaller's book is perhaps a little verbose but well worth reading. As the author himself points out, wildlife is a cultural heritage: "once destroyed it can never be replaced."

PETER CROSKERY

Ontario Ministry of Natural Resources
Chapleau, Ontario

Song of the North Wind: A story of the Snow Goose

By Paul A. Johnsgard. 1974. Doubleday, New York. 150 pp. $5.95.

When this book came to me I was excited about its possibilities. Combining folklore and science in an account of a bird important to mankind has long seemed to me to be an idea worth pursuing. Unfortunately, this attempt does not come off. The "story" in this book concerns a year in the life of a family of snow geese, from the arrival of the adult pair at their nesting grounds on Southampton Island, through the breeding season, fall migration, and overwintering on the Gulf of Mexico Coast, until their return flight to Southampton Island. This narrative, however, is a very slender thread woven through a mass of other material, some of it relevant to the life history of the geese, some of it not. There is a wide diversity here: ecological polemics, Eskimo and Indian legends, the findings of scientific investigations, melodramatic and sentimental treatments of the geese, fictitious episodes drawn from anthropologists' work, and a review of biological literature, as well as allusions to the journals of early travellers and explorers. Like Professor Johnsgard's other books, this one tries to be a synthesis of other people's work. But contrary to the practice of William A. Fuller and John C. Holmes (*The Life of the Far North*. Mc-Graw-Hill, New York, 1972), he gives full bibliographical sources and acknowledgments to those on whom his work depends.

The book also has photographs by the author and drawings by Paul Geraghty. The latter, while interesting and occasionally sensitive, do not always catch the theme of the folklore they attempt to depict. No theme, in fact, is well developed in the book as a whole. There is almost as much in it that is *not* about the geese as there is about them. There is much about rivers, the glacial Lake Agassiz, and considerable discussion of caribou and of Eskimos without clear indications of what they have to do with the main subject. Several of the folklore bits are related to the geese only by stretching a point. The consequence of his apparent purposelessness is that the diverse matter that makes up the book is disjunct. A lack of coherence harms what I consider Professor Johnsgard's most promising idea, demonstrating the compatibility of folklore with animal biology, so that, instead of being revealing, enlightening, and delightful, the book appears to have been pasted together for a quick market. For example, at the end of the book, when the geese are leaving the McConnell River for their Southampton Island nesting grounds, the author concludes, not with a piece of poetry appropriate to the northern scene, but with a Navaho Night Chant suitable for the southwestern deserts. However beautiful this passage is, a song from Diamond Jenness' collection of Eskimo pisiks and weather chants would have been more seemly at this point.

There are many good things about this book. The type is attractive and readable. The dust jacket is attractive. The maps are clear, although the nesting range was painted with a broad brush which destroys the concept of nesting colonies, nor have I ever found snow geese nesting on Boothia Peninsula. The excerpts from folklore, however clumsily handled, retain their ambiguous poetic quality. I am sorry that Professor Johnsgard never saw the geese arrive at Southampton Island in the spring nor sat in an igloo listening to a good Eskimo story teller spin yarns of the land and geese and men.

THOMAS W. BARRY

14322 Ravine Drive
Edmonton, Alberta T5N 3M3

Botany

Pollen. Biology, Biochemistry, Management

By R. G. Stanley and H. F. Liskens. 1974. Springer-Verlag, New York, Heidelberg, Berlin. 307 pages. $24.60.

> Meiotic division has three important features
> 1. Transformation of the chromosomes by cross-over processes
> 2. rearrangement of the genomes by random distribution of the homologous chromosomes, and
> 3. Reduction of the chromosome number from 2n (diploid) to n (haploid). Up to the present time many textbooks emphasize the third event. If this was the most important aspect of meiotic division, nature would renounce the complex processes of meiosis. However, 1. and 2. are decisive, because these events make recombination possible, which is probably the most important contribution of sexuality to evolution.

The above quotation from the early pages of this book sets the tone, brevity with clarity, of the entire work. The authors deal with the morphogenesis of the pollen grain through the formation of the pollen mother cell, meiosis, mitosis, the complex building up of the pollen exine, the dehiscence of the anther, and the distribution of the pollen to the stigma of, hopefully, another flower of the same species, and the fertilization of the ovule. From here the book goes on to deal with every conceivable aspect concerning pollen, hybridizing, collecting, storing, and management. Pollenosis and biochemistry are considered in detail.

This book is likely to become a standard text on pollen. With the extensive bibliography, one can obtain, or find out where to obtain, information on any aspect of the subject presently known to science.

REG ADAMS

Department of Biology
University of Waterloo
Waterloo, Ontario

Genetics of Forest Ecosystems

By Klaus Stern and Laurence Roche. 1974. Springer-Verlag, New York; Heidelberg, Berlin. 330 pp. $29.60.

Forestry is an applied science that must integrate and utilize information gathered from many disciplines in the physical and applied sciences and humanities. The working literature of forestry is correspondingly broad but relatively unknown outside the field and this book will do much to redress this deficiency. Conversely, the literature of plant and animal sciences is well represented in the nearly 1000 references used to develop the major theme of the book, i.e., the essential role of genetic and evolutionary relationships in the development of forest ecosystems and their responses to the environment, including man. *Genetics of Forest Ecosystems* is a book for study and reference rather than light reading, but it will richly reward the serious student who wishes to gain new insights into complex natural systems.

The subject headings of the six chapters proceed from The Ecological Niche, through Adaptations, Genetic Systems, Adoptive Strategies to Forest Ecosystems and, in the final chapter written by the junior author, How Man Affects Forest Ecosystems. The sub-headings listed in the Table of Contents indicate to the reader the order of logic that will lead him to discussions of major forest ecosystems of the world, from the tropics to the subarctic. On page 1, with barely five lines of introduction, the unwary is plunged from the comfort of cosy comprehension into the stark discipline of theory developed through mathematical symbolism and conceptual model building. On first reading, the first ten pages can, and perhaps should, be skimmed to reach the descriptive discussion of the ecological niche before returning to the model. A similar reliance on the elegance of mathematics to crystallize complex concepts is common to the first five chapters, but the non-mathematician should not be deterred. Although the models are the framework, comprehensive discussion, elaboration, and deduction provide the form of the subject matter. Those who avoid mathematics will find themselves returning to explore the symbolic arguments for their conceptual clarity and the theorists will find reality in the exploration of the strengths and limitations of the models.

The book is much more than a review of literature, in fact the literature cited was selected to highlight conflicts in theory and voids of information. There is frequent emphasis on the need for further study and graduate students and research workers will find a wealth of problems yet to be solved, parameters to be quantified, and theories to be tested.

The frequently dominant effect of man, past and present, on the extent and structure of forest ecosystems is examined in the last chapter, although, to quote from the Introductory Remarks, "this subject matter might be more logically dealt with in a separate book." It will be of particular interest to those unfamiliar with forestry literature, and lends support to another quotation from the Introductory Remarks that ". . . foresters and forest biologists have always recognized the need for conservation, i.e., a sustained effort for the protection of the part of the human environment designated as the 'landscape.' Only recently has the general public become aware of this problem." Foresters, in common with many others, are less aware of the great need, referred to in the concluding paragraphs, to protect and conserve a wide diversity of genetic resources represented in natural forest ecosystems, especially those subject to management and utilization.

Technically the book is attractively bound, the print is clear and the reproduction of drawings and photographs is excellent. Editing was inadequate to correct a number of omissions and errors in the literature cited and some typographic errors, including the omission of the first three rows of numbers from Tables 17 and 18. Indexes for Species and Family and for Subject are comprehensive and valuable reference tools. A debt of gratitude must be given Dr. Kris Morgenstern, Canadian Forestry Service, for his outstanding translation from the German.

This important addition to the literature of population genetics and ecology will remain a major reference and deserves to be widely known and appreciated. As Professor Roche writes in concluding the Preface, "The tragic death of Klaus Stern, just as the book was ready for press, and when he was at the height of his powers, has impoverished the lives of all who knew him, and left a gap in scientific forestry which will not easily be filled."

C. W. YEATMAN

Canadian Forestry Service
Petawawa Forest Experiment Station
Chalk River, Ontario

Vegetation of the Earth—In relation to Climate and the Eco-physiological Conditions

By Heinrich Walter, translated from the second German edition by Joy Wieser. 1973. English Universities Press, London, and Springer-Verlag, New York, Heidelberg, Berlin. 237 pp. $5.90.

This small book was abridged by the author from his two-volume (1964, 1968) treatise of the same title. It includes only a few additional new notes arising from field work subsequent to the publication of the larger work. The original of this abridged format was published in German in 1970 and this reviewer has used it in that form before the translation appeared. Joy Weiser has performed a valuable service to English-speaking ecologists in translating this book.

Walter justifies his book in an unusual way by use of a map showing his own extensive travels and visits to research institutes around the world. It is a frank and impressive justification. It does, however, expose Walter to a minor criticism in that, although he has examined much of Europe, Africa, Australia, the United States, and parts of South America, he apparently did not take a corresponding look at Canada, Alaska, or the tropical parts of South America such as Brazil, Colombia, Ecuador, and Peru. The Russian literature was consulted concerning the inaccessible regions of Asia. His arctic and alpine conclusions are based on experience in European and American mountains and in the arctic part of Norway and Finland, augmented strongly by the published literature. In general I am impressed by Walter's masterful grasp of ecological conditions in all parts of the world.

The special strength of this volume is summed up in his sentence "This book is intended as an eco-physiological study rather than as a description of the vegetation." Clear thinking and strict definition of concepts mark his discussions and arguments. An example is the discussion of poikilohydric organisms (bacteria, algae, fungi, and lichens) whose water content varies with that of the surroundings, versus homiohydric plants whose cell water content is more independent of the surroundings. An anglicized spelling, homeohydric, would have been more acceptable in translation. Another example is that he would redefine halophytes as 'plants that store large quantities of salt in their organs without thereby undergoing any damage' instead of 'plants growing on saline soil.' They must balance the osmotic effect of the salt in the soil by a similar salt concentration in the cell sap. True halophytes will greedily take up salt from normal soil. The chloride ions cause a swelling of the particular proteins of these plants and result in succulence. Other halophytic relationships are mentioned including sulphate-halophytes, alkalihalophytes with organic anions, and salt-excreting plants like Tamarisk.

On competition and limits of distribution he has this to say: "The natural limit of distribution of a particular species is reached when, as a result of changing physical environmental factors, its ability to compete, or its competitive power, is so much reduced that it can be ousted by other species." Further: "Only at the absolute distribution limit, in arid or icy desert, or where the forest shade is at its deepest, are the physical environmental factors (usually one particular extreme factor) of direct importance."

Walter's treatment is concrete and replete with examples. It is a rare page that does not contain exact quoted figures of evidence and example. His style is succinct, clear, and readable. Possibly because this book is an abridgment of a much larger work the examples and evidence adduced so consistently to make the point under discussion usually lack references to their sources or authors.

The admirable emphasis on eco-physiology extends throughout the accounts of the major ecosystems of the world. This analysis of the vegetation of the world is the best and most understandable treatment I have encountered. It is well illustrated with black-and-white halftones, climatic diagrams, distributional maps, and many physiological charts. Minor faults include a very few typographical spelling errors, and the lack of a glossary. I made an incomplete list of 142 technical terms freely and well used but often without explanation. A final summary presents estimates of phytomass and yearly primary production of plant material in the whole biosphere and its component major parts.

I recommend Walter's book highly to both ecologists and the interested general reader, providing he is willing to decipher some terminology.

DUNCAN A. MACLULICH

26 Stewart Street
Strathroy, Ontario

Forestry in Newfoundland

By Graham Page, W. C. Wilton, and Tony Thomas. 1974. Canada Department of the Environment, Forestry Service. 118 pp. Free on request from the Newfoundland Forest Research Centre, P.O. Box 6028, St. John's, Newfoundland.

This colorful booklet, primarily designed to entice Newfoundland high-school students into forestry, does so quite successfully by the ingenious approach that forestry is not just another industry but is in fact a complex biological system which can be manipulated, through careful management, into serving the economic and recreational needs of the province. The nine chapters touch all bases: from a short history of the Newfoundland forest industry to a life history of a forest; from a review of legislation germane to forestry, including timber rights, to a consideration of the future of forestry in Newfoundland. Some chapters are curiously ambivalent. On the one hand, the authors recognize that forest fires are an integral part of the boreal-forest ecosystem while on the other they exhort all good Newfoundlanders to prevent forest fires. "Smokey the Bear" is not dead, he has been banned to Newfoundland.

All in all this is a very useful book which, according to Information Canada, will be reprinted and distributed throughout Canada in their bookstores. Before this reprinting occurs, however, I would call on the authors to correct a few errors and omissions: mature trees do not become decadent—societies perhaps, but not trees. The omission of black ash, the only ash which occurs in Newfoundland, from their list of trees found in Newfoundland is difficult to understand. I know it is not commercially important but then neither is red pine, which is discussed. And finally, measurements should be given in SI units, especially since today's high-school student thinks metric. Moreover, since the federal government is pushing ahead with its plans for metrication it might be useful for government departments and their agencies to provide an example.

S. P. VANDER KLOET

Department of Biology
Acadia University
Wolfville, Nova Scotia

ENVIRONMENT

Polar Deserts and Modern Man

Edited by T. L. Smiley and J. H. Zumberge. 1974. The University of Arizona Press, Tucson, Arizona. 173 pp., illustrated. $11.50.

This is one of those books that one goes to for information, and not for easy-chair evening reading. It is full of facts, figures, graphs, charts, and formulae. It is divided into three main parts: Natural Environment (with eight papers); Economic Base for Development (with three papers); and Problems of Immigrants (with three papers). Part One covers climatology, geomorphic processes, geological and limnological factors, soils, microbiology, macrobiology and ecology, and indigenous peoples. Part Two covers processes and costs imposed by severe environment, and resource development. Part Three covers transportation, health and sanitation, and design of living areas in homes, stores, and towns in arctic areas. Emphasis is on the Arctic scene, but the Antarctic is discussed in detail in some papers. There is tremendous variation in the amount of information given in each article. The article by Péwé on geomorphic processes is very readable and informative, whereas that by Rowley on indigenous peoples is barely more informative than most encyclopedias.

Parts One and Two offer little new material and few new ideas. Part Three, the Problems of Immigrants to polar areas, is much more interesting, yet this is a field of study that has attracted little interest or money for studies. My own personal experience in polar areas is that even though the buildings are somewhat permanent, none of the personnel is. All personnel brought in from "outside," "down south," or in the case of Antarctic, "up north," rarely stay, or plan to stay more than several months to a year. Those who do stay for longer periods have visits or rest periods to the outside every few months. As W. M. Smith points out in his article (p. 161) entitled Behavioral Design of Habitats for Man in Polar Deserts, ". . . housing is of generally low quality . . . In temperate climates, inadequate indoor living spaces are somewhat offset by the ready availability of outdoor areas." Thus, if a dwelling is inadequate, the residents will stay outside more. Because of climate, this option is not available to most northern residents. Most life styles of immigrant northern residents reflect styles from more temperate areas. Housing and communities should be designed to fit the region; at present they do not.

At the larger stations of both polar areas, some waste materials are disposed of by burning, but most garbage and human wastes are dumped onto the sea ice, or hauled some distance away. As there was (is?) no health hazard from flies spreading diseases (particularly in the Antarctic), no one worried. And it is almost impossible to bury things in the polar areas. First there is the problem of permafrost near the surface and, therefore, not being able to dig down very far (about one metre). And second, garbage works its way up to the ground surface after several years because of frost-heave activity. Then, because of the cold and arid conditions, things do not decay or rust away as they do in temperate climates.

I identify several lacks in this book. The first is discussion on polar mammals and migratory birds. The effect that numbers of immigrant, industrial man will have on animals such as polar bears, caribou, and muskox is not discussed. These and other animals would be sensitive to an increase in numbers of man. In many areas, the prime nesting grounds for birds would be near potential stations or townsites (on low flat ground near the coast). The second is the effect of exploitive activity on the landscape, flora, and fauna. And the third is one that I find frequently with "edited" books—no synthesis, evaluation, or general conclusions drawn from the articles in the book. The third lack I consider to be an abrogation of responsibilities on the part of the editors. It is all very well to have a symposium, and for the contributors to discuss things among themselves, but we, the readers, need evaluation and general comments and conclusions almost more than the raw information.

The format of the book (small quarto) is a bit large for a reference or source book. It should have been a medium to large octavo. And it is an extravagant book, with large margins, drawings, and photographs. The binding is excellent and the printing is clear and easy to read, although with a few errors.

ROBIN LEECH

Research Secretariat
Alberta Environment
Milner Building
10040 – 104 Street
Edmonton, Alberta

Perspectives of Biophysical Ecology

Edited by David M. Gates and Rudolf B. Schmerl. 1975. Springer-Verlag, New York. 609 pp. $34.80.

Biophysical ecology, a subdiscipline of ecology, uses fundamental principles of physics and chemistry together with mathematical analysis to understand the mechanisms by which organisms interact with their environment. As expressed in the preface, "The intent in biophysical ecology is to obtain not simply a qualitative description of cause and effect, but a precise quantitative relationship between the final event and the causative factors."

In a 28-page introduction Gates points out that ecology is an extremely complex and difficult science and yet universities have traditionally emphasized biology and neglected physical sciences in preparing students to be ecologists. Thus, ecologists for the most part have been satisfied with the qualitative aspects of ecology, or with quantitative aspects in terms of numbers or rates. In Gates' view, ecologists must now get at the fundamental mechanisms that control the components of ecosystems; and these fundamental mechanisms are physiological and physical. Thus the 'complete ecologist' must have adequate training in physical as well as in biological sciences. Those of us who do not have the facility with physics and mathematics that would permit us to engage in theoretical analysis or systems modeling need not despair. Gates acknowledges that few such persons are to be found. Furthermore he believes that the more traditional approaches are also worthwhile and necessary.

The book describes the work of a number of biophysical ecologists, and contains papers offered at a symposium on biophysical ecology held at the University of Michigan's Douglas Lake Biological Station in August 1973. There were 31 papers presented by 47 contributors, 42 from the United States, 4 from West Germany, and 1 from Israel, but none from Canada. Most of the 42 Americans were students, or former students, who had trained with Gates at Michigan during the last 10 years.

Rather than review particular papers, I will give the theme of each part of the book, the number of papers (plus an indication of the subject of some of the papers) in each part, and the number of references cited for each part. These references, most of them quite current (and including a complete bibliography of the papers produced by the Michigan group up to 1973) are a valuable collection. Another value is the methods section of each paper; ecologists are always excited by discussion of design and technique relating to instrumentation. And there is an index that could be more comprehensive but which is fairly good anyway.

The book is divided into six parts:

I. "Analytical Models of Plants"—5 papers, 176 references. Papers on Optimum leaf form; Energy balance in plants.

II. "Extreme Climate, and Plant Productivity"—4 papers, 109 references. Papers on Gas exchange and photosynthesis in desert plants.

III. "Water Transport and Environmental Control of Diffusion"—5 papers, 71 references. Papers on Plant survival in disturbed lands; Environmental influence on plant water consumption.

IV. "Theoretical Models of Animals"—6 papers, 313 references. Papers on Environmental constraints on predator–prey interactions; Body size of homeotherms; Microhabitats.

V. "Observations of Animal Body Temperatures"—5 papers, 208 references. Papers on Energy budget of hummingbirds; Body temperatures of small birds, rodents, and reptiles.

VI. "Energy-Transfer Studies of Animals"—6 papers, 145 references. Papers on Energy budget of rabbit and deer; Energy transfer in fur; Microclimate of marine intertidal zone.

This work, number 12 in the Ecological Studies Series published by Springer-Verlag, is an impressive and valuable book. I was disappointed, however, with the lack of coverage of the mechanisms of adaptation to arctic and subarctic environments. There was some mention of snow and winter in Part VI (paper entitled "Thermal exchange, physiology, and behavior of white-tailed deer," by Moen and Jacobsen), but nothing elsewhere. It will come I am sure. There are a few people who could be termed biophysical ecologists working in Canada at the present time. Gates' students will eventually spread across the continent and join these Canadian workers. I view with pleasure the prospect of the 'complete ecologist' winging his (or her) way northward to apply the biophysical touch to the significant (if traditional) body of information already gathered about the north.

TOM H. NORTHCOTT

Wildlife Division
Building 810, Pleasantville
St. John's, Newfoundland

Life at the Sea's Frontiers

By Richard Perry. 1974. Taplinger, New York. 301 pp. $9.25.

This, the third title of "The Many Worlds of Wildlife" series, deals mainly with the terrestrial vertebrate life of islands, coasts, and estuaries. The book is similar to other books of the same genre in that a good deal of it covers the more sensational aspects of island and coastal life. With seemingly little continuity, the dialogue moves randomly from atoll life to giant island tortoises, then on to such perennial crowd-pleasers as the evolutionary anachronistic *Tuatara* and the giant Komodo dragons. The chapters, for the most part, are interesting in their investigations of various kinds of wildlife, but one detects a lack of continuity between chapters. The only theme connecting them appears to be the ecological relationships found at the land–sea interface. This seeming discontinuity is heightened by the somewhat random arrangement of the chapters.

My main complaint with this book is in its lack of originality. Most of the material is taken from the writings of other naturalists. As such, I found it a chore to continue in many instances, wishing that I were reading material from which the author seemed to be paraphrasing. I had the feeling, in many cases, that something was being lost in the translation. I must admit that Perry's work does have a few interesting sections that seem alive in comparison with the rest of the book. These bright spots occur whenever Perry writes from his own experiences as a naturalist. His chapter dealing with the Northumberland coastal region near his home is excellent, but unfortunately brief. Had the entire book been of that quality Perry could have made an important contribution to the corpus of natural history writing. As the book now stands, I can only recommend it for the few illuminating sections which are a product of Perry's own experiences.

MICHAEL P. KINCH

Sci-Tech Division
Kerr Library
Oregon State University
Corvallis, Oregon 97330

High Arctic—An expedition to the unspoiled North

By George Miksch Sutton. 1971. Paul Eriksson Inc., New York. 11 color plates, 16 black-and-white plates, line drawings. $12.95. Separate portfolio of 11 color plates, $14.95.

George M. Sutton, writer, artist, teacher, internationally acclaimed ornithologist, has made many trips to the Arctic, beginning in 1920 as a crew member on the Grenfell Mission's *Northern Messenger*. In spite of half a life-time of arctic associations he had never seen the far northern islands. The opportunity to complete this lengthy love affair with the arctic regions came in 1969 when Sutton was invited to join an expedition to remote Bathurst Island where long-term studies of animal behavior are being carried out by biologists of the National Museum of Natural Sciences (Canada).

His book, *High Arctic,* immediately captures the reader as Sutton recounts with engaging charm the narrative of this visit to the high north. The informality, freshness, and warmth with which the story is told make it an experience in which the reader feels a part. It conveys a sense of wonder, and even awe of the subtle beauty of the far north and the excitement of being in an unspoiled land where muskoxen, wild white wolves, and King Eiders are part of the landscape.

The month-long period at Bathurst Island occupies most of the story. We are told little about the scientific endeavors of the expedition, but are given ample demonstration that progress towards the achievement of new knowledge is won by hard work and keen observation, and is made in tiny steps, often under trying conditions. The narrative does not purport to be an account of scientific accomplishment, but its spontaneity could easily stimulate young people to field studies.

We are told in an interesting way of camp life, the problems of logistics, the comforts of living in a Parcoll hut and of the camaraderie that prevailed. We became party to conversations about the lateness of the season and scarcity of spring birds, the death from starvation of an old bull muskox, and visitations of an almost legendary arctic wolf, "Bloodface." Beautiful descriptions, some lyrical, tell of the coming of the birds, their nests, the flowers, the storms, and bind together a life story of the transient arctic summer. At the end of the season a flight was made to Ellesmere, Axel Heiberg, and Meighen Islands in search of the nesting site of Ivory Gulls. This search proved unsuccessful, but the described panorama of majestic arctic landscapes, impressions, and adventures which flow from Sutton's pen are a great success.

The text of *High Arctic* is enhanced by eleven full-page or double-page color plates of Sutton's paintings of birds and mammals. There are also sixteen excellent monotone photographs, and numerous line drawings. All are exceptionally well chosen, and add greatly to the reader's sense of participation. Dr. Sutton's descriptions indicate his remarkable capacity to observe, and his paintings superbly demonstrate his ability to share what he has observed with others.

Prints of the paintings are available in a separate portfolio and warrant comment in their own right. Eight are presented in 16 × 16-inch format, and three are 12 × 8 inches. All are delicate water colors, and portray the far north with great sensitivity, perhaps in a way never before presented. The flock of seven Brant in flight is exquisite, and the painting of two Greater Snow Geese flying is so true to life in the atmosphere of beginning spring that one can almost hear the hum of their primaries in the wind. The others all have special qualities of their own to delight the eye. Whether in the book or in the folio they speak to us about the fragile web of life of the far north which we know awaits the onslaught of man's technology. How long can the High Arctic remain unspoiled?

I recommend *High Arctic* to everyone who is interested in the north and its wildlife; it will bring back cherished memories to those who have been there, and it will offer a vicarious journey to those who have not.

S. D. MACDONALD

National Museum of Natural Sciences
Ottawa, Ontario K1A 0M8

Much is Taken, Much Remains. Canadian issues in environmental conservation

By Rorke Bryan. 1973. Duxbury Press, North Scituate, Massachusetts. 307 pp.

This book consists of six parts. The first is a brief Introduction and the last a still briefer Conclusion. The four parts which make up the main body of the book deal with pollution and development in the Canadian environment; transfer and export of Canadian water; the status and conservation of wildlife in Canada; and national parks in Canada. Although the specific problems dealt with are exclusively Canadian ones, the author's concern is not solely with Canada. As he points out (p. xiv), "If we can overcome the environmental problems in Canada, perhaps some of our remedies can be applied in other countries."

I recommend this book to anyone concerned about these problems. Probably most of the topics discussed in it have been dealt with elsewhere, but I have not seen any other book that deals with them all. It is lucidly written, and the author's approach is scholarly and thoughtful. Except in the discussion of eutrophication (pp. 29–30) which is not altogether satisfactory (the author gives the impression that the main troublesome biological consequence of eutrophication is the increased growth of rooted plants, whereas in fact it is the proliferation of planktonic algae), the author has been remarkably successful, as far as I can judge, in avoiding errors in the wide range of subjects that he has covered.

The discussion of water export is particularly noteworthy for the absence from it of the nationalistic tone which has characterized so many discussions of this topic. Much that has been written has, in the author's words, "created the impression that the Americans are waiting to snatch our water as soon as our backs are turned" (p. 151) whereas in fact "many of the proposals for water export are of Canadian, not American, origin" (p. 152). I entirely agree that "it is irrelevant whether or not the water crosses a political boundary. If the costs of damage outweigh the benefits, all people are eventually losers" (p. 14).

It is in the section on national parks that the author appears to speak with the greatest authority. He recognizes the varied and incompatible demands that are quite legitimately placed on these areas, and the necessity for zoning if these demands are to be met. He does not believe, however, that zoning within parks will be successful, and recommends that different parks be zoned for different purposes. One possibility he suggests is that a distinction be made between wilderness parks, with a minimum of management, and recreation parks, with intensive management even to the point of removing animals if they interfere with recreation activities. Here would seem to be an area where the development of successful policies in Canada might be of very considerable value elsewhere. It is hard to imagine what the great African national parks would be like if they received anything like the number of visitors that most North American parks receive, but it seems inevitable that the use of at least some of them will increase enormously as more and more Africans become interested in them, and acquire the means to indulge their interest. As the pressure becomes more intense, it would be pleasant to think that those responsible for the management of these incomparable resources might be able to profit from Canadian experience.

The book is printed on good paper, and is strongly bound in a flexible cardboard cover. The lines are not justified, but this was presumably necessary to keep the cost of production from being too high. Otherwise it is a pleasant book to look at and handle. Since so much care has obviously gone into the writing and manufacture of it, and since it is of more than ephemeral interest, it is a great pity that the book suffers from extremely careless proofreading. The number of misprints is altogether excessive, and although most of these may be no more than blemishes, many are confusing or misleading. I cannot, for example, make sense of the statement that "total foreign investment [in Canada] increased from $1.25 million in 1900 to over $32 billion in 1965, but the American share had risen from $250 million to $23.8 billion" (p. 10). In the discussion of the discharge of Canadian rivers (pp. 126–127) the flow within the Hudson's Bay basin is given twice, as 29% and as 21%, and it is only by adding up the figures that the reader can learn that the first of these is correct. If the author felt that it was useful to present figures like these, surely he, and the reader, are entitled to have them quoted correctly. "Ice-cored mounds" are referred to as "pongos" (p. 112); the correct term is "pingos." Lake Williston is referred to as "Lake Willesden" in the list of plates, and as "Lake Willisden" in the legend to the plate illustrating it, although the name is given correctly in the text. There is even a mistake in a page number in the Table of Contents. The index is virtually useless.

R. M. BAXTER

2256 Upper Middle Road
Burlington, Ontario L7N 2N7

The Restoration of Water Levels in the Peace–Athabasca Delta: Report and Recommendations

Environment Conservation Authority, Government of Alberta, September 1974. (Copies available: Environmental Conservation Authority, 2100 College Plaza Tower 3, 8215–112 Street, Edmonton, Alberta T6G 2C8.)

Background

A drastic reduction in flows of the Peace River occurred between 1968 and 1971 after the construction by B.C. Hydro of the Bennet Dam for hydro-electric power on the upper Peace River in British Columbia. The 1968–1971 period reduction was due to the rapid filling of the dam reservoir, Williston Lake. After the initial filling period, the dam has been operated in such a manner as to store peak spring flows for release later in the year.

The effect of first filling and then regulating the flows of the Peace River was most markedly felt downstream, in the Peace–Athabasca delta on Lake Athabasca in northern Alberta and Saskatchewan in the area of Wood Buffalo National Park. During the filling period, river levels were reduced by 10 to 12 feet adjacent to the delta. Subsequently, the annual fluctuation of the delta levels has been greatly reduced by the regulation. The flow system into the delta is complex with several sources of water and multiple outlet channels. In 1971, the governments of Canada, Alberta, and Saskatchewan undertook a joint study of measures that might be undertaken to restore levels and seasonal fluctuations essential to the delta ecosystems. The findings were reported in 1972 (The Peace–Athabasca Delta: A Canadian resource. Prepared by the Peace–Athabasca Delta Project Group) in a well illustrated and instructive report. Numerous recommendations were made concerning water-level control works and other community-related projects. The report is a necessary companion to the Environmental Conservation Authority report reviewed here.

The Report

The Environmental Conservation Authority report summarizes the proceedings of public hearings that were held in the communities of Fort Chipewyan and Uranium City, both situated in the area affected, and in Edmonton. The hearings were based on the recommendations of the project group which dealt with a broad variety of concerns. The findings of the hearings reflected this breadth by recommending proposals for a rock-fill dam to control artificially levels on the outflow channel from Lake Athabasca as well as proposals for compensation, local government, fish processing plants, improved schools, community utilities, historical centers, new transportation links into the area, and the development of secondary industries, to mention a few. In effect, the hearings identified a plethora of local concerns that ranged far beyond the effects of water levels.

In perspective, the fact that legal hearings were held, and not "information meetings" as is often the case elsewhere, is a positive step by the government of Alberta. But the basic issues of who owns the delta land, what the National Park interests are, why no riparian doctrine was applied to downstream water users, what local development options could be developed by the indigenous people, why the local people were not consulted before the regulation took place, and in general, why the resource of water and land are being externally controlled by governments, National Parks, and hydro corporations rather than the local people remain unresolved. In southern Canada, altering water requirements, zoning for parks, and applying externally developed plans for agricultural land are almost impossible without local support and jurisdiction. Apparently this is not so in the "north" — why not? The funds spent on task force studies and hearings might have been given to the local people to hire their own consultants on development of their own land.

In general, the pair of reports makes interesting and informative reading and certainly represents a good effort by the bodies in authority (excluding B.C. Hydro). The basic questions of northern development remain unanswered.

R. W. NEWBURY

Department of Civil Engineering
University of Manitoba
Winnipeg, Manitoba R3T 2N2

The Oxygen Revolution

By Geoffrey Mains. 1972. New Press, Toronto. 250 pp. $6.50.

The Oxygen Revolution is the author's dramatic way of referring to evolution of photosynthetic processes which led the way to the diversity and complexity of life that we know today. Geoffrey Mains, a biochemist, shows the physical and chemical basis for life and from these beginnings develops the theme of 'spaceship earth.' The uniqueness of life on earth and man's role in it are explored through such topics as agriculture, energy needs, technology, pollution, and population regulation. The book then presents a powerful case for environmental awareness. Modern man's ultimate dependence on biological process is well brought out, as for example in the chapter on the extinction of species where Mains asks, "Were these men incapable of conceiving that the whale was a living creature, that the whale had a reproductive cycle set within physiological limits, and that no amount of technological gee-gaws would ever make a whale grow or breed any faster."

With so many books on the environmental dilemma having appeared in recent years, I began the book wondering if I would learn something new. The novelty is twofold, firstly in its logical development from the inanimate to the cellular to the organismal to the population levels of biological thinking; and secondly in its emphasis on Canadian examples.

There are two dangers which a scientist must face when writing a book of this nature. These are (1) loss of precision due to the need to be understood by a lay audience, and (2) bias in assessing the evidence when one is trying to alert the public to the dangers of the 'environmental crisis.' The author displays a great breadth of knowledge and shows unusual skills in expounding on such diverse topics as atmospheric turbidity and cellular genetics. He quotes a variety of sources, some much more reliable than others. It is difficult for the reviewer to know whether the lack of scientific rigor in some of his statements reflects a lack of caution or a recognition of the need to simplify. Perhaps both are involved.

As for bias, there is inevitably suspicion that since the book is emphasizing the ways in which man is affecting the biosphere in a detrimental way, the author will draw the more pessimistic conclusions. Nevertheless in the final chapter, "Dynamic Equilibrium: A Theme for Survival," he outlines theoretical ways in which human society might progress. The conclusions reached are similar to those reached in *Blueprint for Survival.*

To close, I will detail one example of the difficulties mentioned above. In the penultimate chapter, Geoffrey Mains refers to the increasing level of mutagens in our environment and warns us that in addition to our worry about the effects of mutagens on man, we should also be concerned about the effect of mutagens on the microbial organisms which play such an important role in the ecosystem. He raises the spectre of harmful mutations in nitrogen-fixing bacteria or human pathogens. He says that harmful mutations are much more frequent than beneficial ones. Yet there is confusion about the meaning of harmful. Harmful to whom? If the mutation is harmful to the organism it will be eliminated by natural selection and will not be harmful to man. The spectre that the author raises will emerge only if the mutation is simultaneously beneficial to the organism and harmful to man. There are few examples of this in nature and in the examples which do occur, such as Penicillin-resistant bacteria, the mutation has counteracted the effects of man's interference with the organism's environment, surely an optimistic note from the viewpoint of maintaining a diverse ecosystem.

Despite these minor criticisms *The Oxygen Revolution* is a worthwhile and readable book with a wealth of information.

FRED COOKE

Department of Biology
Queens University
Kingston, Ontario

OTHER BOOKS

Marked by the Wild

Edited by B. Littlejohn and J. Pearce. 1973. McClelland and Stewart, Toronto. 287 pp. $3.95.

Marked by the Wild is an anthology of literature of the Canadian wilderness. The editors have divided their selections into various chapters which contain works of similar mood: The Non-Human World; the Ambivalent Wilderness; The Wilderness as Adversary; The Benign Wilderness; Widlerness and Self-Discovery; Man in Accord with Nature; Wilderness as Cultural Influence; and Wilderness Lost. The introduction to each chapter presents a historical background for the prose and poems that follow. I found that these introductions increased my appreciation and understanding of the selections and made the anthology a more cohesive presentation.

Of the few flaws in the anthology, the most serious is the translation of French-Canadian poetry. Since poetry projects a great deal of its meaning by cadence we lose some of the effect of the poem in translation. Also, the editors do not indicate who translated Des Rochers' poem *I Am the Dwindled Son*, although the poet himself transposes some of his own poetry to English. The greatest asset of the book is the variety and quality of work which is presented. The editors have conscientiously collected some outstanding Canadian literature, some of which has had limited exposure to the Canadian public.

Feelings for our wilderness betray what we are, what fears or joys we have, how our humanness can express itself beyond or through the rigors of living. In this beautiful book you may find part of yourself. It is highly recommended to anyone who has an appreciation for our natural world.

DOUG LEACH

Department of Biomedical Science
Ontario Veterinary College
Guelph, Ontario

Fieldbook of Nature Photography

By Patricia Maye. 1974. San Francisco, Sierra Club. Obtainable from Clarke, Irwin. 210 pp. $6.95.

Patricia Maye's *Fieldbook of Nature Photography* reviews cameras, lenses, films, etc. in an easy-to-read and thorough manner, but I question the title. The book concerns itself more with the equipment than with its field application: from pages 34 to 171 everything you've always wanted to know, from cameras and lenses to filters and film. Because this section answers most of the questions a beginner will ask, the book is worth a place in the home for this information alone. I highly recommend it as a reference/guide to the type of equipment, proper use of filters, and choice of film for any photo work, nature or otherwise.

Unfortunately, the author has not been as explicit in the nature photography area. Only about 16 pages discuss taking pictures outdoors. No mention is made of the practice of pruning branches around nests, or the dangers it causes to eggs and young. Photography in tanks is mentioned, but not the effect of hot lights on subjects so photographed. This is the area in which I feel the book has fallen down. As a photography primer it's great; as a how-to-take-nature-pictures guide, it is just that, a guide.

NORMAN R. LIGHTFOOT

P.O. Box 641
Kitchener, Ontario

Natural History Photography

Edited by D. M. Turner Ettlinger. 1974. Academic Press, London. 395 pp., 64 plates. $23.25.

This is a good reference on natural history photography. Although the price seems high, it is a well prepared book with a great deal of readable, well condensed information on a wide variety of natural-history photographic topics by many noted British photographers. The editor, D. M. Turner Ettlinger, is to be commended for maintaining clarity, thoroughness, and uniformity without sacrificing the authors' individual styles.

In the introduction, the editor sets out the basic premise of the book, that the authors wish to convey how to photograph accurately but artistically with prime concern for the welfare of the subject. The appendix on "The Nature Photographers Code of Practice," produced by the Association of Natural History Photographic Societies (Britain) in cooperation with several British conservationist groups, is very interesting and is worth consideration by Canadian photographic societies and conservationist groups. A code of this type needs wide acceptance in this day when photographs of endangered species are in such great demand, and one often wonders what, if any, care the photographers take in obtaining these photographs.

A diverse range of subjects is covered in individually specialized chapters: big game animals, small vertebrates, bats, birds, plants, underwater photography, cave photography, and stereo photography. The plates included with each chapter are photographs by the author(s) illustrating the types of photographs possible with the techniques they describe.

The chapters are well written and most are well organized in a balanced format. The chapters on birds are perhaps the best examples of this. Arthur Gilpin's "Birds at the Nest" starts with the nest itself, explaining what to look for in both surroundings and the nest. Gilpin cautions the readers not simply to photograph the first nest found, but to survey the area and find a well-constructed typical nest in a good locality; the results of this method are bound to be superior. Next is a detailed and comprehensive section on introduction of the hide to the nest. It outlines methods of approaching various bird species, with the hide, in different habitats. The tables included for working distances and lenses to use for birds of various sizes are a good reference. The Bottomlys' chapter extends Gilpin's, giving more information on the use of hides. They also suggest the use of baits, a tactic which would probably work equally well with North American birds.

The chapters by John and Gillian Lythgoe on underwater photography and by John Woolley on photography of caves take a sound approach in that they not only explain the photographic problems but stress many of the inherent physical problems the photographer will face. It may serve to dampen a reader's first enthusiasm enough to make him take a careful approach to either of these both dangerous and difficult subjects.

David Cooke's chapter on flash photography of bird flight is somewhat confusing, though this is admittedly a difficult field. It could have been made more understandable, and more in keeping with the philosophy of the rest of the book, had he discussed the use of more conventional flash equipment. His ideal flash set-up which can be built by any "competent electronic engineer" is beyond the scope of all but the professional. In addition to John Reynold's chapter on tropical conditions, information on the handling and transportation of camera equipment and other necessities in temperate and sub-arctic areas would have been welcome.

The editor's final chapter rounds out the book with a brief but comprehensive view of some technical aspects of the choice of cameras and other equipment and some personal observations on what he has found most suitable in cameras, lens, films, etc. The chapters mesh well with one another to provide a concise book suitable for both the amateur and professional interested in natural history photography and its ethical approach. Furthermore, the bibliographies after each chapter provide a ready source of additional information.

J. A. JOHNSTON

National Museum of Natural Sciences
Ottawa, Ontario K1A 0M8

NEW TITLES

Zoology

† **Bees and beekeeping.** 1975. By R. A. Morse. Cornell University Press, Ithaca. 295 pp. $13.50.

Biology and paleobiology of Ostracoda. Proceedings of a symposium, Newark, Delaware, 1972. 1975. Edited by F. M. Swain, L. S. Kornicker, and R. F. Lundin. Bulletins of American Paleontology, Volume 65. Paleontological Research Institute, Ithaca. 688 pp. Cloth, $22.60; paper, $18.60.

Butterflies of the world. 1975. By H. L. Lewis. Clark Irwin, Toronto. 208 pp., color ill. $37.00.

A field guide to the birds of Britain and Europe. 1975. By R. T. Peterson, G. Mountfort, and P. A. D. Hollom in collaboration with I. J. Ferguson-Lees and D. I. M. Wallace. 3rd edition. Houghton Mifflin, Boston. 344 pp. + plates. $10.

* **Field studies of the Falconiformes of British Columbia.** Vultures, hawks, falcons, eagles. 1974. By F. L. Beebe. B.C. Provincial Museum Occasional Paper Series Number 17. 163 pp.

* **The Ipswich sparrow.** 1975. By I. A. McLaren. Special supplement to Volume 27 of the Proceedings of the Nova Scotian Institute of Science, Halifax. 105 pp. Paper, $5.

† **The life of birds.** 1975. By J. C. Welty. 2nd edition. Saunders, Philadelphia. 623 pp. $19.05.

The lives of bats. 1975. By D. W. Yalden and P. A. Morris. David and Charles, Newton Abbot, England. About £5.

Mammals of Kentucky. 1974. By R. W. Barbour and W. H. Davis. University Press of Kentucky, Lexington. 322 pp. + plates. $14.95.

† **The Odonata of Canada and Alaska.** Volume 3, Part III: the Anisoptera — three families. 1975. By E. M. Walker and P. S. Corbet. University of Toronto Press, Toronto. 307 pp. $25.

† **Principles of fishery science.** 1975. By W. H. Everhart, A. W. Eipper, and W. D. Youngs. Cornell University Press, Ithaca. 288 pp. $12.50.

Sociobiology. The new synthesis. 1975. By E. O. Wilson. Harvard University Press, Boston. $20.

Ultrasonic communication by animals. 1974. By G. Sales and D. Pye. Chapman and Hall, London. 282 pp. + plates. $15.75.

Whitetail deer. A year's cycle. 1975. By C. K. Stadtfield. Dial, New York. 164 pp. $7.95.

Botany

The Alaska-Yukon wild flowers guide. 1974. Edited by H. A. White and M. Williams. Illustrated by V. Howie. Alaska Northwest Publishing Co., Anchorage. 218 pp. Paper, $7.95.

Aquatic vegetation and its use and control. 1974. Edited by D. S. Mitchell. Unesco, Paris. 136 pp. Paper, $6.60.

Atlas of United States trees. Volume 2, Alaska trees and common shrubs. 1975. U.S. Department of Agriculture, Miscellaneous Publication Number 1293. U.S. Government Printing Office, Washington. 19 pp. + 105 maps. $3.10.

A field guide to the ferns. 1975. By B. Cobb. Illustrated by L. L. Foster. Houghton Mifflin, Boston. The Peterson Field Guide Series, Number 10. Reprint of the 1963 edition. 282 pp. Paper, $3.95.

A field guide to the trees of Britain and northern Europe. 1974. By A. Mitchell. Color plates by P. Dahlstrom and E. Sunesen. Line drawings by C. Darter. Houghton Mifflin, Boston. 416 pp. + plates. $12.95.

Multivariate analysis in vegetation research. 1975. By L. Orloci. Junk, The Hague. 276 pp. 50 Dutch Guilders.

Toward a wetland classification system in Ontario. 1974. By J. K. Jeglum, A. N. Boissonneau, and V. F. Haavisto. Great Lakes Forest Research Centre, Sault Ste. Marie. Information Report 0-X-215. 55 pp. Free.

Water plants of the world. A manual for the identification of the genera of freshwater macrophytes. 1974. By C. D. H. Cook, B. J. Gut, E. M. Rix, J. Schneller, and M. Seitz. Junk, The Hague. 266 pp. 120 Dutch Guilders.

The wild flowers of Britain and northern Europe. 1975. By R. Fitter and A. Fitter. Illustrated by M. Blamey. Scribner, New York. 336 pp. $10.

Environment

The automobile and the regulation of its impact on the environment. 1975. By F. P. Grad *et al.* University of Oklahoma Press, Norman. 482 pp. Paper, $9.95.

The biology of estuaries and coastal waters. 1974. By E. J. Perkins. Academic Press, New York. 678 pp. $37.75.

Coevolution of animals and plants. Papers from a symposium, Boulder, Colorado, August 1973. 1975. Edited by L. E. Gilbert and P. H. Raven. University of Texas Press, Austin. 246 pp. $12.50.

On defusing the population bomb. 1975. By M. E. Endres. Schenkman, Cambridge, Massachusetts (distributer, Halsted [Wiley], New York). 196 pp. Cloth, $10; paper, $5.

Ecological sites in northern Canada. 1975. Edited by D. N. Nettleship and P. A. Smith. The Canadian Committee for the International Biological Programme Conservation Terrestrial — Panel 9, Ottawa. 310 pp. $3.75.

The ecology of natural resources. 1974. By I. Simmons. Halsted (Wiley), New York. 424 pp. Paper, $8.95.

Environmental dynamics of pesticides. Proceedings of a symposium, Los Angeles, April 1974. 1975. Edited by R. Haque and V. H. Freed. Environmental Science Research Volume 6. Plenum, New York. 388, $29.50.

Environmental planning: a guide to information sources. 1975. By M. J. Meshenberg. Gale Research Press, Detroit. 480 pp. $18.

The impact of energy development on water resources in arid lands. Literature review and annotated bibliography. 1975. By C. Bowden. University of Arizona Office of Arid Lands Studies, Tucson. 278 pp. $10.

Indicators of environmental quality. 1975. Edited by W. A. Thomas. Plenum, London. 275 pp. Paper, $6.95; cloth, $18.50.

Living in the environment. Concepts, problems, and alternatives. 1975. By G. T. Miller, Jr. Wadsworth, Belmont, California. 380 pp. $13.95.

Natural resources measurements. 1975. By T. E. Avery. 2nd edition. McGraw-Hill, New York. 340 pp. $12.95.

Pollution and physiology of marine organisms. 1974. Edited by F. J. and W. B. Vernberg. Academic Press, New York. 506 pp. $18.50.

Miscellaneous

The Alaska pipeline. The politics of oil and native land claims. 1975. By M. C. Berry. Indiana University Press, Bloomington. 302 pp. $10.95.

† **Applications de la télédétection à l'étude de la biosphère**. 1975. By C. M. and M. C. Girard. Masson, Paris. 186 pp. 96F.

Biology and society: the evolution of man and his technology. 1975. By A. McClary. Collier MacMillan, Don Mills, Ontario. $8.75.

* **A boater's guide to the upper Yukon River.** 1975. By the publishers of Alaska magazine. Alaska Northwest Publishing Company, Anchorage. 66 pp. $3.95.

† **Climate** — diagram maps of the individual continents and the ecological climate regions. 1975. By H. Walter, E. Harnickell, and D. Mueller-Dombois. Springer-Verlag, New York. 36 pp. + 9 maps + 14 figs. Cased, $29.60.

* **The nature of the stratigraphical record.** 1973. By V. A. Derek. Halsted (Wiley), New York. 114 pp. $9.50.

* **Fieldbook of nature photography.** 1974. By P. Maye. Sierra Club (Clarke Irwin), San Francisco. 210 pp. $6.95.

International conference on the prehistoric and paleoecology of western North American Arctic and Subarctic. Calgary, November 1972. 1974. Edited by S. Raymond and P. Schledermann. University of Calgary Archaeological Association, Calgary. 262 pp. Paper, $6.50.

* **A guide to the Queen Charlotte Islands.** 1975. By N. G. Carey. Alaska Northwest Publishing Company, Anchorage. 72 pp. $2.95.

The land no one knows. 1975. By T. H. Watkins and C. S. Watson, Jr. Sierra Club (Clarke Irwin), San Francisco. 32 pp., photographs. $8.95.

Marine geology and oceanography of the arctic seas. 1974. Edited by Y. Herman. Springer-Verlag, New York. 398 pp. $34.80.

Metropolis and hinterland in northern Manitoba. 1975. By P. D. Elias. Manitoba Museum of Man and Nature, Winnipeg. 128 pp. $5.50.

† **Ottawa waterway.** Gateway to a continent. 1975. By R. Legget. University of Toronto Press, Toronto. 291 pp. $15.

* **Our search for wilderness:** the story of a sixty-year marriage. A journey through the natural beauties of America. 1975. By C. E. Graves. Exposition Press, Hicksville, N.Y. 224 pp. $8.

† **Principes de conservation du sol.** 1975. By I. Nahal. Masson, Paris. 144 pp. 52F.

The trail of the hare. Life and stress in an arctic community. 1974. By J. S. Savishinsky. Gordon and Breach, New York. 256 pp. Paper, $4.95; cloth, $14.95.

Water resources of the world. 1975. By F. van der Leeden. Water Information Center, Port Washington, N.Y. 578 tables + 47 maps. $32.50.

---

† Available for review.
* Assigned for review.

Information Concerning Content of *The Canadian Field-Naturalist*

Articles

The Canadian Field-Naturalist is a medium for publication of research papers in all fields of natural history. If possible, major articles should be illustrated.

Notes

Short notes on natural history and related topics written by naturalists and scientists are welcome. Range extensions, interesting behavior, pollution data, and other kinds of natural history observations may be offered. It is hoped, however, that naturalists will also support local natural history publications.

Letters

Letters commenting on items appearing in this journal or on any developments or current events affecting natural history and environmental values are welcome. These should be brief, clear, pertinent, and of interest to a wide audience.

News and Comment

Informed naturalists, biologists, and others are invited to present documented narratives and commentaries upon current scientific and political events that affect Canadian natural history and the environment. Contributions should be as short as possible and to the point.

Book Reviews

Normally, only solicited reviews are published. Biologists and naturalists, however, are invited to submit lists of titles (complete with pertinent information regarding authors, publisher, date of publication, illustrations, number of pages and price) for listing under "New Titles."

Special Items

As *The Canadian Field-Naturalist* has a flexible publication policy, items not covered in the traditional sections can be given a special place provided they are judged suitable.

Index to Volume 89

Compiled by R. Emerson Whiting

Index to Book Reviews

Botany

Environment

Zoology

Other Books

Instructions to Contributors

Manuscripts

Authors should submit three complete manuscripts with two copies of figures (in addition to the originals) for use by referees. Manuscripts are accepted in either English or French. They should be typewritten on paper measuring $8\frac{1}{2} \times 11$ inches, and if possible, the paper should have numbered lines. Margins should be 1 to $1\frac{1}{2}$ inches wide to allow for copy marking. All text matter, including quotations, footnotes, tables, literature citations and captions for figures should be double-spaced. Only words meant to appear in italics should be underlined. Every sheet of the manuscript should be numbered. In no case should words be abbreviated; this includes references to tables and figures as well as literature citations. Authors are requested, however, to use SI symbols for units of measure.

It is strongly recommended that, before submitting a paper, authors ask qualified persons to appraise it.

An abstract is required for all Articles but is optional for Notes. Authors are requested to use at least one given name. Literature cited should be listed alphabetically according to author and should be placed immediately after the main body of the text, except in Letters to the Editor. If only one or two references are cited, they should be inserted in the text. The tables should be titled and numbered consecutively in arabic numerals, and each should be placed on a separate page after the Literature Cited. Captions for figures should be typed together on one page. The places in the text for tables and figures should be marked in the margin.

Extensive tabular or other supplementary material not essential to the text should be submitted on letter size paper ($8\frac{1}{2}'' \times 11''$) for the Editor to place in the Depository of Unpublished Data, National Science Library, National Research Council of Canada, Ottawa, Canada K1A 0S2. A notation in the published text should state that the material is available, at a nominal charge, from the Depository. Two copies are required for the Depository.

The **CBE Style Manual**, third edition (1972), published for the Council of Biology Editors, Committee on Form and Style, by the American Institute of Biological Sciences, is recommended as a guide to contributors.

Webster's New International Dictionary is the authority for spelling. In a case, however, of difference in the spelling of a common name, and in the use of a variant name, a decision of a learned society is preferred.

The order in which papers are published will be determined by the Editor.

Illustrations

All illustrations should be numbered consecutively in arabic numerals. The author's name, title of the paper, and figure number should be written in the lower left corner of the sheet on which each illustration appears. The caption should **not** appear on the illustration.

Line drawings should be made with India ink on white, good quality drawing paper, blue tracing linen, or good quality blue-lined co-ordinate paper. Co-ordinate lines that are to appear on the reproduction should be ruled in black ink. Descriptive matter should be lettered, not typewritten, and all parts of the drawing should permit easy legibility even if a reduction is made. Photographic reproductions of line drawings are acceptable in lieu of large originals.

Photographs should have a glossy finish and show sharp contrasts. For reproduction as a complete plate they should be mounted with minimal space between prints.

For large drawings and mounted photographs the ratio of height to width should conform to that of the printed journal page (ratio of 45 up to 35 across) or roughly $7\frac{1}{2} \times 5\frac{3}{4}$ inches, but the height should be adjusted to allow for the caption if the caption is to go on the same page.

Special Charges

Authors must share in the cost of publication by paying $40.00 for each page in excess of six journal pages. When grant or institutional funds are available, we ask authors to help defray a higher proportion of the cost of publishing their manuscripts. At the time the galley proofs are sent to authors, the journal will solicit on a voluntary basis a commitment to pay $40.00 per page for all published pages. Authors will also be charged for changes in proofs.

Illustrations cost $5.00 each for any size (up to a full page). Tables cost up to $40.00 per page, depending upon size. The special charges for illustrations and tables are *in addition* to all charges that are levied for pages in excess of six. Reproduction of color photos is extremely expensive and the full cost must be borne by authors. Price quotations may be obtained from the Business Manager.

Limited journal funds are available to help offset publication charges to authors with minimal financial resources. Requests for financial assistance should be made to the Editor when the manuscript is submitted.

Reprints

An order form for the purchase of reprints will accompany the galley proofs sent to authors.

TABLE OF CONTENTS *(concluded)*

Notes *(continued)*

Mailing date of previous issue September 5 1975

The Publications Committee of The Ottawa Field-Naturalists' Club acknowledges with thanks the contributions of the **National Research Council of Canada** and **The Canadian National Sportsmen's Show** toward the publication of this volume.

TABLE OF CONTENTS

concluded on inside back cover

THE CANADIAN FIELD-NATURALIST published by **The Ottawa Field-Naturalists' Club**

Box 3264, Postal Station C, Ottawa, Canada K1Y 4J5

Second Class Mail Registration No. 0527 — Return postage guaranteed

ISSN 0008–3550

Date Due