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The Canadian Field-Naturalist

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Ask the Grass, Not the Teacher

Man is a threatened species. The danger to his survival is caused by his own intelligence, and by the man-centered thinking that restricts his understanding of human ecology in today's changing environments. Man exists as part of a biosphere made sick by his own multitudes; education is the only hope of spreading the attitudes necessary for change.

Educational systems are traditionally conservative and slow to meet new social needs, but the rapid transformation of teaching that followed Russia's Sputnik demonstrated an unexpected ability to evolve rapidly into new curricula with new purposes and new vitality. But now that another crisis confronts us, the old crisis has us facing in the wrong direction, for the new one involves biology, the old one was mostly concerned with hardware.

Sputnik brought an infusion of indoor experimentation and discovery into the old teaching method of memorizing second hand information. Learning by experience had new emphasis, but education remained largely a classroom process little influenced by the real world of people alive in green, productive landscapes. Biology remained eclipsed by more precise sciences and by more traditional and "useful" subjects. Ecology remained a rare word. It was a system that encouraged teachers to teach about leaves by using paper cutouts instead of the real leaves growing in the schoolyard, and to teach about streams on sand tables rather than beside a stream in a nearby valley.

Some teachers and some educational systems have developed impressive outdoor oriented programs to meet the new needs of our society. Across the nation, however, the total picture of environmental education is rather dismal. Canadian facilities are few for adequately training teachers for this new emphasis on ecology. We see an urgent need of Canadian courses to help teachers be informed and effective in teaching about our Canadian environments.

The poor training to date is obvious. At our Wye Marsh Wildlife Centre, north of Toronto, we have met hundreds of teachers with their classes who have come for an experience in outdoor education. Most teachers are visibly afraid to lead an outdoor program. When we first planned school use of the Centre, we decided to supply facilities and teaching aids, so teachers could lead their students into outdoor discoveries. The results had a high percentage of disasters making it obvious that we must lead both the teacher and the children with our own staff. This failure of the teachers was due to lack of confidence due in turn to lack of familiarity with both the subject and its teaching methods. The cure is experience and training. Teachers at all levels should be taught about the content and methods of environmental education; and teaching teachers, like teaching children, should include the experience and discovery of outdoor education in the outdoors.

We are disturbed also by a scarcity of high quality teaching aids and textbooks suitable for Canadian needs. In part we blame educators for this, but much more we blame those scientists and other specialists who hoard environmental understanding in their professional circles while making no effort to communicate intelligibly with the public. In many such circles, professionals comunicating with the public in appropriate language actually risk a lowering of their professional status in the eyes of their colleagues.

School buildings too, and their locations, have helped to isolate the child from his natural environment. Schools are larger and self contained, and located in the most urbanized areas. Buses contain the child between school and home. We are raising a generation of children given minimum opportunity to identify with the living landscapes of which they are part.

Many recent changes in education are not as great as superficial observation may suggest. Good teachers have always used most of the "new" methods of today. It is their general use on today's large scale that is the new dimension. Through human history the best teachers have been real, live people encouraging pupils to explore and experiment for themselves in order to experience truth, not just memorize it. While this is not always possible, it is an ideal to reach for even at considerable cost.

One great new dimension in teaching has been electronic communication, especially television. Its impact upon people have been profound, yet has fallen far short of the first rush of optimism that accompanied its spread across urbanized Canada. Its greatest impact on people has been in the home, where in a few decades it has influenced young generations to the extent that teachers in all levels of education are constantly expressing awe and amazement at the sophistication and knowledge of today's young people. Recently a teacher told us that the schools and television are in competition for the attention of young minds, and television is winning. We agree with these teachers only in part. In our work, helping children experience real rural environments, we find that usually the children's understanding of and familiarity with the world are disturbingly superficial. Far from being worldly, these children are experience poor.

Home television does increase knowledge, but as most of us will agree, it is hardly mind stretching, and even documentaries and travelogues rarely deviate from a light approach that usually manages to be misleading. The medium is well known for giving entertainment priority over truth, often at the expense of truth. High costs result in haste, so television is the superficial medium. Its limitations are not only from aiming too low in intelligence, but there are severe limitations to what a camera can put into a video tube. A television screen is a confined visual space accepting capably only confined visual objects.

Yet another limitation is evident from talking to people watching closed circuit television at Wye Marsh. The camera is outside beside a bird's nest or a winter feeder, and the action on the television screen in the foyer attracts people. Their interest increases astonishingly, however, when even casual viewers are told that the "show" is live, and that the real thing is just outside the door. Television, as communication, seems to be received as something less than reality, perhaps because viewers feel buffered from real experience by both time and distance.

Television in the classroom was not long ago considered a heaven-sent solution to many teaching problems. It has not measured up. Most large schools have television, and most of them use it effectively. At the same time it has severe limitations, not the least of which is that television does not make a poor teacher any better, and for all teachers it destroys the two way communication essential to good teaching.

Gadgets have their role to play in environmental education, but that role is limited. At Wye Marsh we expose children to television, taped message machines, slide shows synchronized with sound, and push button movies. None of these can react to a child's aroused curiosity nor to the blank stare of his not understanding. Children write letters after visiting the Centre that usually focus on something "our naturalist said", or on something that he did. The machines are secondary if mentioned at all.

We adults are obligated to educate the youth of Canada about the environment necessary to their living. It is a matter of life or death. The best place to educate is in our school systems; and the best method to use is live teachers, trained and competently advised, who help children disover why the grass is green by asking the grass, not asking the teacher.

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Nest Record Card Program in Canada

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Abstract. A brief account is given of the purposes of nest record card programs, their history and present organization in Canada, problems in use of nest record data, examples of papers based on Canadian nest records, and prospects for their future use. The importance of nest recording as an aid in conservation education is emphasized.

The purpose of this account is to explain the nature and purposes of nest record collection programs in Canada, to outline the progress towards the various objectives, and to discuss the future of nest record study in Canada. A brief note (Peakall, 1967) with the same title and objectives aroused an extended comment in this journal (Myres, 1967) a few years ago. This article will not resolve all of the critical points raised by Myres, but it should help naturalists to realize some of the potential values of nest records while avoiding the more obvious pitfalls in their collection and use.

A nest records scheme is a program for gathering detailed information on the nesting of birds, particularly from people who would not otherwise publish their data. Observers enter their findings on nest record cards (Fig. 1a and b) which are turned in to a central file. The main purposes for assembling such observations include studies of (a) breeding success, (b) nesting biology, and (c) breeding distribution. The first objective is of interest to all persons concerned about the continued existence of birds, and particularly those responsible for conservation and management of bird populations. It is the most critical as well as the most difficult objective. The second is probably most often pursued in university research programs, while the third objective is a primary concern of museums. Persons pursuing the other objectives can contribute to the first one, which by other means can only be studied on a local scale. Naturalists are interested in all of these, but especially in the last two objectives.

Nest record schemes are not and never have been a substitute for detailed research, but they can be very helpful. Examination of nest record files at the start of a study shows quickly whether nests of a given species are easy or difficult to find, where studies may begin, and which people may be able to give useful advice. Nest records extend the range of special studies by providing data from areas which the research worker could not visit in the time available. And they save for future studies the by-products of other field activities, i.e. observations not bearing on the study in hand, which would otherwise pass unrecorded or remain unheeded in a notebook.

Tim Myres brought the English idea of a nest records scheme to British Columbia in 1955. Now the coverage spans the country, except for Keewatin and Franklin (Table 1). Over 85,000 cards are already on file, and about 9,000 more are received each year. All the files contain some records from years before the local program began; there has been a major effort in Ontario to seek out such records, which now make up at least 10,000 of their cards. The Ontario scheme was not well publicized and supported until 1964, and the Quebec program similarly languished until 1968. The other major programs grew rapidly for three or four years and then levelled off.

The regional nest records schemes operate independently, and the activity of each has fluctuated with the varying enthusiasm of its co-ordinators. The Canadian Wildlife Service (CWS) supported the Maritimes and Newfoundland schemes from their starts, and in 1968 I was asked to co-ordinate the efforts of the regional nest records programs, as part of the CWS non-game bird populations studies. CWS has undertaken to supply nest record cards to the regional schemes, using a standard card design developed in consultation with the regions; to maintain liaison between the regional co-ordinators through visits and a series of newsletters; and to explore the fields of storage, retrieval, duplication, and analysis of nest record data, by computer and other means.

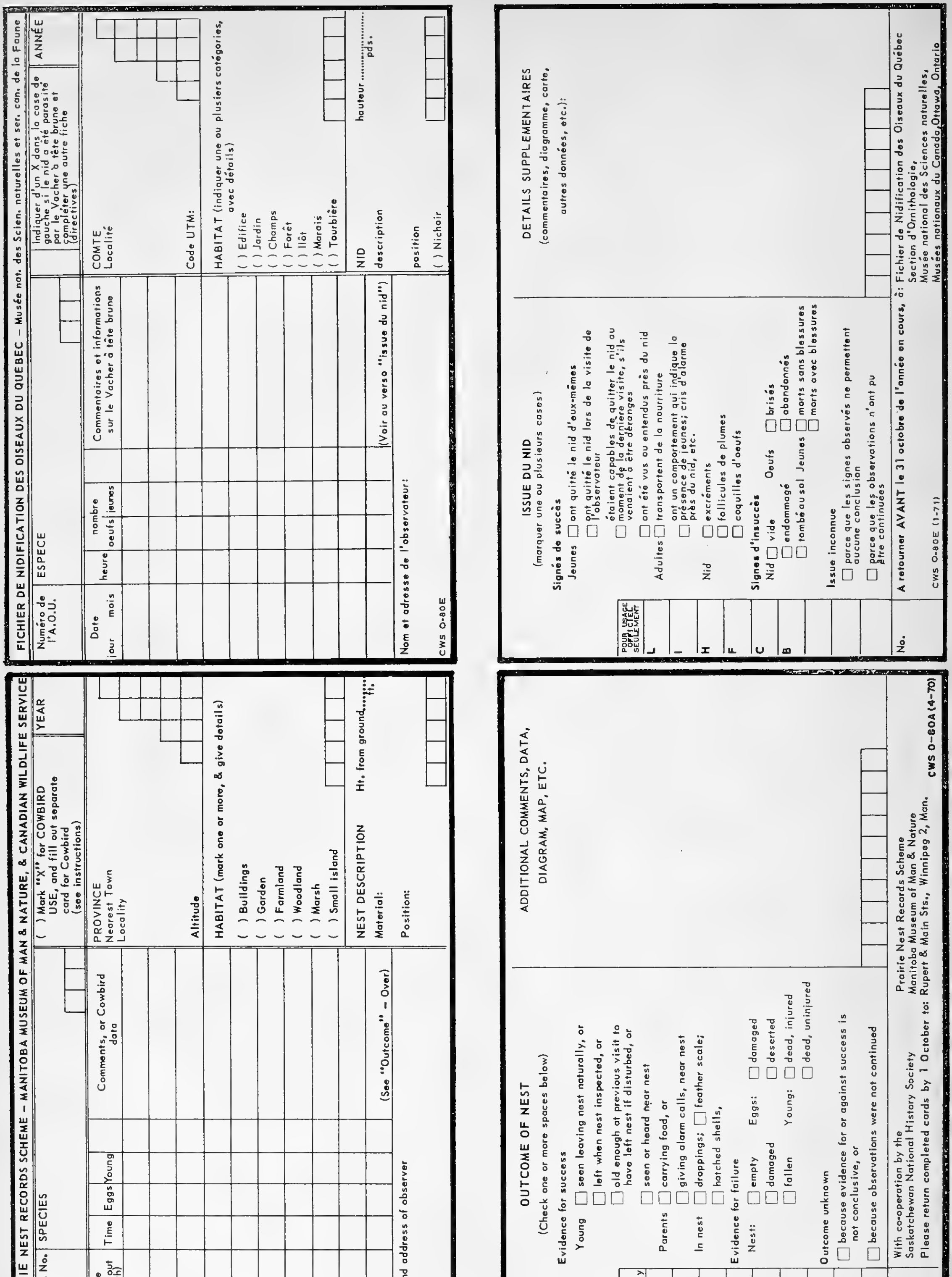

FIGURE 1. Standard nest record card layout. Heading, return address, and submission date differ between regional schemes. Actual size of cards is 4 in. by 6 in. Top: French language version, to be introduced in Quebec in 1971. i — Front; ii — Reverse. Bottom: English launguage version, introduced in the Prairies and Ontario in 1970, to be started in the Maritimes and Quebec in 1971. i — Front; ii — Reverse.

TABLE 1. — Canadian nest record programs.

Name	Area covered	Year started	Total cards§	Address of regional file
British Columbia NRS*	British Columbia, Yukon	1955	27,337†	Dept. of Zoology, University of B.C., Vancouver 8, B.C.
Prairie NRS	Alberta, Saskatchewan, Manitoba, Mackenzie	1958	est. 13,800 (12,695 thru 1969)	Manitoba Museum of Man and Nature, 190 Rupert Ave., Winnipeg 2, Man.
Ontario NRS	Ontario	1956 (1964)‡	est. 30,000 (25,262 thru 1969)	Dept. Ornithology, Royal Ontario Museum, 100 Queen's Park, Toronto 5, Ont.
Fichier de Nidification des Oiseaux du Québec – Quebec NRCP	Quebec	1959 (1968)‡	3,537	Section d'Ornithologie, Musée national des Sciences naturelles, Ottawa, Ontario – Ornithology Section, National Museum of Natural Sciences, Ottawa, Ontario
Maritimes NRS	New Brunswick, Nova Scotia, Prince Edward Island	1960	11,744	Natural Science Dept., New Brunswick Museum, 277 Douglas Avenue, Saint John, N.B.
Newfoundland NRS	Newfoundland	1969	562	Canadian Wildlife Service, Room 611, Sir Humphrey Gilbert Bldg., St. John's, Nfld.

§Through 1970; Ontario and Prairie totals estimated from annual intake and totals through 1969.
*NRS = Nest Records Scheme; NRCP = Nest Record Card Program.
†Total for British Columbia only; Yukon cards numbered less than 100.
‡Activity in Ontario and Quebec was at low levels until the dates in parentheses.

Contact with individual observers, and distribution, collection, and storage of the cards, remain the concern of the regional co-ordinators, who know many of their contacts personally. The cards are kept in the regional files since most studies must examine the data region by region before combining records from diverse areas.

The kinds of results that may be obtained from nest record cards are extremely varied (for more details, see e.g. Myres *et al.*, 1957; Mayer-Gross, 1970). Descriptive data such as regional preferences for particular nest sites or habitats; vital statistics such as clutch or brood size, incubation or nestling period; variation of laying date with area or habitat or temperature; these and many other topics may be explored with the help of large numbers of carefully filled-out nest record cards. Whereas the disastrous declines in breeding success of certain raptorial birds (Peregrine Falcon, Bald Eagle, Osprey) were detected by special field studies, examination of nest record cards for other species may show up further side-effects of application of toxic chemicals or of changes in land use — if sufficient data have been placed on file. A single nest record by itself may not be especially valuable, but if 1000 or more persons across Canada each sent in one nest record (of Robins, for example) these could add up to a coherent picture. Both quantity and

FIGURE 2. Adaptable birds such as Robins (b) often nest on city buildings even when trees are present (a), so long as adequate feeding areas — lawns and gardens exist nearby. Concrete and asphalt (c) offer scant opportunity for foraging. Mini-parks with trees and grass in the downtown areas of cities would better serve people — as well as birds — than do parking lots. (Credits: (a) and (c) — National Film Board; (b) — Author.)

quality of data are necessary when one considers a country as vast and varied as Canada.

One major problem is that most nest records are incomplete. Among Barn Swallow nest records in the four major Canadian files through 1969 (unpublished data), only 33-51 per cent gave a laying date accurate to $\pm$ 2 days; 22-38 per cent gave a confirmed clutch size (i.e. counted twice or more at intervals of more than 24 hours); 21-38 per cent were found before laying was completed (the preferred stage for determinations of success; Snow, 1955b), but barely half of these (8-23 per cent of the total) were followed until they either succeeded or failed. The fraction of cards usable varied rather little between groups of years (most samples were too small to be worth comparing individual years), although Ontario and British Columbia showed decreases in usability for these purposes in 1967-69. The fraction of usable cards for Barn Swallows was markedly higher on the Prairies than elsewhere. Probably this is a result of easy access to their nests in prairie farm buildings, as the cards from the Prairies were not better for the other species examined: Starling, Brewer's Blackbird, Common Grackle, Song Sparrow. The recent decline in usability in British Columbia was partly owing to an unsuitable nest record card, which can easily be remedied.

A high proportion of incomplete cards is an inevitable result of the method. The nest record movement rests on the assumption that every single visit to a nest can provide some useful biological information. A single visit to a nest of a seldom observed species or in a seldom visited area can be quite valuable, in the absence of other data. Unfortunately, far too many cards for all species, even in easily accessible areas, are left incomplete. A nest record has a far greater value if the contents of the nest have been accurately determined, even only once, than if no details are observed. Additional visits escalate the value much farther. About six suitably timed visits will provide almost all the data one requires from a nest record, and even three or four visits will provide most of this (cf. Erskine and Teeple, 1970). A certain level of quality is essential and should take precedence over almost any quantity of undetailed records.

There is an increasing need for responsible attitudes in the collection and use of nest records. The welfare of the nest should be paramount; extra visits beyond those needed to obtain the basic data will do more harm than good. The most important points to avoid are: attracting attention to the nest by one's presence or trail, damaging or exposing the nest by careless or over-zealous actions around it, and frightening the adults into desertion or the young into premature fledging. In the long view, a nest known to have succeeded (even though some details were missed) is more valuable than one fully documented in the early stages but later destroyed as a result of the study.

Use of data filed in nest records schemes varies with the policy of the regional co-ordinator. One basic dilemma is: should one reduce access to the data by insisting that the investigator clear it with the original observers before use or publication; or should one make the data available more or less on demand? The latter approach is simpler, and many observers neither expect nor wish for further acknowledgement than they have already received (a letter or card confirming receipt of their completed cards, and mention by name in the annual summary of the regional program). The other extreme, to require clearance from every observer (even those who sent in one card many years ago) is obviously unworkable, so we encourage a middle course. In the present state of Canadian nest records, any observer who contributed 50 or more cards for the species under study during the preceding five years or who is known to have a continuing interest in a particular species should be contacted, and any observer who provided really important data — regardless of the number of cards or when they were submitted — deserves similar courtesy. The time required to write the relatively few letters needed is much less than that spent to find the nests, and most observers are happy to know that their data are being used. Their contribution should be acknowledged in any resulting publication. This is one way in

FIGURE 3. An acre of softwood forest (b) will yield enough newsprint for one day's run of a city newspaper, most of which is discarded next day as trash. An acre of softwood forest can offer a recreational opportunity for many people, as well as nesting places for Magnolia Warblers (a), White-throated Sparrows (c), and many other birds. We can have both forests and newspaper if we will insist that waste paper be salvaged and recycled. (Credits: (a) and (c) — Dalton Muir; (b) — Author.)

which people can be encouraged to feel that filling out nest record cards is a worthwhile activity. An attitude of "You do the work and we'll write the papers" could rapidly kill interest in the program. One special case requires further comment: the cards for rare or threatened species are not released without special clearance, since the activities of collectors pose a real threat to these birds if the nest locations are widely known.

Another problem is preservation of the original records. There is no difficulty in consulting nest record cards in the regional files, but many people find it inconvenient to visit the more distant files in person. Lending the original cards brings a risk of loss or damage in the mails or at their destination, so most co-ordinators now copy (usually xerox) the records in response to enquiries involving fewer than 100-200 cards. But even this scale of copying is expensive, and it is no solution for species with hundreds or even thousands of cards in a regional file. Computer operations may prove worthwhile for the major species, but these will be still more expensive. Persons wishing to study large numbers of nest record cards must recognize that the cost, whether of travelling to the regional files, of having xerox copies made, or of having a computer tabulation prepared, will be far less than that of collecting the equivalent data in the field. Nest recording is a co-operative activity, not a one-way street.

Have the Canadian nest record programs produced any worthwhile results in the fifteen years since their start? Even though few major nest record studies have yet been published, a list of publications based on nest records in Canada would be a lengthy one. It would include both major compilations: e.g. Drent *et al.* (1961, 1964), on sea-bird colonies in British Columbia, and on the breeding birds of Mandarte Island, B.C.; and brief studies: e.g. of Purple Martin distribution in New Brunswick (Hunter, 1967), and of rural vs. urban Starlings on Cape Breton Island (Erskine, 1970). Many publications dealing only indirectly with nesting (e.g. local bird lists) have referred to nest record data, and the total number of occasions on which Canadian nest record cards have been consulted and used (if not always acknowledged) must be many hundreds or even thousands. The potential for use of these records is still greater, if they can be made available to bird students, and if it is recognized what problems they can and cannot solve.

Myres (1955, 1957) and Snow (1955a and b) showed how nest records may be used to study breeding seasons, clutch size, and nesting success in Britain and Canada. Von Haartman (1969) summarized Finnish nest records for nest site and height, clutch size, laying date, and incubation and nestling periods, but Udvardy (1970) pointed out how little data these gave on certain subjects. Peakall (1970) included Canadian records in his compilation of North American nesting data for Eastern Bluebirds, the first computer analysis of nest records by the program at Cornell University (Ithaca, New York, U.S.A.). Recently (Erskine, in press) I summarized Canadian nest records for Common Grackles; the samples were too unevenly distributed to give representative data on range, habitat and nest site, but they allowed the first comprehensive survey of breeding seasons and clutch size in Canada for this common species.

Where do we go from here? It is an oversimplification to urge that the masses of data already in nest records schemes be written up and published. The totals for the top 20 species, excluding ducks and colonial water birds (Table 2), show how few cards are on hand in any one region for most of them. My recent Grackle study used about 1,500 nest record cards; when the totals were reduced to those giving useful information, it was not worth attempting a study of nesting success, although other topics were explored successfully. Unless the quality of cards is unusually high, at least 500 cards of a species are needed from any one region, to allow comparison between sub-samples. At present, only Robin, Red-winged Blackbird, and Barn Swallow have achieved this level in all four long-term files. A start can and should be made for these major species. The data for many others are worth summarizing for regional studies, although they would not warrant formal publication on their own. One may fairly ask how often the clutch size given for a species

TABLE 2. — The 20 species (excluding ducks and colonial water birds) represented by the largest numbers of cards in Canadian nest records schemes, through 1970*.

Species	B.C.	Prair.	Ont.*	Que.	Mar.	Nfld.	Total
Robin	2023	592	2091	251	1504	76	6537
Red-winged Blackbird	545	624	1839	243	524	2	3777
Barn Swallow	1088	459	725	126	621	1	3020
Tree Swallow	572	622	896	126	301	3	2520
Starling	740	157	779	73	506	13	2268
Common Grackle	3	92	717	94	951	0	1857
Brown-headed Cowbird	245	328	785	79	82	0	1519
Song Sparrow	294	122	585	99	364	2	1466
Cliff Swallow	919	90	116	69	197	0	1391
Crows (combined)	270	444	276	41	113	5	1149
Flickers (combined)	407	159	326	47	114	7	1060
Mourning Dove	120	250	678	9	2	0	1059
House Sparrow	315	135	372	28	192	1	1043
Yellow Warbler	67	180	556	60	163	14	1040
Eastern Bluebird	0	29	851	111	6	0	997
Chipping Sparrow	217	115	378	80	129	0	919
Killdeer	250	213	361	48	45	0	917
House Wren	184	399	314	12	0	0	909
Bank Swallow	251	45	243	97	245	0	881
Catbird	79	140	508	32	76	0	835

*Through 1969 only for Ontario.

in a provincial bird book was based on observations in that province; in future it should be possible to use local figures for many species. For example, a new account of the breeding birds of Ontario, last summarized by Baillie and Harrington (1936-37), will be based largely on nest record cards (G. Peck and R. Montgomerie, in preparation).

With increases in environmental contamination, nest records have been suggested as an aid in following the effects of pollution on breeding birds. This approach has been followed up in Great Britain, where about 24,000 nest record cards are received annually from an area of 50,000 square miles with a population of about 50 million people (say, 2½ times Canada's population in an area the size of the Maritimes). The top 10 species make up about one-half of the annual total. Two years of full-time work for one man was needed to summarize the data received for these 10 species since 1950. After all this effort, the conclusion was that it could not be proven that environmental contamination had affected breeding success of the birds studied. In one sense, this is encouraging, since the song birds reported in largest numbers are those which nest around gardens and farms, where toxic chemicals are most often applied deliberately. But it is unhelpful in another sense, since the scarce birds near the ends of predator food chains where toxic chemicals are accumulated, and the water birds into whose habitats runoff washes the pollutants, are seldom represented in useful numbers in nest record programs. Bird observers spend little time and report few nests in areas blighted by urban sprawl or industrial pollution. Nesting success cannot be measured by nest record programs if there are no longer any nests to be reported because the population has declined. Thus, sophisticated analysis of nest record data is not necessarily or always the best means of monitoring effects of pollution on birds breeding in an area; it may be helpful when used with other methods, and in some situations it may be the only available approach.

Finally, someone is sure to ask, "How important is all of this anyway?" We can only reply that we don't know, but we think it may be vital. Pessimists tell us that within 10 years man will have poisoned the environment so that neither birds nor men can exist in it, and that no measures acceptable to people used to a North American standard of living can prevent this disaster. Optimists tell us that things may have been a bit messy for a while but that modern technology has them under control now. Still others will invoke "The will of God" or "The basic goodness of man" as reasons why such events will or will not come to pass. I feel that by encouraging people to look at birds and their nests with care and judgement we are stimulating public awareness of our natural environment as something to be treasured. Collections of nest record cards extending over many years may prove particularly valuable in providing documentation acceptable to the legislators who must formulate the restrictions on man's abuses of the enviroment. The act of looking critically at our natural environment and acting to ensure its conservation may seem far removed from noting that the Barn Swallows are building under the porch eave again, but the two are related. Man finds it easy to identify with birds, easier than with most other living things: birds communicate with each other by voice, they build complicated homes, some even go to Florida for the winter. Like man, birds depend on their environment, but only man can ensure that it survives.

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Distribution and Biology of Black-crowned Night Herons in Alberta

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Abstract. Black-crowned Night Herons have expanded their range in Alberta since the first record in 1958. They have been found nesting at several locations at the latitudes of Edmonton and Calgary, primarily in emergent vegetation of marshes. Three colonies in southern Alberta were studied in 1964 and 1965. Most of the initial egg-laying took place in late April and early May, and average initial clutch size varied from 3.2 to 4.1 eggs. Some pairs laid replacement clutches which were consistently smaller but more successful than initial clutches. The average incubation period was 23.6 days. Measurements of nestling growth are presented, and fledging required about six weeks. Production of young in both years (maximum of 1.1 fledged per pair) was insufficient for maintenance of the population. The major factor responsible for low productivity was destruction of eggs and predation on nestlings by Ring-billed Gulls.

Black-crowned Night Herons (*Nycticorax nycticorax*) were recorded in Alberta for the first time in 1958, and their status in this province up to 1960 was reviewed by Salt (1961). Subsequently this species has been sighted, collected, or found nesting at several additional localities throughout the province. During the summers of 1964 and 1965, we studied three colonies of these herons in the Eastern Irrigation District of southern Alberta. In this paper we document the presently known distribution of Black-crowned Night Herons in Alberta and discuss some population attributes of these birds in what is apparently a recently occupied part of their range.

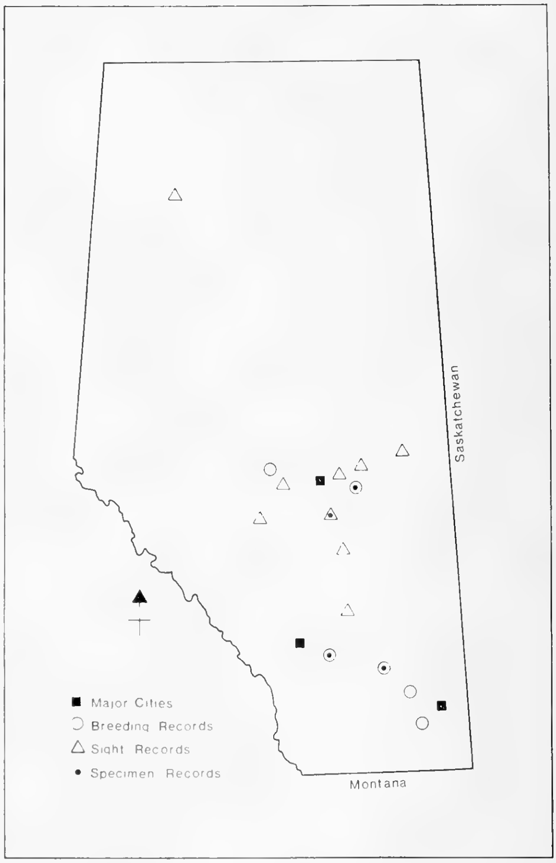

FIGURE 1. Locations at which Black-crowned Night Herons have been recorded in Alberta.

Distribution

The locations at which Black-crowned Night Herons have been recorded in Alberta are shown in Figure 1. The northernmost record was of an immature bird (yearling), sighted by one of us (D.A.B.) in mid-May of 1966 along the MacKenzie Highway. The bird was observed close at hand both on the ground and in the air, thus excluding possible confusion with the American Bittern (*Botaurus lentiginosus*). The concentrations of sight and specimen records at the latitudes of Edmonton and Calgary probably reflect the fact that ornithologists spend more time in these areas. The possibility does exist, however, that in fact this distinctively marked heron is distributed mainly in these areas, where appropriate habitat is apparently more available. In the Edmonton region there are permanent natural ponds and lakes which are surrounded by the broad bands of emergent vegetation utilized by these herons

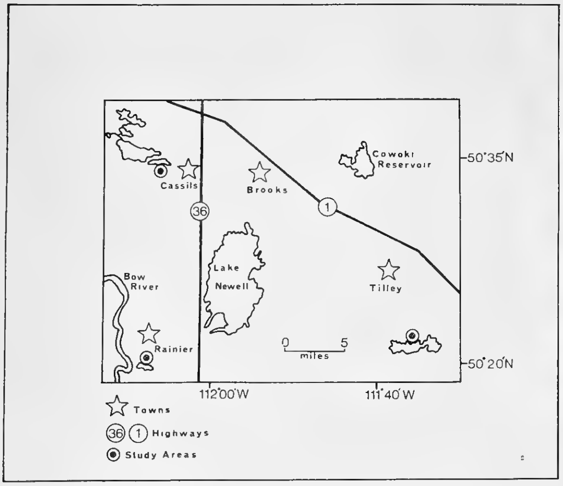

FIGURE 2. Portion of Eastern Irrigation District showing locations of study areas near Cassils, Tilley, and Rainier, Alberta.

FIGURE 3. Typical Black-crowned Night Heron nest composed largely of gumweed in old growth of cattail, Cassils, Alberta.

for nesting cover. Farther south, it is not until the irrigated areas east of Calgary are reached that this type of habitat again appears commonly. Thus in both areas the requirements of habitat and food seem to have been met. The concentration of birds in the southern area extends the known distribution considerably south of that shown by Godfrey (1966).

Population Attributes

Three colonies of these herons in marshes of an irrigated district near Lake Newell, Alberta, were studied (Fig. 2). Each colony was located in emergent vegetation, predominantly cattail (*Typha latifolia*) with lesser amounts of round-stem bulrush (*Scirpus validus*). Two of the marshes, near the towns of Cassils and Tilley, were associated with impoundments created by Ducks Unlimited (San Francisco Lake and Scots Reservoir, respectively). The third marsh near the town of Rainier was associated with an old oxbow of the Bow River. These marshes were located in a matrix of heavily grazed native prairie in which the dominant grasses were *Stipa comata, Bouteloua gracilis, Agropyron trachycaulum,* and *Koeleria cristata* (Coupland, 1950). These impoundments and others were interconnected via a maze of irrigation canals from the Bow River and various reservoirs.

TABLE 1. — Changes in the numbers of Black-crowned Night Herons nesting in three colonies in southern Alberta.

Year	Number of pairs		
	Cassils	Tilley	Rainier
1963	300*	–	–
1964	71	–	11
1965	0	55	6
1966	10	0	9

*Estimated by S. G. Sealy (pers. comm.).

The numbers of birds present in these colonies for the years 1963 through 1966 are presented in Table 1. The great fluctuations in numbers of birds inhabiting two of the colonies are difficult to explain. The 55 pairs at the Tilley marsh in 1965 could have been a portion of the birds present at Cassils in 1964, but, since no birds were marked, we have no evidence for or against this possibility. The very rapid decline from an estimated 300 pairs (S. G. Sealy, pers. comm.) to 71 at the Cassils colony is also difficult to explain, since the habitat apparently remained constant and the colony was not known to have been disturbed in 1963, apart from two days when young birds

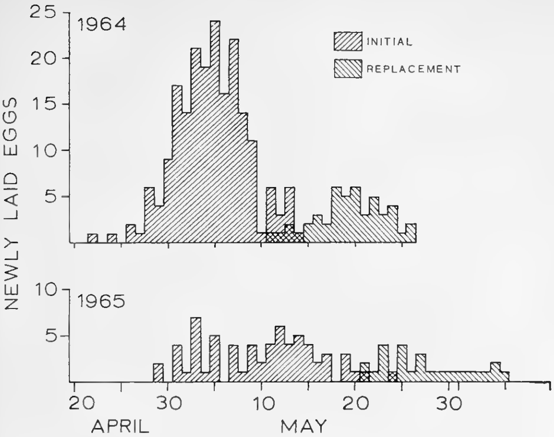

FIGURE 4. Frequency distribution for newly laid eggs of Black-crowned Night Herons in Alberta.*

were banded. Only the small colony near Rainier remained relatively constant in numbers over the three years.

The herons apparently arrived at these colonies in mid-April each year and began laying by the last week in April. The nests were placed in standing remnants of the previous year's growth of emergent vegetation. It is interesting to note that dry stems of gumweed (*Grindelia squarrosa*) from the surrounding prairie, and Russian thistle (*Salsola kali*) which had been blown into the marsh, were often used with cattail and bulrush for nest construction (Fig. 3). We found nests only in emergent vegetation; this seems to be the usual habitat for night herons in Alberta (Hampson, pers. comm.; Freeman, pers. comm.), though Vermeer (1969) has recorded them using small trees.

The nests were clumped in their distribution within the marsh, though within the clumps they tended to be uniformly spaced. The locations within the marshes occupied by the colonies tended to be in stands of emergent vegetation that were farthest from shore and largely surrounded by open water. Such areas retained water througout the season and thus were the most secure from terrestrial predators.

We investigated the extent to which the members of the colonies demonstrated synchrony in their reproductive cycles, and we chose the deposition of eggs as a manifestation of this phenomenon (Fig. 4). In 1964, when the numbers of breeding birds were somewhat greater than in 1965, the initiation of first clutches was earlier and the degree of synchrony was apparently greater. In 1964, when 199 eggs were laid in the initial clutches, 83 per cent of them were produced in the 10-day period between April 30 and May 9; in 1965, when only 65 eggs were laid in initial clutches, 15 days, from May 3 to 17, were required to lay a similar percentage.

It would appear that these colonial herons are not particularly synchronized in their reproductive activities. However, the data for 1964 show a greater tendency towards such a phenomenon than do those of 1965. It is tempting to speculate that the greater numbers of herons involved in 1964 effected an earlier and more highly synchronized reproductive cycle through mutual stimulation (Allen and Mangels, 1940). However, the delayed onset of laying in 1965 might be equally well explained by a later spring in that year (Wolford, 1966).

In both years some birds renested after losing their initial clutches. Birds producing replacement clutches built new nests, nearly always a few hundred yards from the initial colony. The construction of the second nests occurred after most of the remaining initial clutches were well into incubation.

The reproductive performance of these herons was investigated. The numbers of eggs, recorded for both initial and replacement clutches, are presented in Table 2. Significantly smaller clutches were produced in 1965, possibly reflecting a lack of physiological stimulation associated with poor social stimulation suggested in that year. Replacement clutches were significantly smaller than initial clutches in both years; this appears to be normal for birds nesting in temperate regions (Lack, 1966). In 1964, three nests containing seven eggs and

*Only those eggs for which the laying dates were known, or were estimated from the hatching dates are included here.

TABLE 2. — Clutch sizes of Black-crowned Night Herons nesting in colonies near Cassils and Tilley, Alberta

Year	Clutches		Number of Eggs						Mean Clutch Size
	Sequence	Number	1	2	3	4	5	6	
1964	Initial	67	3	3	9	34	15	3	4.0
	Replacement	15	1	0	4	7	3	0	3.7
1965	Initial	49	0	4	31	14	0	0	3.2
	Replacement	19	3	6	8	2	0	0	2.5

one with eight eggs were recorded. These clutches were not included in Table 2 because the rates at which the eggs were laid suggested two or more females were involved.

Clutch sizes from other colonies in Alberta were apparently larger. At Beaverhills Lake, Hampson (pers. comm.) recorded a mean clutch size of 4.6 based on 33 clutches observed in 1959 and 1960, and at Stobart Lake an average of 5.0 eggs per nest was recorded for 18 nests in 1966 (Calgary Bird Club, 1967). It is known, however, that the latter sample also included clutches of up to 9 eggs which influenced the mean.

We had the opportunity to determine the incubation periods (date of laying to date of hatching of the last egg in the clutch) for 11 cases. The mean incubation period was 23.6 days with a range of 21 to 28 days. Such variation in the duration of incubation probably reflects variations in attentiveness of the adults, insulative characteristics of the nests, and time required for actual hatching. However, the mean incubation period agrees with that reported by Nobel and Wurm (1942) for this species in captivity and is slightly less than that recorded by Gross (1923) for wild Black-crowned Night Herons. These data could be interpreted as a partial affirmation that the daily presence of one of us (J. W. W.) in the marsh was not unduly disturbing the herons.

The fates of all clutches were followed. The data recorded on hatching and fledging success are presented in Table 3. Coupled with smaller clutches in 1965 were disproportionately lower hatching and fledging successes. In neither year was the fledging success comparable to that reported for other studies (Palmer, 1962; Teal, 1965; Vermeer, 1969). This low success was attributed mainly to excessive avian predation on both eggs and young. It is noteworthy that the success of replacement clutches was greater in both years, a fact which was related to the heavier avian predation on the initial clutches.

TABLE 3. — Hatching and fledging successes of Black-crowned Night Herons nesting in colonies near Cassils and Tilley, Alberta.

Year	Clutches		Mean Clutch Size	Mean Number/Nest		No. Fledged Per Pair
	Sequence	Number		Hatched	Fledged	
1964	Initial	71	4.1	1.4(34)*	0.7(17)*	1.1
	Replacement	15	3.7	2.8(76)	1.7(46)	
1965	Initial	55	3.2	0.4(13)	0.0(0)	0.1
	Replacement	22	2.5	0.6(24)	0.2(8)	

*Per cent of eggs laid.

TABLE 4. — Fate of Black-crowned Night Heron eggs laid from colonies near Cassils and Tilley, Alberta.

Number of eggs	1964 Clutches		1965 Clutches	
	Initial	Replacement	Initial	Replacement
Laid	293	56	176	55
Hatched	97 (33)*	42 (75)*	23 (13)*	13 (23)*
Lost to predators	115 (39)	0 (0)	126 (72)	23 (42)
Infertile	12 (4)	3 (6)	3 (2)	2 (4)
Addled	20 (7)	5 (9)	9 (5)	3 (5)
Fell into water	37 (13)	5 (9)	7 (4)	4 (7)
Abandoned	12 (4)	1 (2)	0 (0)	2 (4)
Unknown	0 (0)	0 (0)	8 (5)	8 (15)

*Per cent of eggs laid.

The fates of eggs laid by the night herons in 1964 and 1965 are documented in Table 4.

Apart from the replacement clutches in 1964, predation was the major cause of loss of eggs. In 1965 as many as seven Ring-billed Gulls (*Larus delawarensis*), most in immature plumage and presumably non-breeders, were seen regularly near the colony and on several occasions were seen eating heron eggs. Although gulls were not seen actually preying on the eggs in 1964, the regular presence of a few of these gulls and the similar damage to the eggs suggested the same predator in that year. Franklin's Gulls (*Larus pipixcan*), which nested in colonies near the herons, were not involved in this predation. Replacement clutches may have escaped predation in 1964 because the later nests were less densely associated and in better cover (new growth). But similar conditions did not prevent predation in 1965. However, even in the latter year the loss of replacement clutches to predation was less than that of initial clutches. The fact that 42 per cent of the replacement eggs were lost suggests that the predators had established an efficient hunting pattern over the area after having destroyed about 70 per cent of the initial eggs.

The possibility that a human presence contributed to this high rate of predation must be considered. At no time was predation recorded while one of us (J. W. W.) was in the colony. Furthermore, the herons immediately returned to their nests after J. W. W. left the colony. Only when observing the undisturbed community through a telescope was actual gull predation seen. In 1965, some predation had occurred in the Tilley colony even before we located it. We conclude, therefore, that predation can and did occur at heron nests without human interference. The degree to which we aided predators in finding nests by disturbing vegetation as we moved through the colony remains unknown.

The survival of young to the age of fledging is shown in Figure 5. Mortality was heaviest during the first four or five days after hatching. The causes of death included drowning (reported previously by Hampson, *in* Salt (1961)), predation, heavy rains, and heat prostration.

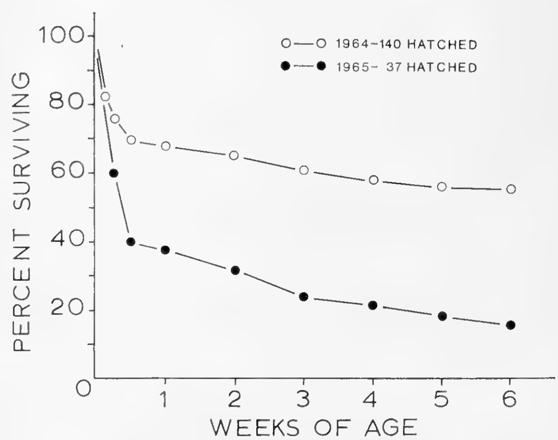

FIGURE 5. Survival from hatching to fledging for nestling Black-crowned Night Herons in Alberta.

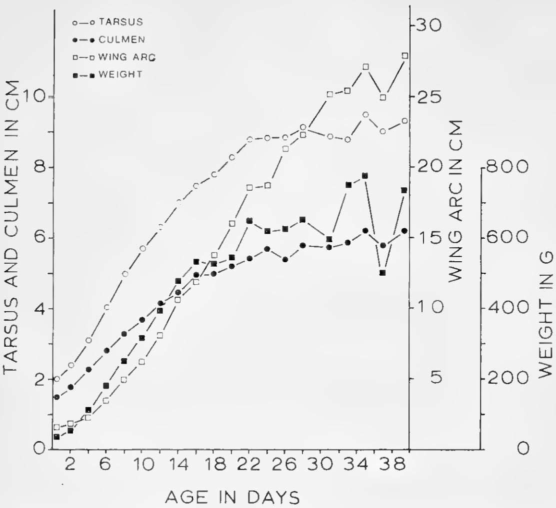

FIGURE 6. Growth of Black-crowned Night Heron nestlings at Cassils, Alberta, 1964.

Drowning occurred in both years but was especially important at Tilley, where many young aged one to three weeks were lost; here the water below the nests was much deeper than at Cassils. Again Ring-billed Gulls were apparently the major predators and were observed taking young herons. This loss of nestlings to predation did not occur in 1964 but was very important in 1965, and most of the nestlings taken were less than a week old. We believe that starvation occurred only in broods of more than four nestlings and thus was not a significant mortality factor.

Growth curves for nestling weights and measurements are presented in Figure 6. Sample sizes for birds more than three weeks of age were too small to allow much confidence in their accuracy, particularly the measurements of wing arc and weights. In no broods of five or more were all nestlings fledged. There was no difference in the rates of growth among broods of 1, 2, 3, and 4. The period from hatching to fledging was nearly six weeks.

We banded 104 Black-crowned Night Heron nestlings in 1964 and 10 in 1965. Three birds have since been recovered, all banded in 1964. The first was found dead near Gothenburg, Nebraska, on October 10, 1964; the second was shot 150 miles south of Guadalajara, Mexico, on December 20, 1964; and the third was shot at Cerca I Palacios, Cuba, on January 28, 1968.

We tested the adequacy of production in 1964 (1.1 fledged juveniles per pair at Cassils) in sustaining a theoretical population of 100 birds (10 non-breeding immatures and 90 breeding subadults and adults). We used Hickey's (1952) mortality rates and determined that, with the above level of production, the population would steadily decline to disappear in about 20 years. To maintain the population over time, production would have to reach two fledged young per pair.

Despite the low production of young in the colonies studied, each year in August and September we sighted many unbanded juvenile night herons. These birds must have represented post-fledging dispersal from other colonies, where the level of production may have been somewhat better.

It appears then, that in the two years this species was studied intensively, the birds were being subjected to very heavy environmental selection — particularly avian predation. It is possible that this selective pressure has resulted in a tree-nesting habit over most of the night heron's range and may also explain why the ecologically similar American Bittern has evolved non-colonial habits and excellent camouflage, thus reducing its susceptibility to avian nest predation.

Summary

The expansion of the range of Black-crowned Night Herons in Alberta is documented herein. Colonies of this species were studied intensively through two reproductive seasons in large marshes in southern Alberta. The reproductive success in both years was far below the level necessary to maintain the population. The major reason for this low production appeared to be predation on eggs and nestlings by Ring-billed Gulls.

Acknowledgments

We wish to thank S. G. Sealy and C. A. Gordon for acquainting us with the study area and W. R. Salt, R. Lister, and B. Smiley for distributional records. Financial assistance from the National Research Council of Canada is gratefully acknowledged.

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The Past Abundance of Willow Ptarmigan on the Avalon Peninsula of Newfoundland

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Abstract. A study of the past abundance of Willow Ptarmigan (*Lagopus lagopus*) on the Avalon Peninsula of Newfoundland was made by searching old newspaper accounts 1843 to 1963. High ptarmigan populations occurred in 1909-10, 1925-26, 1929-31, 1940-41, 1950-51, and 1960-61.

A study of the past abundance of Willow Ptarmigan (*Lagopus lagopus*) on the Avalon Peninsula of Newfoundland was made by searching old newspapers for reports on ptarmigan abundance 1843 to 1963. Notes were also taken on the occurrence of forest fires; it was thought that extensive fires might have reduced conifer growth and provided successional stages with more food species for ptarmigan which could have influenced early numbers.

Now-defunct newspapers, such as *The Standard* and *The Mercury* faithfully reported the opinion of hunters on ptarmigan abundance in the past. Many reports compared the supply of birds with those in a previous season. Researchers located approximately 900 statements in newspapers on ptarmigan abundance. An index of annual abundance from these newspaper reports was based on the following formula:

Per cent abundance index $=$
$(Nvs) + 2\ (Ns) + 3\ (Ni) + 4\ (Np) + 5\ (Nvp)\ /\ 5\ (N)$

Where:

- N = total newspaper reports in one year
- Nvs = number of reports stating ptarmigan very scarce
- Ns = number of reports stating ptarmigan scarce
- Ni = number of reports stating ptarmigan intermediate in numbers
- Np = number of reports stating ptarmigan plentiful
- Nvp = number of reports stating ptarmigan very plentiful

The abundance index indicated high populations in 1909-10, 1925-26, 1929-31, 1940-41, 1950-51 and 1960-61 (Fig. 1.) The high populations in 1940-41, 1950-51, and 1960-61 agreed with another indice of abundance based on hunting statistics and the 1960-61 peak with census data of an 11-year study 1955-1965 (Bergerud, unpublished).

I calculated the mean interval between peak populations in the newspaper abundance index series to ascertain if the periodicity was greater than that expected from a random fluctuating series (*see* Keith, 1963). A peak population was defined as any annual value immediately subtended by lower values (Cole 1951 and 1954, and Hickey 1954). The mean interval between peaks from 1909 to 1960 was 4.64 years (Fig. 1). This interval was significantly greater than

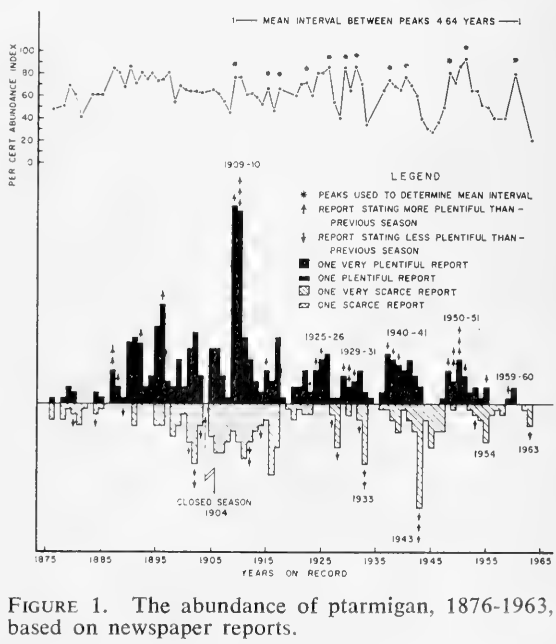

FIGURE 1. The abundance of ptarmigan, 1876-1963, based on newspaper reports.

TABLE 1. — Comparison of ptarmigan killed per hunter between 7 regions in Newfoundland from 1959 to 1964. Asterisk indicates year of highest kill (number of hunters in parentheses)

Regions	1959	1960	1961	1962[1]	1963	1964
West Coast	2.8 (447)	2.9 (427)	1.4 (493)	3.9 (507)*	1.1 (408)	1.8 (513)
North Central	0.8 (268)	1.3 (241)	0.6 (317)	3.3 (292)*	0.5 (341)	0.8 (277)
North East	0.8 (316)	1.0 (268)	1.1 (289)	1.2 (255)*	1.0 (178)	0.9 (470)
Avalon Pen.	4.7 (389)	6.1 (345)	6.9 (592)*	5.1 (429)	2.9 (503)	3.0 (665)
Bonavista Pen.	2.0 (167)	2.2 (191)	3.3 (240)*	3.3 (212)	2.0 (181)	2.1 (205)
Burin Pen.	3.4 (161)	4.4 (321)	8.9 (233)*	5.8 (142)	2.3 (151)	3.5 (161)
South Coast	8.2 (222)	14.5 (275)*	6.3 (273)	9.2 (169)	3.4 (164)	4.6 (199)
Total	3.2 (1970)	4.7 (1978)	4.0 (2447)	4.3 (2006)	1.8 (1926)	2.2 (2593)

[1]Liberal hunting regulations.

that expected on a random series (Keith 1963). The mean interval between peaks prior to 1909 was of insufficient length to meet the test for non-randomness.

The newspaper abundance index suggested a 10-year periodicity between major population peaks 1930 to 1960 but failed to show a 10-year periodicity prior to 1930 (Fig. 1). Prior to 1930 local populations might have adhered to approximate 10-year periodicities, but the amalgam of newspaper reports from many populations, if slightly unsynchronized, might have obscured an overall cyclic trend. An analysis of kill statistics from various regions in Newfoundland 1959-1964 suggested that populations could be slightly unsynchronized (Table 1). Prior to 1930 numerous reports were posted in from residents living on the isthmus of the Avalon Peninsula from hunters tramping the Conception Bay Barrens, etc. In recent decades newspaper reports were from fewer populations as barrens have grown up to trees and shrubs following fire protection. Further, prior to 1930 fires during the summer may have killed large numbers of young birds. For example, a high population in 1926 was out-of-phase with a 10-year periodicity (Fig. 1). Serious conflagrations of 1927 and 1929 (Fig. 2) might have reduced populations resulting in a lower peak in 1930 than might have occurred. A large section of Newfoundland was aflame in 1920 when a high population would have been predicted based on the other cyclic peaks.

Has there been a long-term decline in numbers — the highs and possibly the lows becoming less in each decade? Complaints of scarcity are not new. Some newspaper excerpts: *The Standard,* September 23rd, 1876: "Many of our gallant sportsmen have been ranging the hills in every direction but we cannot learn of any heavy bags being secured. It is apparent that partridge is becoming very scarce . . . and it might be a prudent suggestion of ours in recommending an armistice for at least one year to enable a little recuperation . . ." A decade later from *The Standard,* September 13th, 1884: ". . . local nimrods have been ranging the woods in this direction in search of game. Their labours have not, however, been crowned with much success; experienced sportsmen say that they have never seen ptarmigan so scarce as it this season." In 1904 there was such concern for the scarcity of ptarmigan that a closed season was declared.

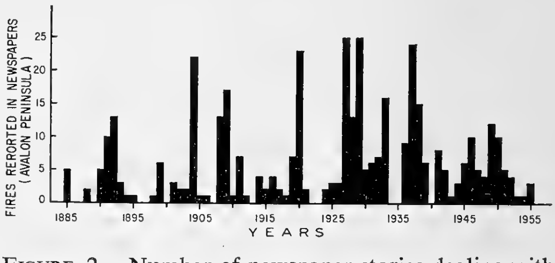

FIGURE 2. Number of newspaper stories dealing with forest fires on the Avalon Peninsula, 1885-1955 (broken). Many ptarmigan habitats were burned in 1927-1929 and 1937.

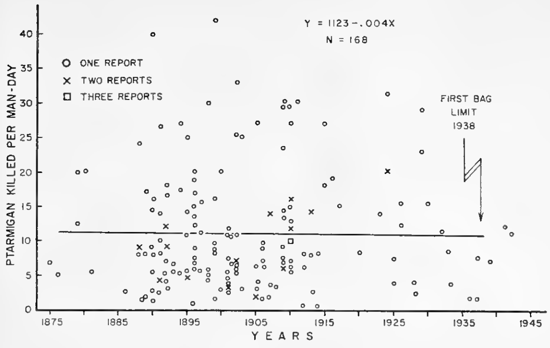

FIGURE 3. The abundance of ptarmigan, 1874-1938, based on ptarmigan killed per man-day as reported from newspapers.

I arranged chronologically the newspaper reports of the total birds killed per man-day, 1874-1942 to evaluate population trends. This plot failed to document a general decline prior to 1940 (Fig. 3) even though in bygone years birds were less wary and there was less hunter competition.

However, peak populations may have declined since 1940 based on hunting statistics (unpublished). One possibility is that unusually dense populations occurred in the 30's and 40's following the numerous fires that burned from 1920-1937 (Fig. 2). Such burning improved the plant succession temporarily for ptarmigan (Peters, 1958). However, such an increase might not have necessarily been reflected in an increase in hunting success (Fig. 3), because of more hunters and wilder birds in the 30's and 40's (Fig. 3). Since 1940, fire protection has become more effective in Newfoundland and ptarmigan habitat has declined as tall *Kalmia* shrubs and woody regeneration recolonized the burned barrens (Peters 1958).

Acknowledgments

I would like to acknowledge that Dr. Wilfred W. Templeman searched many of the newspapers 1843 to 1943 for references to ptarmigan.

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Description of the *Festuca scabrella* Association in Prince Albert National Park, Saskatchewan

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Abstract. A reconnaissance survey of the *Festuca scabrella* grasslands in Prince Albert National Park, Saskatchewan was conducted in the summers of 1967 and 1968. Distribution of upland grassland areas was delineated from aerial photos. Data on the cover abundance and importance values of the dominant species within *Festuca scabrella* association were gathered from quadrat sampling. The grasses *Festuca scabrella* Torr. and *Stipa spartea* var. *curtiseta* Hitchc. varied in dominance. Forbs were common in the areas examined. Encroachment into the grasslands by shrub and tree species, principally *Populus tremuloides* Michx. was evident.

Introduction

The native grasslands of the Canadian prairie provinces (Alberta, Manitoba, Saskatchewan) are classified in various ways. One classification divides the distribution into four zones, namely, mixed prairie, true prairie, fescue prairie and communities of mixed and fescue prairie (Coupland, 1961). Figure 1 depicts the general distribution of these grasslands.

Modern farming practices have altered the floral composition of most of the native grasslands. For this reason it has become increasingly important to protect the remaining examples of these associations. This need was recognized by the National Parks Branch of the Department of Indian Affairs and Northern Development which is responsible for the administration of the National Parks of Canada. The Canadian Wildlife Service, a branch of the same department, in 1967 initiated a series of studies in order to describe biotic communities in the National Parks. This paper is a result of one of those studies which is a general description of the grasslands in Prince Albert National Park.

The main objective was to determine whether rough fescue prairie existed in the park. An effort was also made to describe the relative abundance of the dominant species within the association.

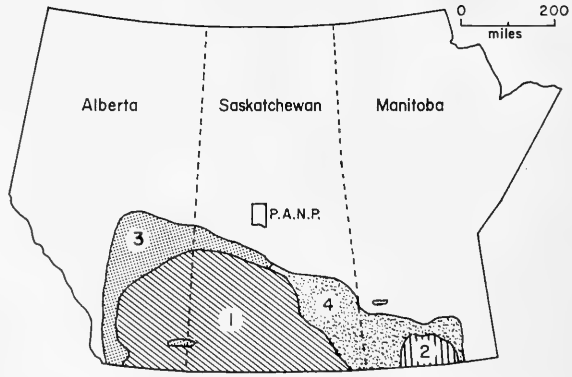

Figure 1. Generalized map indicating the location of Prince Albert National Park and the general distribution of the natural grasslands in western Canada, (1) Mixed prairie, (2) True prairie, (3) Fescue prairie, (4) Mixed and fescue prairie (after Coupland, 1961).

General Description of the Association

Rough fescue prairie extends as a narrow strip from central Saskatchewan westwards to the foothills of the Rocky Mountains in Alberta, then southward to the border of the United States (Coupland, 1961). To the east of central Saskatchewan (Saskatoon area) the association loses its dominance (Coupland and

Table 1. — Cover abundance categories and equivalent cover abundance values used for calculating importance values of the species encountered on the quadrats.

Cover Abundance Categories	Equivalent Cover Abundance Values
R – less than 1%	10
T – cover between 1 – 5%	20
1 – cover between 6 – 25%	30
2 – cover between 26 – 45%	40
3 – cover between 46 – 65%	55
4 – cover between 66 – 75%	70
5 – cover between 76 – 85%	85
6 – cover between 86 – 100%	100

FIGURE 2. Clump of trembling aspen in rough fescue prairie grasslands.

TABLE 2. — Species composition, number of quadrats, frequency, cover abundance and importance values of grass-sedge species encountered in sampling nine rough fescue grassland areas in Prince Albert National Park.

	Area 1		Area 2		Area 3		Area 4		Area 5		Area 6		Area 7		Area 8		Area 9		Importance Value
	5 Quad.		15 Quad.		25 Quad.		10 Quad.		30 Quad.		5 Quad.		15 Quad.		10 Quad.		10 Quad.		
	F	C	F	C	F	C	F	C	F	C	F	C	F	C	F	C	F	C	
Festuca scabrella Torr.	5/5	2	9/15	2	16/25	2	4/10	2	26/30	1	1/5	T	12/15	1	9/10	1	9/10	2	105
Carex spp.	5/5	1	14/15	T	13/25	T	6/10	1	24/30	T	3/5	T	14/15	1	7/10	1	9/10	T	104
Stipa spartea var. *curtiseta* Hitchc.	3/5	T	12/15	2	21/25	T	3/10	T	7/30	T	3/5	T	8/15	1	3/10	1	3/10	1	77
Koeleria cristata (L.) Pers.	2/5	T	12/15	T	8/25	T	2/10	T	6/30	T			8/15	T	4/10	T	2/10	T	53
Agropyron subsecundum (Link.) Hitch.	3/5	T	1/15	R	3/25	T	6/10	T	16/30	1			4/15	T	5/10	T	1/10	T	49
Agrostis scabra willd.					8/25	T			2/30	T	5/5	2	1/15	T			1/10	T	30
Other grasses[1]					10/25	T	4/10	T	2/30	1									18
Stipa richardsonii Link	1/5	T					2/10	1							1/10	T	1/10	T	17

F = Frequency; C = Cover.
[1]Other grasses encountered:
Schizachne purpurascens (Torr.) Swallen, *Elymus innovatus* Beal, *Helictotrichon hookeri* (Scribn.) Henr., *Muhlenbergia glomerata* (Willd.) Trin. *Muhlenbergia richardsonis* (Trin.) Rydb., *Poa pratensis* L., *Danthonia intermedia* Vasey, *Hierochloe odorata* (L.) Beauv., *Bromus ciliatus* L., *Bromus inermis* Leyss., *Bromus pumpellianus* Scribn., *Calamagrostis montanensis* Scribn., *Festuca saximontana* Rydb.

FIGURE 3. View of rough fescue grasslands in south-west corner of Prince Albert National Park, Saskatchewan.

Brayshaw, 1953; Looman, 1969). Small areas of the rough fescue prairie have also been described for southern Manitoba (Blood, 1966), northern Dakota (Crosby, 1965) and for southeastern Alberta (Moss and Campbell, 1947). The grasslands described in this paper are located to the north of the previously described northern limit of this association (Figure 1).

As is implied by the name, rough fescue (*Festuca scabrella* Torr) is the dominant grass species in this association (Looman, 1969). It is a bunch grass that generally grows on black (chernozemic) soils (Coupland, 1961). Distribution of this association is closely linked to the aspen parkland region which forms the transition between mixed prairie to the south and boreal forest to the north. Porcupine grass (*Stipa spartea* var. *curtiseta* Hitchc.) is a codominant, being generally more prevalent in drier areas. The latter species also generally increases in dominance from north to south.

Study Area

Prince Albert National Park (total arae of 1,496 square miles) is located in central Saskatchewan (mean latitude 53°51'). The undulating topographical relief of the park has its origins in the pleistocene glaciation and subsequent erosions. Numerous hills, depressions and ridges account for the variety of plant communities within the park. About two-thirds of the northern part of the park is covered by dense, coniferous and mixed forests that exist on grey-wooded soils. Although the whole area is included in the mixed forest zone by Rowe (1959), the southern section of the park more closely resembles the aspen grove belt described by Moss (1955a). This is the transition zone between northern forests

TABLE 3. — Species composition, number of quadrats, frequency cover abundance and importance values of shrubs and forbs recorded in nine different rough fescue grassland areas sampled in Prince Albert National Park. Plants with importance values less than 20 are listed below[1]

	Area 1		Area 2		Area 3		Area 4		Area 5		Area 6		Area 7		Area 8		Area 9		Importance Value
	5 Quad.		15 Quad.		25 Quad.		10 Quad.		30 Quad.		5 Quad.		15 Quad.		10 Quad.		10 Quad.		
	F	C	F	C	F	C	F	C	F	C	F	C	F	C	F	C	F	C	
Galium boreale L.	4/5	1	4/15	T	15/25	T	5/10	1	13/30	T	4/5	T	7/15	1	8/10	1	6/10	1	83
Vicia americana Muhl.	2/5	T	1/15	R	6/25	T	6/10	1	17/30	T	3/5	T	7/15	T	7/10	T	3/10	1	68
Solidago missouriensis Nutt.	2/5	T	10/15	T	5/25	T	5/10	1	14/30	1	1/5	T	7/15	T	5/10	1	3/10	T	66
Achillea millefolium lanulosa Nutt.	4/5	T	1/15	R	4/25	T	3/10	T	11/30	T	4/5	T	4/15	T	5/10	T	1/10	T	57
Comandra umbellata (L.) Nutt.	4/5	T	2/15	T	3/25	T	2/10	T	9/30	T			13/15	1	5/10	T	4/10	T	57
Sisyrinchium sp.	1/5	T	1/15	R	15/25	T	2/10	T	17/30	T	5/5	T	3/15	T	7/10	1	1/10	R	57
Thalictrum venulosum Trel.	3/5	T			2/25	T	4/10	1	15/30	T			4/15	1	9/10	1	7/10	1	56
Campanula rotundifolia L.	3/5	T	1/15	R	13/25	T	3/10	T	8/30	T	1/5	T	5/15	T	4/10	T	5/10	T	54
Cerastium arvense L.	3/5	T	11/15	T	7/25	T	2/10	T	9/30	T	4/5	T	1/15	T					49
Rosa acicularis Lindl.			3/15	T	14/25	T			15/30	1			11/15	1	4/10	T	4/10	T	46
Solidago spp.	1/5	T			3/25	T	3/10	T	9/30	T	4/5	1			2/10	T	4/10	T	45
Agoseris glauca (Pursh) Paf.	5/5	T			7/25	T	2/10	T	1/30	T			4/15	T	5/10	T	1/10	T	44
Geum triflorum Pursh	2/5	T	3/15	T	1/25	R	2/10	T	5/30	T	2/5	T	1/15	T	1/10	T	1/10	T	42
Oxytropis Campestris var. *ocacilis* (A. Nels.) Barneby			1/15	R	7/25	T	1/10	1	4/30	T	4/5	1	1/15	T	1/10	T	1/10	T	38
Viola spp.			1/15	R	10/25	T	10/25	T	6/30	T			3/15	T	3/10	T	3/10	T	34
Amalanchier alnifolia Nutt.	3/5	T	1/15	R			2/10	T	6/30	T	1/5	T			7/10	T	4/10	T	32
Symphoricarpos occidentalis Hook.			8/15	1	3/25	T	1/10	R	3/30	T	1/5	T	1/15	T	2/10	T			29
Artemisia ludoviciana Nutt.			5/15	T	4/25	T	3/10	T	2/30	R	1/5	T	4/15	T			1/10	T	29
Lathyrus ochroleucus Hook.	2/5	T			1/25	R	1/10	R	2/30	T			3/15	T	4/10	T	1/10	T	29
Heuchera richardsonii R. Br.	2/5	T	3/15	T	2/25	T			4/30	T	1/5	T					2/10	T	27
Smilacina stellata (L.) Desf.									6/30	T			4/15	T	7/10	T	4/10	T	26
Artemesia campestris L.			7/15	T			1/10	R			2/5	T	4/15	1					25
Aster spp.									7/30	T			2/15	T	1/10	T	1/10	T	24
Anemone multifida Poir.							1/10	T	2/30	T	2/5	T			2/10	T	2/10	T	22
Arctostaphylos uva-ursi (L.) Spreng.	2/5	1					1/10	T	4/30	2			2/15	T					22
Potentilla pensylvanica L.			11/15	T	3	T			1/30	R	1/5	T							20

F = Frequency; C = Cover.

[1]Species encountered on the quadrats having importance values less than 20:
Artemesia frigida Willd., *Artemisia dracunculus* L., *Aster Laevis* L., *Erigeron glabellus* Nutt., *Antennaria neglecta* Greene, *Antennaria nitidae* Greene, *Taraxacum* sp., *Gaillardia aristata* Pursh, *Potentilla* spp., *Fragaria glauca* (S. Wats.) Rydb., *Hedysarum alpinum* L., *Populus tremuloides* Michx., *Astragalus straitus* Nutt., *Orthocarpus luteus* Nutt., *Androspace septentrionalis* L., *Polygala senega* L., *Zizia aptera* (A. Gray) Fern., *Agastache foeniculum* (Pursh) Ktze., *Zygadenus elegans* Pursh.

and the mixed prairie (*Stipa-Bouteloua* association). Trembling aspen (*Populus tremuloides* Michx.) and balsam poplar (*Populus balsamifera* L. stands form groves which are interspersed with patches of open and semi-open grassland areas (Figures 2 and 3). Scattered jackpine (*Pinus banksiana* Lamb.) are present in a few areas. Most of the larger grassland areas are located in the gently undulating hills bounded by a glacial spill in the southwest corner of the park. Mean annual precipitation for the general area is 16.1 inches (Kendrew et al., 1955) with approximately 10 inches falling as rain. Cumulative snowfall over the winter months averages approximately 50 inches.

Methods

Initially aerial photos (scale 4 inches = 1 mile) were examined to delineate all upland

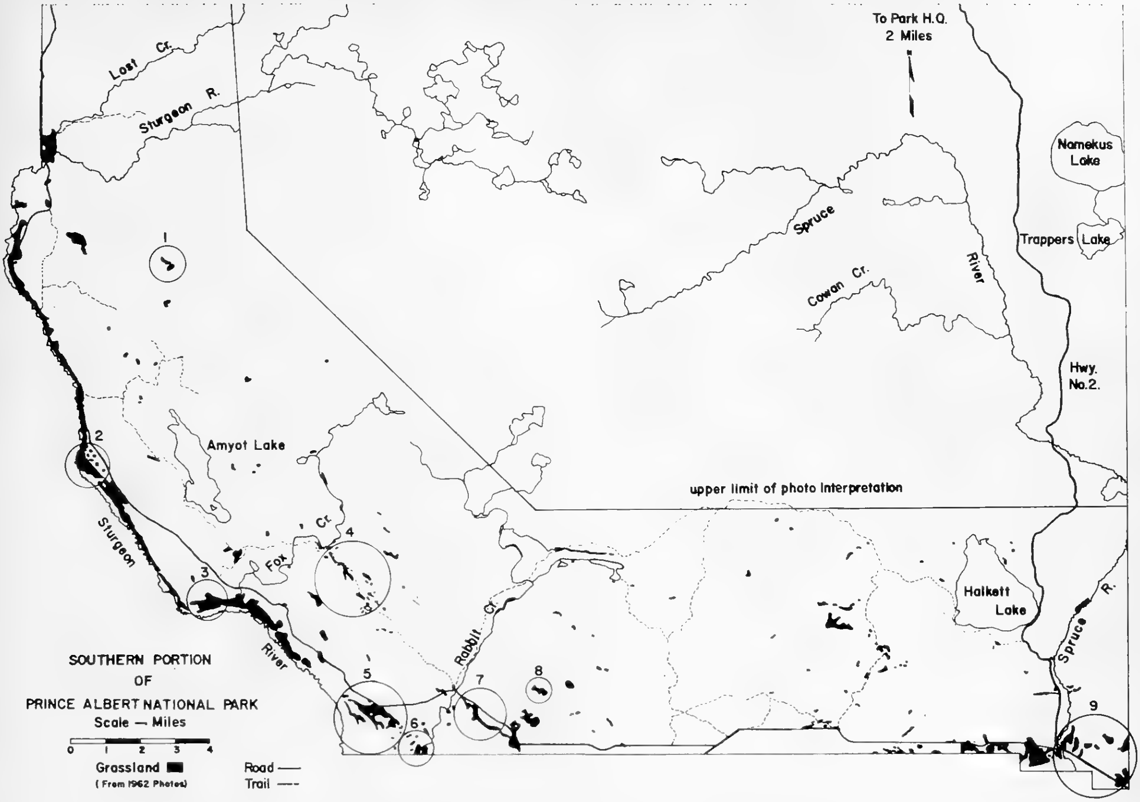

FIGURE 4. Distribution of upland grassland areas in southern and southwestern sections of Prince Albert National Park, Ssaskatchewan. Areas circled and numbered were sampled.

grassland areas within the park. Subsequent detailed mapping of the grasslands was carried out for the southwestern and southern portions of the park where the major grasslands are present.

In July and August of 1967 two major rough fescue prairie areas were examined to become familiar with the plant species in the different communities. In June, July and August of 1968 all areas that on inspection were identified as rough fescue were sampled.

For each area the location of the initial sample was arbitrarily chosen at a site judged to be typical "fescue prairie". In larger areas additional quadrat samples were located at 300 feet intervals. At each site a wooden stake marked the center of a set of five quadrats. Each quadrat measuring 3 square feet. The first quadrat in each set was located at that stake, and the remaining four 25 feet north, south, east and west of the initial stake. Vascular plant species within the quadrats were recorded and evaluated on a "cover-abundance" scale (Table 1). The cover-abundance values for each species on each area were averaged using the mean values for the cover-abundance categories. From these data and the frequency information "importance values" were calculated for each species. These were obtained by assigning importance value figures to each cover-abundance category (Table 1) and adding frequency values calculated on a percentage basis. Frequencies refer to the number of times a species was present in the total number of quadrats samples in a specific area. The highest possible importance value (I.V.)

is 200. Nomenclature as listed by Moss, 1955b was used in reference to all plant names.

Results

Nine different areas were sampled. Those areas were chosen upon ground inspection of all the grassland areas which were mapped in detail from aerial photos (Figure 4). The map does not include low-lying wet meadows, or meadows found on the lake bottoms. Such areas are especially numerous around the west and north ends of Amyot Lake.

Grassland areas in which *F. scabrella* Torr. was an obvious component of the vegetation are circled (Figure 4). It was not possible to delineate the exact boundaries between areas of *Festuca scabrella* association and other grassland communities.

Results of quadrat sampling are listed in Tables 2 and 3. Table 2 lists the number, frequency, average cover abundance of graminoid species encountered. In Table 3 the data for shrubs and forbs encountered in the quadrats are summarized. All species are listed in descending order of importance values.

F. scabrella Torr. was present in all of the nine areas sampled but varied considerably in abundance. This species was not present on all the quadrats that were sampled. The foliage of rough fescue was generally not as vigorous as was reported by others (Moss and Campbell 1947, Blood 1966). Tussock size rarely exceeded 4-7 inches in diameter.

Forbs were common throughout the grassland areas. Most abundant forbs were *Galium boreale* L., *Achillea millefolium lanulosa* Nutt., *Vicia americana* Muhl., *Solidago missouriensis* Nutt. and *Thalictrum venulosum* Trel. The main shrubs (*Rosa acicularis* Lindl., *Amelanchier alnifolia* Nutt. and *Symphoricarpos occidentalis* Hook. were patchy in distribution.

Surrounding the rough fescue prairies were groves of aspen *Populus tremuloides* Michx.) and balsam poplar (*Populus balsamifera* L.) Encroachment of aspen into grassland areas through suckering of adventitious roots is a common phenomenon in the park. This encroachment threatens the remaining grassland areas. The rate of encroachment since 1947 has been quantitatively documented and is described elsewhere (Carbyn et. al., 1968).

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Breeding and Territoriality of the Palm Warbler in a Nova Scotia Bog

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Abstract. The Yellow Palm Warbler (*Dendroica palmarum hypochrysea*) was studied throughout the breeding season on a coastal bog heath in Nova Scotia. The territories of ten males observed ranged from 1.02-2.14 hectares. Three males were unmated, one was polygynous and the rest were monogamous. Most females laid only one clutch and the two second clutches laid were not successful. The average clutch size was four eggs and success rates were low.

Introduction

The importance of breeding habits and territoriality in understanding avian ecology has been realized since Howard's (1920) book on territoriality was first published. Recently (Brown, 1969), the role of territoriality in regulating population numbers and the ever increasing evidence of polygyny in passerines of two-dimensional habitats (Verner and Wilson, 1966) have also been emphasized.

In our attempt to understand these aspects of bird life, observations must be carried out throughout the breeding season and ideally for several seasons. A season's study of the Yellow Palm Warbler (*Dendroica palmarum hypochrysea*) was undertaken to investigate the habits of an interesting but poorly studied open habitat species.

Materials and Methods

The Palm Warbler was studied in a bog heath area near Bayer's Settlement, Halifax County, Nova Scotia (44 40′N, 63 10′W) from the time of its arrival, April 27, 1969, until the complete breakdown of territorial behaviour around August 15, 1969.

The territories of the full complement of ten males in the study area were observed carefully. Separation of the sexes was possible on the basis of plumage. Males are brighter yellow with more sharply contrasting chestnut cap and have breast stripes farther down the sides than the females.

Birds were captured with 30 mm mist nets, leg banded, and given temporary colored plumage marks; one was color banded. Birds were initially distinguished on the basis of these markings but increased familiarity with the birds enabled the observer to identify those not color marked as well. Male song proved to be one of the most helpful distinguishing characters.

Habitat

The study area (Figure 1) is best classified as bog-heath and heath forest. It comprises an area approximately ¾ mile × ½ mile with an overall range in elevation of 50 feet. The northernmost end (see Figure 1) has several ponds and a swamp surrounded by bog heath and forest. The entire area is underlain by bedrock, with a very thin layer of soil overtop.

Figure 1 gives an outline of the area, distinguishing among three main types of vegetation. The forested area is composed mainly of black and red spruce with some balsam fir. The easternmost portion is a raised ridge with some hardwood, mainly maple. The open margins have a number of tamaracks. The bog-grassland-heath area is distinguished mainly on the basis of height of its cover and contains a large variety of species, particularly pitcher plant, sphagnum mosses, reindeer moss, cotton grass, cranberry, bog orchids, ground juniper and various sedges. The shrubland is mainly Labrador tea, rhododendron, swamp laurel, bog laurel, sheep laurel, wild rosemary, leatherleaf and alder. There were at least 36 other species of birds living or breeding in the study area, the most common being: Slate-colored Junco, White-throated Sparrow, Myrtle Warbler, Magnolia Warbler, Black-throated Green Warbler and Lincoln's Sparrow. The main predators in the area were apparently Gray Jays, short-tailed weasels, and garter snakes.

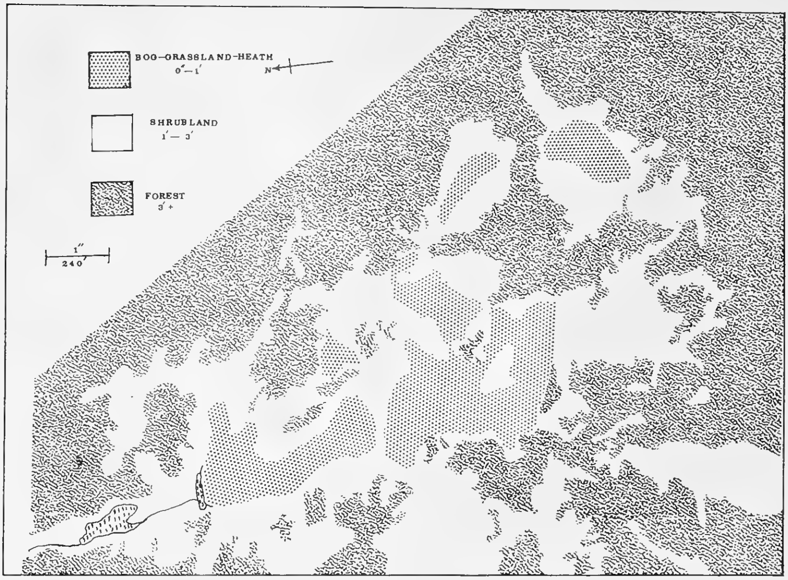

FIGURE 1. Map of study area showing vegetation types.

Territorial Behaviour

For the purposes of this study the territory of any male was defined as that area in which he was normally found, which he announced as his by singing at song posts, and which he defended from intruding or boundary males. The boundaries are shown on Figure 2.

Establishment

The first male was seen on April 27 in the southernmost portion of territory 1. He was present in this area from that date until July 24 and some singing was observed on most days. The second male appeared in territory 2 on May 2 and sang in that area until July 7.. Other birds soon arrived and set up territories (approximate dates of territorial establishment are shown on Table 1). The first signs of aggressive behaviour were seen on May 11. It is worthy of note that there were apparently two main concentrations of territories; males 3, 7, 8, and 9 around territory 1 and males 4, 5, and 10 around territory 2.

In all cases the territories were set up in a peripheral position to the open bog-heath with preference being given to "open bays" or clearings loosely connected to the open area (see Figures 1 and 2). No birds established territories in the open area. In general it can be said that the boundaries of territories were established along natural delimitations, usually lines of well-developed trees or the forest edge. In all cases the territories were expansible in at least one direction into areas unoccupied by other males and territory size was to this extent determined by each bird himself.

Singing

The position of song posts are shown on the territory map (Figure 2). All birds began the season using high positions (above approximately twenty feet) and moved to lower positions at least once during the season. High positions were usually tree tops and low positions were shrubs close to ground level. The periods during which these activities were carried out are shown in Figure 3. It is worthy of note that birds showed a great preference for tamaracks as high song posts. These trees did not have much foliage until late June and were among the tallest along the boundary lines. The criterion for determining use of high or low song posts presented no problem as the birds invariably chose one or the other on any given day. The song posts shown in Figure 2 are almost all high posts as they were the only ones maintained throughout the season. Singing was carried out from many different spots in the territory but invariably certain positions formed the focal point for singing and were consistently used; these are the song posts shown.

Due to the density of vegetation in territories 2, 7, 8 and 10, it was impossible to follow the bird's movements completely and the song post positions are therefore incomplete. The spring extensions of territory shown for males 3, 6, and 9, are areas which they initially defended but did not consistantly maintain throughout the season.

The frequency of singing at song posts varied throughout the season as well as from bird to bird. Birds normally sang from soon after dawn until early afternoon and did not usually sing during the rest of the day. From observations of males 1, 3, and 6, some generalizations about song can be made. Songs were 1.5-2.0 seconds long and normally 12-18 seconds apart. These birds sang 7-14 times from each high position and 5-9 times from each low position. When actively announcing their territory, particularly at the beginning of the season the birds moved from post to post within 2-4 minutes. Later in the season there was often up to 30 minutes between singing at song posts.

Although the birds did not have a set sequence of movement from post to post they did move around their territory so that each area was visited several times each day. At times the song posts served only as observation posts; whether the bird sang or not was apparently related to several things, particularly the movements of adjacent males and the weather.

Role of the Female

The females did not appear to play an active role in territorial establishment or defence. They were normally quiet and secretive, being vocal only when disturbed on the nest or when feeding young. The position of the nest within the territory does not appear ordered and cannot be construed as influencing or aiding in the establishment of territorial boundaries.

Effect of Breeding

Success in securing a female and breeding seemed to affect singing behaviour (see Figure 3) but apparently did not alter the size of territory held or the amount of aggression shown. Generally a male sang at low posts until the clutch was completed. He sang at high posts during incubation but returned to low posts during the period when young were being fed, if he was actively involved. Feeding did not generally reduce the amount of territory held although it did affect frequency of singing. One male (No. 6), however, left his territory to feed his fledglings which had strayed away and stayed with them, not defending his territory again.

Size

Table 1 shows the approximate size of territories as well as the number of song posts and the date of establishment of the territory. The size of territory is not obviously related to breeding success although with the spring extension male 6 had the largest territory and also had two females. His territory was different in other ways as well, particularly because it was separated from the others and contained a swamp and pond area.

Seasonal Patterns

A general description of the activities of several of the better known males is given in order that a fuller understanding of the relationship between territoriality and breeding can be achieved.

Male 1

April 27 — Sang in the tree tops in the southernmost extremes of his territory.

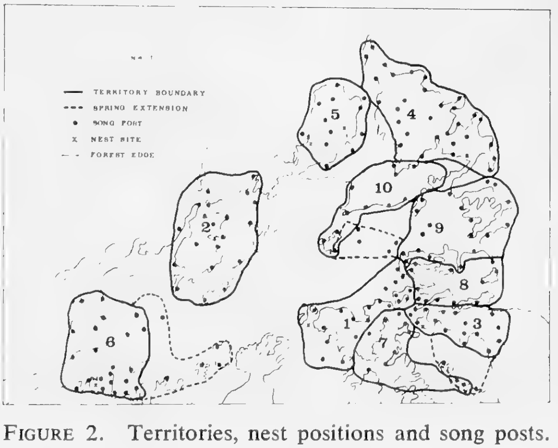

FIGURE 2. Territories, nest positions and song posts.

TABLE 1. — Territory size, song posts, and date of establishment.

Territory	Terr. size, hectares (acres)	Estab. date	No. of song posts
1	1.66(4.09)	April 27	20
2	2.62(6.48)	May 2	20 I[1]
3	1.02(2.51)	May 10	16
plus spring extension	1.55(3.84)	—	18
4	2.68(6.61)	May 12	30
5	1.28(3.17)	May 12	12
6	2.09(5.16)	May 9	22
plus spring extension	3.26(8.07)	—	27
7	1.34(3.31)	May 6	10 I
8	1.12(2.78)	May 10	12 I
9	2.14(5.29)	May 10	19
plus spring extension	2.62(6.48)	—	24
10	1.66(4.10)	May 12	11 I

[1]I – incomplete – see text.

May 2 — Established song posts around the edge of his territory and actively moved from one to the other throughout the morning and early afternoon.
May 11 — A female was in his territory with nesting material.
May 14-17 — Sang at high song posts from dawn to approximately 14:00; after this time he was with the female in the nest area and did not sing, although he moved rapidly around the territory periodically.
May 18-June 2 — Sang mainly from positions close to the ground often hopping from one to the other. His exact positions were often difficult to determine. The use of lower positions did not seem to imply a reduction in potential for defence, since he did move progressively around the territory.
June 2 — Began to sing at high positions again. The female now had a clutch of four, probably completed June 1.
June 11-26 — A second female was observed in the south end of his territory and although he was often with her she apparently did not nest. The eggs from his first clutch hatched on June 11 but he was not observed feeding the young.
July 3 — Actively fed two fully grown young from nest 1 on the southern edge of his territory. One of the young was seen flying to that area that morning. His first female was not seen after this date.
July 6 — Sang several times from the central song posts. After this date he was not heard singing.
July 24 — He was still helping the two young to feed although he often chased them. This was the last date that he was seen.

Male 2

May 2 — Began singing in the tree tops and was apparently the second bird to arrive in the study area.
May 3-May 20 — Sang actively in the tree tops. Most of his song posts are shown (Figure 1), but it was impossible to establish all those in the forested area although he sang there regularly.
May 20-June 8 — Sang mainly from low perches around the edges of his territory. He fed with the female several times in open areas during mid-morning. She apparently completed her clutch about May 30 and it was destroyed.
June 8 (the nest was tipped over and 2 eggs were gone).
June 8-10 — Both birds disappeared.
June 10-July 7 — Reappeared and sang vigorously from the tree tops, particularly in those positions near the destroyed nest. His frequency of singing gradually decreased and he was not seen after July 7. He was near nest 1 on July 3 and female 1 was not seen after that date.

Male 6

In general this male behaved similarly to male 1 but needs mention because his territory did not border on any others and because he had two females. His territory was very large at the beginning of the season and was subsequently reduced (see Figure 2 and Table 1). The young left the nests on June 28 and June 30.
July 2-4 — Fed young of both females actively but spent most time with young of female 1.
July 4 — Two young from nest 6-B-1 moved off and he spent the day outside his territory feeding them. He was not observed with the others.
July 6 — Was seen on the southeastern edge of territory 2 with two young.
July 8 — Was seen feeding two young in the unoccupied area between territories 2 and 5 and was also seen in his territory with young of nest 6-A-1.
July 9-15 — Fed two young on the border between territories 4 and 5 and was not seen returning to his territory at all. No aggression was shown towards him by any other males.

To continue a review of the day-to-day activities of the males would be redundant. It should be mentioned that male 3 fed his young persistently from the day of their hatching until eleven days after they left the nest. Males 8, 9, and 10 apparently did not have females; at least no young were observed in their territories and no females were seen.

Defence and Aggression

Most aggression occurred during the early part of the season when territories were being established. Conflicts were centered along natural boundaries and often involved disputes over a tree line. An intruder usually announced his presence by singing and was chased. Chases were of short duration, usually only a few seconds, after which the "owner" of the area would sing from adjacent song posts. The only areas in which active defence and aggression were observed was along the boundaries between territories 1, 3, 7, and 9.

Little interspecific aggression was observed although male 1 was seen chasing a male American Redstart; male 3 chased the juncos nesting near his own nest on several occasions; male 6 chased a neighbouring Magnolia Warbler on at least two occasions; and female 5 chased a male Yellowthroat out of the territory.

Nesting and Care of the Young

Seven nests were found of the ten known to have been made. Six of the seven were less than a foot from the ground on the outside edge of hummocks of ground juniper (*Juniperus communis saxitalis*). These nests were made of fine grasses and were lined with feathers and soft grasses. The other nest (No. 5-1) was about one foot off of the ground in a clump of fern. It was constructed of coarse grasses and a few leaves and was generally flimsy.

Table 2 summarizes all the known data on nesting and Figure 3 summarizes nesting phenology and compares it with male singing behaviour. Where dates were not not known they have been estimated assuming an incubation period of eleven days (as observed for nest 3) and a further feeding period on the nest of ten days (as observed for nests 1, 3, and 6-B-1). Nests 4-1, 6-A-1, and 7 were not found and their phenologies are based on age estimates of recently fledged young.

Feeding of the young from hatching until after fledging was observed sporadically for three broods:

Nest 1:

The female looked after feeding the two young alone until well after they had fledged when the male took over. She was not seen after the time the male was first observed feeding the young.

Nest 3:

Both male and female looked after the young from the day they were hatched until at least eleven days after leaving the nest, eight days after fledging. The young on the nest were often noted being fed on large white moths from a tamarack. Both birds exhibited great caution

TABLE 2. — Nesting Data: Each nest is designed according to its territory, eg. 4–1 being the first and 4–2 the second nesting of female number 4. The nests of the two females within territory 6 are designated 6-A-1 and 6-B-1

Nest No.	Date completed	Date hatched	Date left	Number of eggs	Number hatched	Number leaving
1	*June 1**	June 11	June 20	4	2	2
2	*May 30*	—	—	4	—	—
3	June 7	June 18	June 28	4	4	4
4–1	*May 26*	*June 7*	*June 17*	—	—	4+
4–2	July 8	—	—	4	—	—
5–1	*June 9*	—	—	3	—	—
5–2	*July 22*	—	—	4	—	—
6–A–1	*June 9*	*June 20*	*June 30*	—	—	4+
6–B–1	*June 7*	June 18	June 29	5	4	4
7	*June 5*	*June 16*	*June 27*	—	—	3+

[1] – approximate dates in italics.

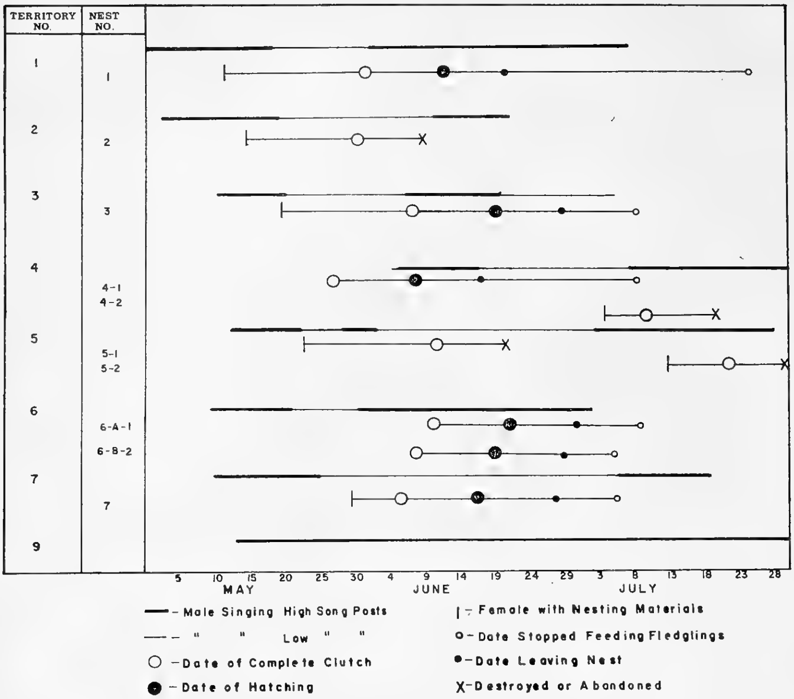

FIGURE 3. Male singing behaviour and nesting phenology.

approaching the nest, normally waiting at least five minutes before actually feeding. Both birds were usually around the nest site during the feeding period, with one watching while the other fed.

Nest 6-B-1:

Male 6 was observed feeding young on the nest on three occasions only, twice on June 24, and once on June 27.

Discussion

The study area is a mosaic of different plant covers yet is readily divisable into three main areas as shown in Figure 1. This seemingly superficial analysis of a basically two-dimensional habitat and its surrounding forest is actually quite meaningful. All territories held by "successful" males contained a significant portion of open area and were clearly delimited by natural boundaries.

No completely open area without surrounding forest was selected as a territory although many such areas were available with no apparent differences from the open parts of selected territories. In view of observations that tamaracks, as well as other trees, on the periphery of the forest edge provided natural boundaries which the birds used to separate their territories, it may be that a naturally delimited area is particularly suitable as a territory site. This conflicts with Knight's (1904) description of their habitat in Maine which he classifies as open sphagnum bog, specifying that the "palm warbler does not tarry to nest" in more overgrown areas.

No published data on territory of this species are available but the study area is topographically similar to other nesting sites in the area and may well be typical. The territories were certainly much larger than would be expected for a warbler (Kendeigh, 1948) and larger than needed for any obvious reason; but each territory was actively defended and could have been larger had the bird chosen or been able to defend more area.

Basically the territories must be classed as Type A (Nice, 1943) since mating, feeding, and nesting occurred within their boundaries.

This in no way presupposes that any or all of these factors were intrinsically involved in the adaptive function of Palm Warbler territories.

Superficially the males seemed ready to mate throughout the season and constantly advertised their territories. Presumably they were not as strongly motivated to breed when they were singing from low posts. It is interesting to note that low post singing roughly corresponds with similar stages in nesting for each territory. One closely observed male, which did not mate, sang from high posts throughout the summer and another returned to high posts after losing his mate.

Of the three males thought not to have bred, two had territories in almost totally wooded areas and in the other a significant percentage of the territory was wooded. One male was bigamous (No. 6) and the rest were monagamous although an extra female was observed on one territory for a protracted period. The territory of the bigamous male was separated from the others and contained two ponds and a swampy area, but was not noticeably different in any other way.

Most birds had only one clutch but this may have been due to the late starting date caused by a late spring (the bog did not thaw completely until early May). The average clutch size of 4 is lower than that found by Tufts for 61 nests in Nova Scotia (Bent, 1963) and the clutch of three is presumably smaller than usual. In the two cases where a second clutch was tried it was not successful due to predation. It would be unsound to estimate reproductive success from the data collected because of its limited nature and especially because losses due to predation may well be related to the finding of the nests. Four of the seven nests found were destroyed before the eggs were hatched.

No general statement about feeding can be made except to say that the male may be involved during nest feeding, and is usually involved once the young leave the nest.

Conclusions

Most Palm Warbler territories within the study area were adjacent although all were expansible. Territories were very large (1.12-2.62 Hectares) but each was actively defended and was maintained by the uses of set song posts. All territories were at least partially bounded by trees and preference seemed to be given to open bays and clearings separated from the open bog-heath area.

Seven of the ten males were successful in finding a mate and one was bigamous. The average clutch size was 4 eggs and the incubation of one clutch was 11 days. The young left the nest when about ten days old and fledged about three days later. Males were involved in feeding at some stage (usually after the young left the nest) but the extent seemed dependent on the individual male.

There is no evidence to indicate that food or nesting cover were limited in any way and it therefore seems questionable to assume that food or potential nest sites were the basis of territorial establishment or defence.

Acknowledgments

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Abundance of Forage on the Winter Range of Newfoundland Caribou

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Abstract. The abundance of forage for caribou (*Rangifer tarandus*), mainly evergreen shrubs and terrestrial lichens, was measured at 22 locations in Newfoundland. Study areas were selected to represent plant successional stages following fires on former forest sites and in lichen woodlands and also on subalpine winter range used by caribou. The supplies of forage were substantial and there appeared to be no absolute shortage of food for caribou. It was concluded that forest fires in the past have increased the extent of winter range by altering closed-canopy forests to lichen woodlands or shrub-barrens, and prostrate subalpine spruce — fir thickets to lichen-shrub barrens.

Introduction

Caribou (*Rangifer tarandus*) were abundant in Newfoundland about 1900 (Millais 1907:333 and Dugmore 1913: 12) but declined rapidly in the period 1915 to 1930 (Dugmore 1930: 127). Numbers have increased since 1930 but have remained much lower than prior to 1915. I studied the abundance of forage on caribou winter range from 1957 to 1959 to ascertain if a shortage of winter food might possibly limit numbers. Specific objectives were to ascertain the influence of forest fires on forage abundance, plant succession and species composition, and quantify the absolute abundance of terrestrial lichens.

There are four, apparently discrete, caribou herds in Newfoundland: the Interior Herd, the Humber River Herd, the Avalon Peninsula Herd and the Northern Peninsula Herd (Bergerud (1969: 3) The winter distribution of the first three herds was determined by aerial censuses in most winters, 1957 to 1963 (Figure 1D). The Northern Peninsula Herd was counted only in 1958. All the herds wintered in open habitats largely unaffected by logging operations and recent forest fires (Figure 1). The Interior Herd had three main wintering areas (Figure 1D); these will be called western, central and eastern.

Range description

I recognized three major vegetative sites: (1) Forest sites — sites that had supported closed-canopy forests prior to the most recent forest fire, (2) lichen woodland sites, and (3) subalpine sites. The forest sites had supported merchantable-size stands of black spruce (*Picea mariana*) and balsam fir (*Abies balsamea*). The lichen woodland formation consisted of a thinly scattered forest of open-grown and unpruned conifers (Figure 2). Black spruce and larch (*Larix laricina*) were the dominant species. Surrounding the conifer clumps or lone trees was a continuous and uniform carpet of reindeer lichens (*Cladonia* spp.). This formation is recognized as the ecotone between the boreal forest and tundra (cf. Hustich 1951:9 and Fraser 1956:1). The subalpine zone, if unburned for at least 60 years, was often characterized by climax *Krummholz* spruce and fir. These stands varied from a tangle 6 inches deep to 10-foot stands surviving in sheltered defiles (Figure 3). Protective snow cover appeared to limit height.

The western and central winter ranges of the Interior Herd (Figure 1D) are best described as subalpine, as is the winter range of the Avalon Peninsula Herd. The winter range of the Humber River Herd is mostly large bogs with some lichen woodland. The eastern winter range of the Interior Herd is lichen woodland. The range of the Northern Peninsula Herd was not studied.

Methods

The areas selected for study included 7 former closed-canopy forest sites burned 7 to 37 years prior to investigation, 10 lichen woodland sites burned 6 to 65 years previously, 1 subalpine site burned 35 years earlier and 7 subalpine sites that showed a history of fire

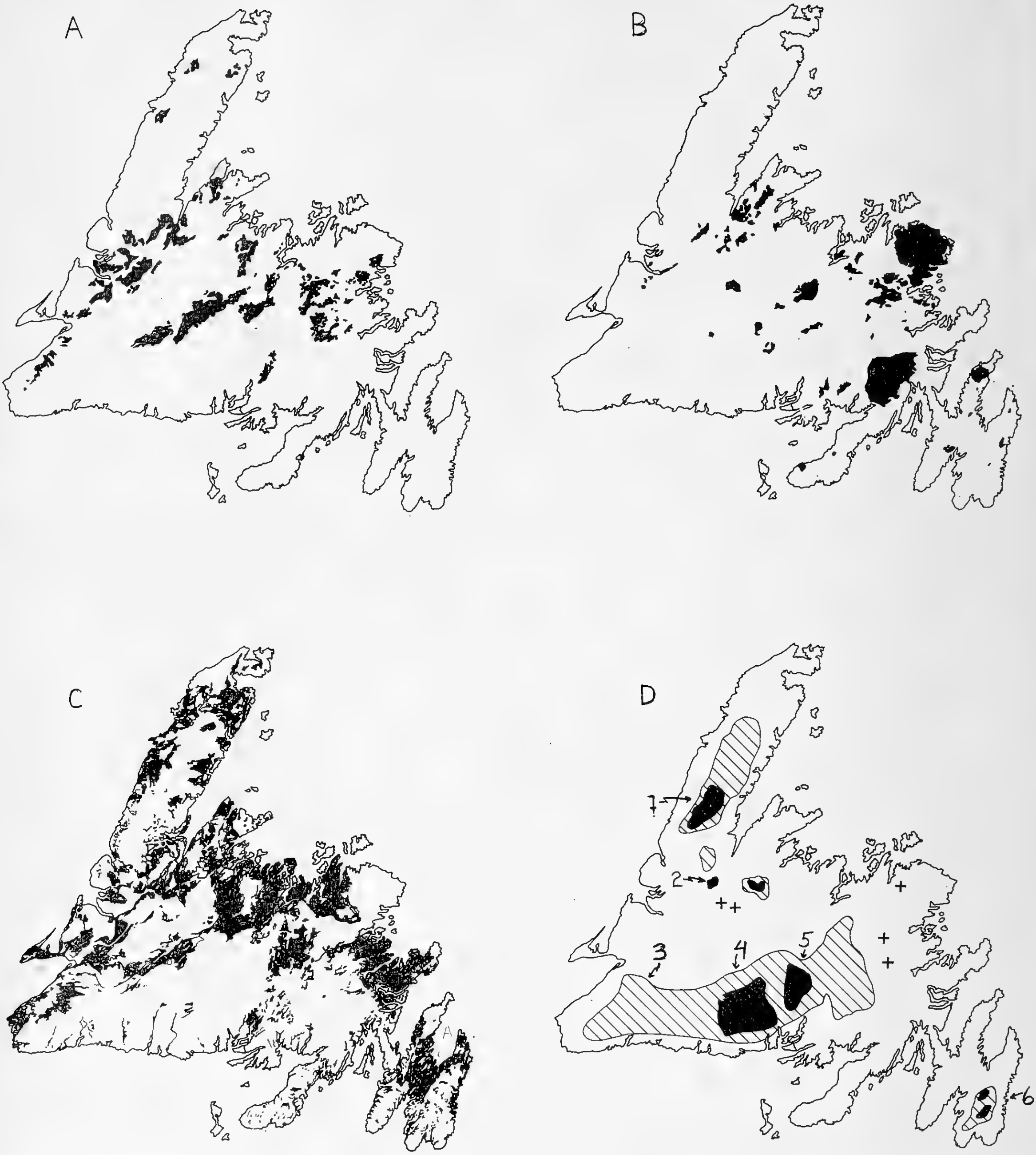

FIGURE 1. Comparison of the locations of caribou winter range, crosses represent minor wintering areas, (D) with areas cut for pulpwood, 1940 to 1963 (A), important burns, 1940 to 1963 (B), and closed-canopy forest in 1963 (C). The winter ranges of different caribou herds in (D) were (1) the Northern Peninsula Herd, (2) the Humber River Herd, the Interior Herd Nos. 3, 4, and 5 ((3) — Western range, (4) — Central range and (5) — Eastern Range), and (6) the Avalon Peninsula Herd.

TABLE 1. — The abundance of five plant groups on 25 ranges examined.

Vegetation Zone, Range and (Years Since Burned)	No.[1]	Percentage of the Ground Covered With:				
		Green Mosses	Evergreen Shrubs	Deciduous Shrubs	Conifer Trees	Herbs and Forbs
Subalpine						
Avalon P. Interior	(1)	18	37	23	5	8
Connoire Bay	(2)	4	32	27	18	6
Cold Spring Pond	(3)	9	34	10	6	2
Dolland Brook	(4)	21	41	17	10	4
Buchans Plateau	(5)	5	27	26	21	7
Grandys Brook	(6)	3	38	15	15	10
Stephensons Pond	(7)	5	19	33	21	7
Buchans Plateau (35)	(5)	11	31	21	—	12
Lichen Woodland						
Birchy Lake	(8)	2	32	11	tr.	tr.
Partridgeberry Hills (65)	(9)	6	34	12	tr.	3
Newfoundland Dog Pond (65)	(10)	9	39	14	1	1
Sandy Lake, Badger (57)	(11)	9	34	30	4	1
Lower Humber River (55)	(12)	37	47	4	—	2
Indian River (52)	(13)	2	25	14	tr.	tr.
Crooked Lake (27)	(14)	9	49	21	4	2
Island Pond (20)	(15)	8	27	17	2	3
Crooked Lake (10)	(14)	8	41	20	tr.	2
Nw. Gander River (6)	(16)	7	33	37	tr.	6
Forest sites						
Red Indian Lake (35)	(18)	30	47	41	7	2
Harrimans Brook (32)	(17)	46	13	8	4	29
Paradise Lake (22)	(19)	30	25	20	tr.	13
Division Lake (14)	(20)	17	10	11	tr.	31
Cormack Burn (10)	(21)	34	12	20	1	9
Miguel Mountain (10)	(22)	37	11	13	1	16
Division Lake (7)	(21)	35	6	15	—	50

[1]Numbers identify the location of the sites shown in Figure 4.

TABLE 2. — *Cladonia* lichen succession following burning on forest sites in Central Newfoundland.

Lichen Species	Frequency/ Per cent of Ground Cover					
	7[1]	10	14	22	32	36
Cladonia spp.	5/tr.	37/1	100/5	73/4	73/7	40/tr.
Cladonia cristatella	5/tr.	26/1	100/10	87/1	—	20/tr.
Cladonia rangiferina	—	7/tr.	100/2	67/8	60/2	80/13
Cladonia sylvatica (coll.)	—	10/tr.	97/1	73/9	53/4	80/3
Cladonia uncialis	—	3/tr.	—	27/tr.	—	20/tr.
Cladonia elongata	—	—	40/tr.	67/tr.	40/1	—
Cladonia alpestris	—	—	5/tr.	13/tr.	—	10/tr.
Total Cover	tr.	2	19	21	15	16

*Site investigated 7 years after it was burned.

FIGURE 2. The lichen woodland formation at Sandy Lake, Badger (See Figure 4, Number 11).

but the destruction had occurred many decades earlier and the date of the burns could not be determined (see Figure 4 for the specific locations).

These ranges were mostly in the more remote areas of the interior of Newfoundland. This study was meant to complement the lichen investigations of Ahti (1959) who visited mostly peripherial ranges seldom utilized by caribou (Figures 1 and 4).

FIGURE 3. The subalpine zone characterized by stands of stunted spruce and fir.

Neither a random nor systematic selection of vegetative sites was feasible in the extensive blocks of wilderness habitat investigated. Sampling procedures included both quadrats (3.1 $\times$ 3.1 feet) and line point transects. Representative portions of a burn or range being investigated were visited and a toss made at each sampling site to locate the first quadrat. Four additional quadrats were placed 50 feet each, north, east, south and west from the initial center one. Transects were located so as to sample uniform, contiguous plant communities. Nearly all sampling was limited to upland communities.

In each quadrat the percentage of the ground covered by a species in each the ground and shrub layer was estimated to the nearest 5 per cent. The outstretched fingers and hand when held a few inches above the vegetation covered approximately 5 per cent of the total area in the quadrat.

Shrub and lichen height measurements were taken in each quadrat. Sections of the lichen mat were removed before measuring so as to not include in the measurements the hollow cavity existing in mature stands between the ground and the bottom on the lichen mat.

The entire lichen cover in many plots was picked and weighed, air dry, to the nearest 5 grams. A quadrat 3.1 $\times$ 3.1 feet was selected because the weight of forage in grams from 9.6 square feet can be converted to pounds per acre by multiplying by 10 (Brown 1954: 104).

The transect technique was relied on to give a broader and more objective appraisal of floral cover than possible with quadrats. The procedures used were similar to those tested in the Northwest Territories by Kelsall (1957: 62) for barren-ground caribou ranges. Plant species were recorded under each foot mark of a steel tape consecutively for 100 feet. There were ten 100-foot subsamples per transect along the sampling route.

Lichen growth rates were determined after Ahti (1959:20). The method described by Andreev (1934) was used to determine the annual production of lichens.

Succession following burning

Forest Sites

Shrubs and forbs quickly invaded the seven burned forest sites (Table 1). Pioneering deciduous shrubs in descending order of abundance were: blueberry (*Vaccinium angustifolium*), rhodora (*Rhododendron canadense*), raspberry (*Rubus idaeus*), and fire cherry (*Prunus pensylvannica*). The most common forb was bunchberry (*Cornus canadensis*); it accounted for over 80 per cent of all the forbs recorded

Cladonia lichens were common on two sites 10 years after burning (Table 2). Lichens on another site yielded 600 pounds of forage per acre 14 years after the fire (Table 3). On another burn lichens covered 21 per cent of the ground 22 years after the fire. On the 36-year-old burn forest regeneration was sufficient so that only the most shade tolerant lichen *Cladonia rangiferina* was common (Table 2). On 6 of the 7 areas the forest succession sequence indicated that the areas would ultimately revert to closed-canopy stands and eliminate lichen and shrub strata. However, in the site burned 22 years previous succession had developed a lichen woodland rather than a spruce forest because of poor seed germination. Thus, in this one case, fire had increased the potential pastures for caribou.

Lichen Woodlands

Shrubs rapidly recolonized burned lichen woodland sites (Figure 5 and Table 1). Sheep laurel (*Kalmia angustifolia*), rhodora, and blueberry were abundant species 6 years after

TABLE 3. — Summary of terrestrial lichen analysis.

Vegetative Zone, Range and (Years Since Burned)	No.[1]	No. of Quad. No. of Trans.	Lichen Height In. (cm.)	Per cent Lichen Cover	Pounds Lichen Per Acre
Forest Sites					
Red Indian Lake (36)	(18)	10/0	1.8 (4.6)	15.5	400
Harrimans Brook (32)	(17)	15/0	1.1 (2.8)	14.9	300
Paradise Lake (22)	(19)	15/0	1.1 (2.8)	21.1	200[2]
Division Lake (14)	(20)	20/0	0.7 (1.6)	19.1	600[2]
Cormack Burn (10)	(21)	15/1	0.1 (0.8)	1.7	—
Miguel Mountain (10)	(22)	10/0	0.2 (0.5)	tr.	—
Division Lake (7)	(20)	10/0	—	—	—
Lichen Woodland					
Birchy Lake	(8)	10/0	5.2 (13.2)	95.5	12,000
Partridgeberry Hills (66)	(9)	54/4	1.6 (4.0)	73.1	7,200
Newfoundland Dog Pond(65)	(10)	75/3	1.5 (3.8)	80.2	5,000
Sandy Lake, Badger (57)	(11)	17/0	2.6 (6.6)	91.7	6,500[2]
Lower Humber River (55)	(12)	48/0	1.6 (4.0)	55.6	5,200
Indian River (52)	(13)	15/0	1.2 (3.0)	86.2	5,300
Crooked Lake (27)	(14)	15/1	1.2 (3.0)	40.2	800
Island Pond (20)	(15)	14/2	0.6 (1.5)	34.2	700
Crooked Lake (10)	(14)	15/0	0.4 (1.0)	27.6	300
Nw. Gander River (6)	(16)	20/0	0.4 (1.0)	tr.	—
Subalpine					
Avalon P. Interior	(1)	24/3	2.0 (5.0)	60.1	4,000
Connoire Bay	(2)	25/0	1.0 (2.5)	59.9	2,500
Cold Spring Pond	(3)	25/3	1.1 (2.8)	60.8	2,100
Dolland Brook	(4)	50/3	0.9 (2.3)	58.8	2,100
Buchans Plateau	(5)	10/0	1.2 (3.0)	73.0	1,600
Grandys Brook	(6)	10/0	1.2 (3.0)	62.5	?
Shephensons Pond	(7)	10/0	1.2 (3.0)	35.0	1,100
Buchans Plateau (35)	(5)	10/0	0.9 (2.3)	27.0	700

[1]Numbers identify the location of the sites shown in Figure 4.
[2]Oven-dry weight, other weights air dry.

TABLE 4. — Comparison of plant species abundance on a subalpine site burned 35 years previously and an adjacent unburned site on the Buchans Plateau.

Plant Group and Plant Species	Per cent of ground cover	
	Burned 35 years prev.	Unburned
Ground Lichens		
Cladonia mitis	16	28
Cladonia rangiferina	9	23
Cladonia alpestris	1	5
Cetraria islandica	1	3
Cladonia uncialis	tr.	1
Cetraria spp.	tr.	2
Cetraria nivalis	tr.	1
Total Cover	27	63
Bryophytes		
Dicranum spp.	8	1
Polytrichum spp.	3	—
Calliergonella schreberi	—	2
Others	tr.	2
Total Cover	11	5
Deciduous shrubs and forbs		
Vaccinium angustifolium	22	18
Rhododendron canadense	4	3
Cornus canadensis	7	4
Vaccinium uliginosum	—	8
Amelanchier Bartramiana	1	tr.
Total Cover	34	33
Evergreen Shrubs		
Kalmia angustifolia	15	6
Empetrum nigrum	5	15
Chamaedaphne calyculata	3	4
Ledum groenlandicum	1	2
Vaccinium Vitis-Idaea	2	tr.
Lycopodium sabinaefolium	5	tr.
Total Cover	31	27
Conifers		
Picea mariana	—	17
Juniperus communis	—	4
Total Cover	—	21

burning (Figure 5). It appeared that there were no intermediate seral stages for shrubs; the original dominant species were the pioneer species (Figure 5).

The ground lichens took over 25 years to recolonize the sites (Figure 6 and Table 3). I recognized five seral stages (slightly modified after Ahti 1959:23):

Years after Fire	Serial Name	Dominant Lichens
0-3	bare ground	none
3-10	crustose	*Lecidea* spp.
10-25	horn lichen	*Cladonia crispata, Cladonia deformis Cladonia cristatella*
25-80	1st reindeer	*Cladonia mitis, Cladonia rangiferina, Cladonia uncialis*
80	2nd reindeer	*Cladonia alpestris*

Lichen cover increased rapidly between 30 and 40 years but the weight of lichens did not exceed 1,000 pounds per acre until some time after 40 years (Table 3). After 40 years the weight of lichens increased rapidly until 50 to 60 years when a leveling trend was evident (Table 3). Beyond this age forage increased only if the cryptogams passed into the second reindeer phase dominated by *Cladonia alpestris* (see Birchy Lake Table 3). Grazed lichen stands were usually in the first reindeer stage; possibly disturbance by animals helped maintain the first reindeer phase.

Subalpine Ranges

Plant succession was compared in one 35-year-old burn with an adjacent unburned site. *Cladonia* lichens were common on the burned site whereas a conifer mat covered the lichens on the unburned quadrats (Table 4). Apparently timber-line spruce and fir were the last species to recolonize a burn. The lichen mat on the burned site was less than half that growing beneath the low conifers:

	Unburned	*Burned*
Lichen heights (inches)	1.2	0.9
Per cent lichen cover	63	27
Pounds lichens per acre	1,600	700

Shrub densities were similar on both burned and unburned sites but species composition differed (Table 4). Crowberry (*Empetrum nigrum*) and alpine blueberry (*Vaccinium uliginosum*) were common in the unburned section, while sheep laurel was dominant in the flora of the burn (Table 4).

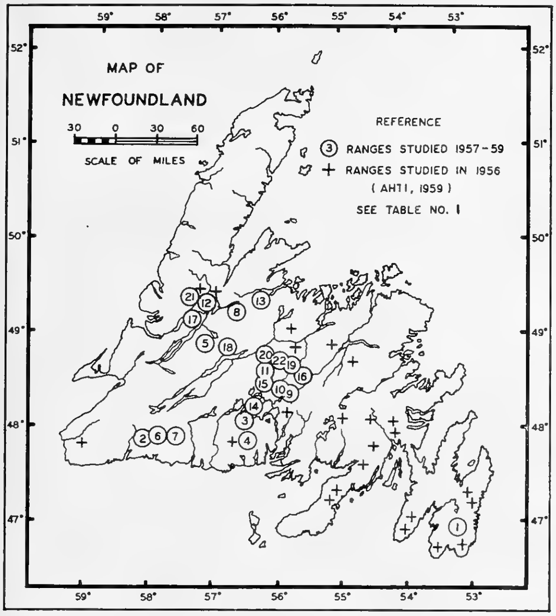

FIGURE 4. Locations in Newfoundland where the plant composition was measured: the Numbers refer to the place names listed in Table 1.

Abundance of forage on winter range

Terrestrial Lichens

The abundance of terrestrial lichens varied greatly between winter ranges (Table 5). The best supplies were available on the winter pastures of the Avalon Peninsula and Humber River herds and in the Eastern Interior (Numbers 9 and 10, Figure 4). These ranges had 2-3 times more lichens by weight than subalpine ranges in the central and western interior (Table 3). However, a comparison of total weights may not be entirely valid. In Sweden reindeer do not eat the rotten, jelly-like base of the dead lichen plant (Skunke 1963:157). Russian reindeer show a similar behaviorism (Larin *et al.* 1937). Thus, not all the weight advantage of the heavier lichen woodland stands is useful. A comparison between areas, of the living length of lichen filaments reduced the discrepancy between subalpine and lichen woodland supplies to a ratio of 1:1.5. Possibly the central subalpine region had about ½ the palatable fruticose ground lichens as the eastern lichen woodlands.

The wide divergence in the densities of reindeer lichens between regions was attributed to site exposure. *Cladonia* lichens are delicate and require protective snow cover (Larin *et al.* 1937, Hustich 1951:26). Lichens were taller at lower elevations (Figure 7) where they were less exposed to wind. Also, shrub height, an index of exposure, was positively correlated with the height of the lichen mat between ranges ($r=0.935$, $n=12$) and within quadrats, all ranges combined (Figure 8).

Both lichen height and the extent of lichen cover on the ground contributed to weight, but cover was slightly better correlated (Table 6 and Figure 9). A common occurrence was a quadrat with a dense shrub stratum which reduced the area of the lichen mat but not its height. Dense evergreen shrubs may provide sufficient shade to stimulate podetion growth; in closed-canopy forest *Cladonia rangiferina*, the most shade-tolerant reindeer lichen, sometimes reached a height of 3 inches.

Annual terrestrial lichen production was calculated at about 300 pounds increment per acre

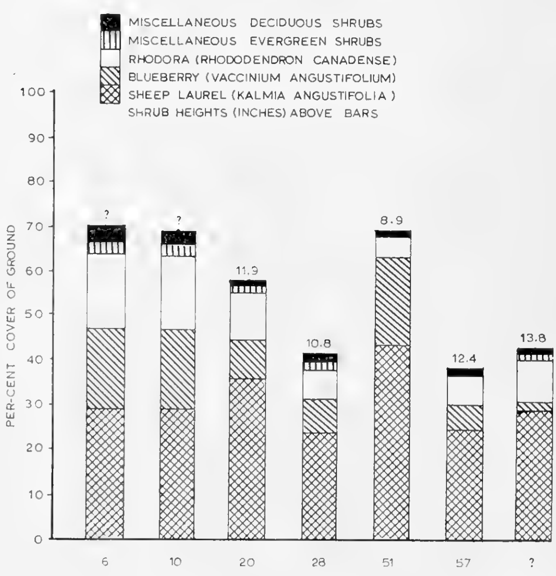

FIGURE 5. Recovers of shrubs in lichen woodland sites following destruction by burning. The numbers above each bar signify the average height of the shrubs.

TABLE 5. — Species composition of ground lichen on the winter ranges used by the Interior Herd and the Avalon Peninsula and Humber River Herds.

Scientific Name of Lichen Species	Per cent Ground Covered with Lichen Species by Caribou Herds								
	Interior Herds							Avalon Herd 1	Humber R. Herd 12
	Western			Central		Eastern			
	2[1]	6	7	3	4	9	10		
Cladonia sylvatica[2]	21	23	13	24	26	35	28	26	23
Cladonia rangiferina	22	32	19	20	25	26	30	17	13
Cladonia uncialis	3	3	1	7	3	4	6	4	9
Cladonia alpestris	2	5	1	3	2	6	11	4	8
Cladonia boryi	—	tr.	tr.	1	tr.	tr.	1	1	—
Cladonia elongata	—	—	—	tr.	tr.	tr.	tr.	1	1
Cladonia spp.	tr.	tr.	tr.	4	1	1	1	1	3
Cetraria islandica	4	1	1	1	1	tr.	2	1	1
Cetraria nivalis	3	1	tr.	1	tr.	tr.	tr.	—	—
Sphaerophorus globosus	1	tr.	1	tr.	tr.	tr.	tr.	6	—
Cornicularia spp.	tr.	tr.	tr.	tr.	tr.	1	2	1	—
Stereocaulon spp.	tr.	—	—	—	—	—	—	1	—
Total	54	64	36	61	59	73	80	61	56

[1]Numbers refer to location numbers in Figure 4.
[2]Includes C. mitis.

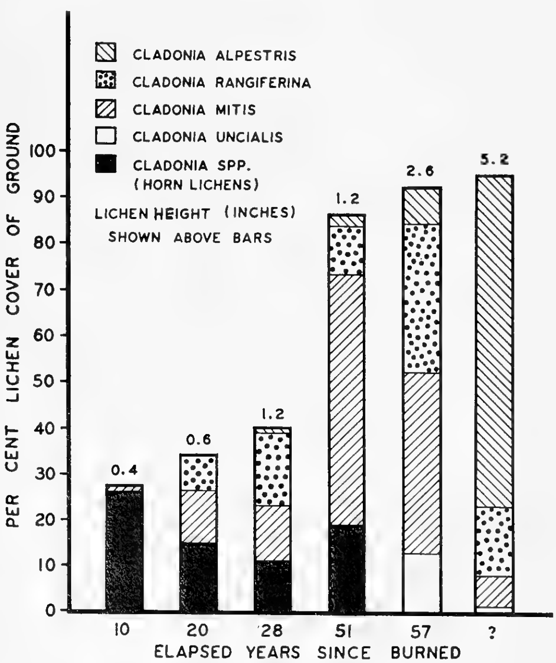

FIGURE 6. Succession of reindeer lichens on lichen woodland sites following destruction by fire.

for the central subalpine ranges of the Interior Herd and approximately 700 pounds per acre for the lichen woodland ranges in the eastern Interior. Actually these figures are probably too high since many of the lichen stands were in the early renovation stage (Ahti 1959: 20). At this stage the lichen cover is also losing forage by the decay of the extreme basal portion of the mat. A better approximation of the net annual gain would likely be about 150 pounds for the central subalpine range and 350 pounds for the eastern lichen woodlands.

Shrubs

Shrubs were universal in the winter ranges. About 50 per cent of the upland sites were covered with shrubs, of which ⅔ were evergreen species that might be utilized in the winter.

The species composition of the shrub layer was quite similar across the Island (Table 7). Actually the survey was aimed at upland tundra and is not valid for riparian associations.

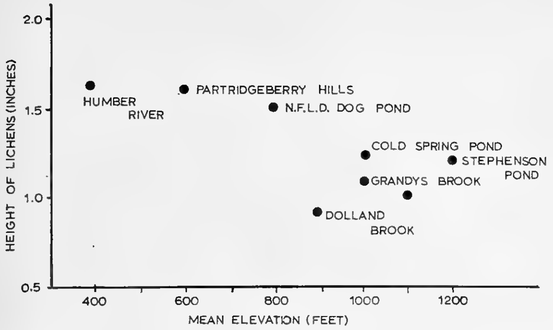

FIGURE 7. The height of reindeer lichens on caribou winter ranges in central Newfoundland compared to elevation.

Neither birch (*Betula* spp.) nor willow (*Salix* spp.) were included in the top assortment (Table 7). Rouleau (1956: 57-58) listed 40 species of *Salix* for the Island yet none were frequent on the ranges where caribou winter. Conversely, 10 of the 13 common shrubs were from the Ericaceae family (Table 7). Sheep laurel and blueberry were abundant; each species occurred in over 80 per cent of the quadrats. Lichen woodland formations contained more rhodora and partridge berry (*Vaccinium Vitis-Idaea*) while subalpine exposures showed more crowberry (*Empetrum* spp.) and alpine blueberry.

Discussion

Forage Abundance

The investigations of the winter ranges showed that reindeer lichens were substantial on ranges not burned for 30 years (Figure 9). Terrestrial lichen quantities exceeded those reported for northern Saskatchewan (Scotter 1964: 48-49), Northwest Territories (Kelsall 1957: 123), Ontario (Ahti and Hepburn 1961: 6, Cringan 1957: 495), and the Gaspé Peninsula, Quebec (Moisan 1958: 18). Similar or greater quantities have been shown for Labrador (Hustich 1951: 41), Alaska (Palmer 1926: 30 and Palmer and Rouse 1945: 46), and the U.S.S.R. (Igoshina 1939: 28-29, Larin *et al.* 1937).

Shrubs were abundant on all ranges (Tables 1 and 7). Evergreen shrubs were more frequent than deciduous. These evergreen shrubs are extremely important in the winter diet (Bergerud 1971).

Shrub supplies exceeded those recorded in Northwest Territories by Kelsall (1957: 113 & 120). His figures suggested that evergreen species covered 10-15 per cent of the ground, while deciduous types comprised less than 5 per cent of the ground covered. The caribou range at Mount Albert, Quebec also had less shrubs; Moisan's (1958: 18) transects showed that the Ericaceae coverd 18 per cent of the ground, while birch and willow covered an additional 16 per cent of the substrate. Lastly, shrubs in Newfoundland appear to be more common than woody species in coastal Alaska and Labrador (data evaluated from Palmer and Rouse 1945 and Hustich 1951). It is difficult to envisage an absolute shortage of shrubs in Newfoundland; they were everywhere in good supply and showed little sign of adverse utilization.

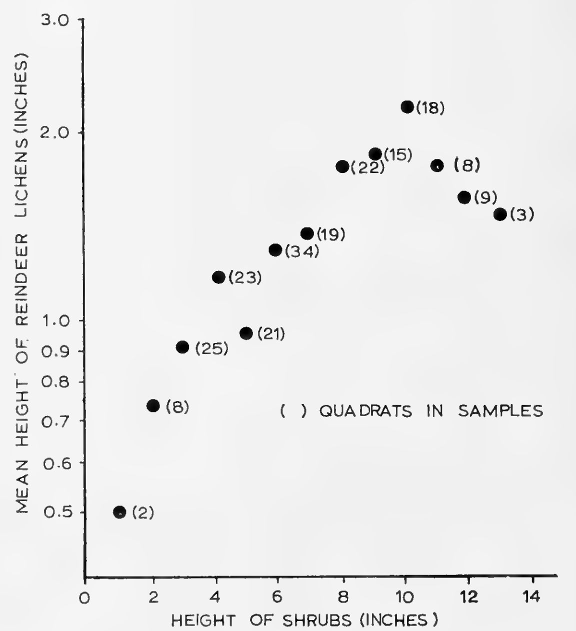

FIGURE 8. A comparison of the mean height of reindeer lichens and shrub heights within the same quadrat.

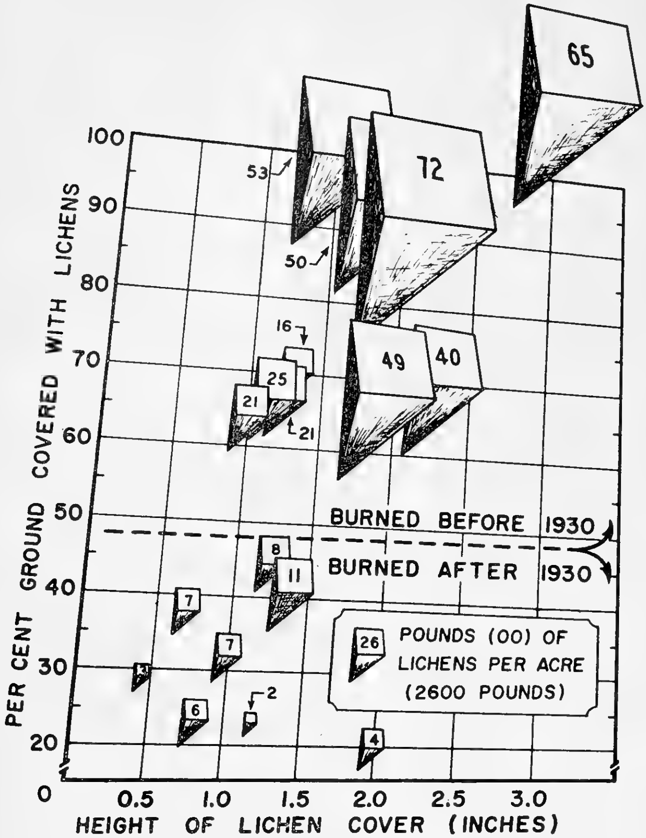

FIGURE 9. Reindeer lichen weights per unit area are a product of both lichen height and per cent of the ground covered with lichens. Weight is better correlated with lichen cover than lichen height.

Forage abundance should be evaluated on the basis of three distinct layers, cryptogam, shrub and tree. Supplies in these strata are probably positively correlated. For example the height and densities of trees and shrubs were reduced on exposed habitats; reindeer lichen quantities showed a similar trend. This correlation implies that the absolute supplies of one stratum will not usually compensate for a reduction in another layer, when viewed on a broad range basis. Locally a site might have a high density of shrubs that would depress the lichen stand and vice versa.

Overall forage was most abundant where forest and tundra met in the lichen woodlands. Here the scattered trees protected the shrubs and lichens from exposure but were not sufficiently dense to seriously reduce the light required by lower stratas (Figure 2). Further the scattered trees carried heavy loads of arboreal lichens. In general, relative shelter and elevation provided the best index to forage abundance on subalpine barrens.

The Effect of Fire

Here we are interested in the possible past role of range destruction in the caribou decline 1915 to 1930 and the current impact of range destruction by fires on the extent of winter range. There is no historical suggestion that range destruction by fire caused the caribou decline of 1915-1930. Ranges that were burned 1915-1930 could still be recognized during this investigation. The only extensive sections of potential winter range destroyed were on the Gaff Topsails and the Avalon Peninsula. Large fires occured on the Avalon in 1904, 1908, 1909, 1920, 1927 and 1929. Further, snow depths

TABLE 6. — Multiple correlation analysis of the influence of lichen cover and lichen height on lichen weight for 19 ranges.

Simple correlation coefficients	
Lichen cover and height..	r = 0.592 ($P < 0.01$)
Lichen cover and weight..	r = 0.863 ($P < 0.01$)
Lichen height and weight.	r = 0.818 ($P < 0.01$)
Partial correlation coefficients	
Lichen cover and weight (height constant)........	r = 0.817 ($P < 0.01$)
Lichen height and weight (cover constant)........	r = 0.754 ($P < 0.01$)
Multiple correlation coefficient	
Combined affect height and cover on weight.....	r = 0.943 ($P < 0.01$)

were below average in the years of decline, 1915-1930. Thus, I can see no correlation between the frequency of forest fires and decline of the herds.

Damman (1964) provided a comprehensive analysis of forest succession in central Newfoundland following burning and logging. I have summarized his findings for potential caribou habitat in lichen woodlands and closed-canopy forests in Figure 10. Forest fires would improve shrub and terrestrial lichen supplies if they caused closed-canopy forest sites to revert to lichen woodland or shrub barrens. Fires would reduce food supplies on lichen woodland sites if such areas became permanent shrub barrens (loss of the tree stratum).

In this study 1 of 7 closed-canopy sites developed a subclimax of lichen woodland. In the 6 other areas closed-canopy tree cover was regenerating. But even in these areas the fires improved shrub and lichen supplies in the interval 15 to 35 years after the burn.

A hot fire in 1961 destroyed 770 square miles of forest in northeastern Newfoundland (Figure 1B). Considerable acreage was marginal spruce forests. Some of this land will regenerate to lichen woodlands. A large area of potential range for caribou has been created.

In the 9 disturbed lichen woodlands investigated there was no evidence that the fires had altered the sites to permanent shrub barrens;

TABLE 7. — Species composition of the 13 most important shrubs on the winter ranges used by the various populations of the Interior Herd and the Avalon and Humber Herds.

Evergreen and Deciduous Woody Shrub Species	Interior Herds							Avalon Herd	Humber R. Herd
	Western			Central		Eastern			
	2	6	7	3	4	9	10	1	12
Kalmia angustifolia	10	8	8	10	14	16	23	11	27
Chamaedaphne calyculata	12	13	4	9	11	3	4	2	10
Ledum groenlanicum	1	3	2	4	4	6	5	3	5
Vaccinium Vitis-Idaea	2	1	3	2	3	6	5	3	—
Empetrum nigrum	1	8	3	5	5	2	1	18	tr.
Empetrum Eamesii	7	4	tr.	tr.	1	—	—	—	—
Kalmia polifolia	tr.	tr.	tr.	2	2	tr.	tr.	tr.	3
Andromeda glaucophylla	tr.	3	tr.	2	tr.	tr.	tr.	tr.	1
Vaccinium Oxycoccos	tr.	—	—	tr.	tr.	tr.	tr.	tr.	1
Total Evergreen Shrubs	32	38	19	34	41	34	39	37	47
Vaccinium angustifolium	10	9	8	5	10	7	7	8	3
Vaccinium uliginosum	12	3	17	3	—	tr.	—	10	—
Rhododendron canadense	2	1	1	2	3	3	6	tr.	1
Myrica Gale	2	2	5	tr.	2	1	tr.	5	tr.
Others	2	tr.	3	tr.	2	tr.	tr.	tr.	tr.
Total Deciduous Shrubs	27	15	33	10	17	12	14	23	4

*Numbers refer to location numbers in Figure 2.

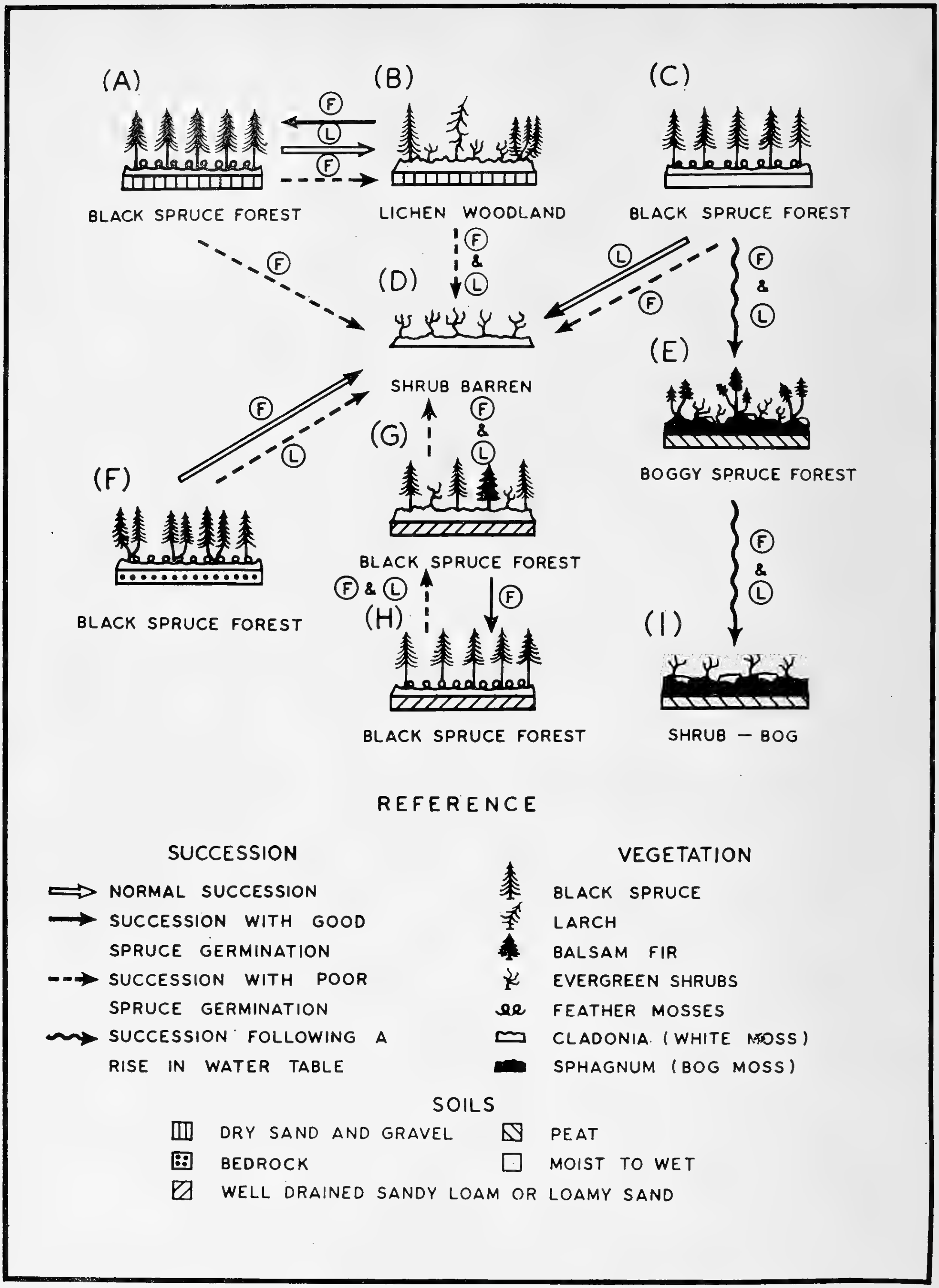

FIGURE 10. Forest succession of lichen woodlands and spruce forests following logging (L) and fires (F), adapted from Damman (1964). The probable value of the forests for caribou winter range in descending order is: B, G, D, I, E, and F; A, C, and H are probably of little value as winter ranges since they contain feather mosses rather than *Cladonia* lichens and accumulate snow.

scattered spruce were common at all sites. The immediate effect of the fires was to reduce the abundance of lichens for at least 30 years. However, evergreen shrubs which are equally as important as ground lichens in the winter diet (Bergerud 1971) were abundant on at least one site 6 years after the fire.

The role of fire on forage resources in the subalpine is less clear. It is generally conceded that fires assist the "barren devil" in altering the forest line in favor of barren. Ahti (1959: 23) felt that much of Newfoundland's tree-less habitat was fire caused. Cormack, the first man to cross Newfoundland in 1822, noted vast savannas and plains in the interior and indicated that they exhibited proof of once having been burnt.

An immense section of subalpine habitat in southeastern Newfoundland has been repeatly burned. Milais (1907) traveled this region in 1902 and found it nearly treeless. The largest and most recent fire burned 500 square miles in 1961 (Figure 1B). This range will be recolonized by shrubs within 10 years of the fire and the reindeer lichens will regenerate in quantities 20 years after the fire, but there will be no trees for many decades. The terrain is quite level so that the wind does not sweep snow from extensive areas. Thus, the absence of the tree stratum will likely prevent caribou from using this range except in years of reduced snow cover.

In assessing the role of fire on forage abundance in the subalpine zone two regions might be distinguished, (1) a near-alpine section characterized by 6-inch to 3-foot high conifer mats, and (2) the remainder of the subalpine zone with scattered taller conifer clumps, and lone spruce and larch trees. Near tree-line topography frequently rises so gently that these types can exist in a meshed patchwork laced with level savannas.

An initial fire is of benefit in the near-alpine in destroying the conifer mats. These woody plexuses prohibit the use of understory lichens by caribou. Such areas are avoided by caribou. For example, caribou on the Avalon Peninsula each year in December and January grazed a subalpine highland that was free of low fir and spruce. These hills had lost their conifer mat by a fire earlier in the century. Immediately north of this range was a series of hills that displayed the same physiography but were blanketed with a low conifer mat. Never in 10 years did I find large numbers of caribou in these green hills. Snow was soft in such mats and difficult, at least for man, just to wade through. Then too, such tangles held snow and reduced the total area of slopes blown bare of snow.

The assessment of fire in the remainder of subalpine requires further study. If such fires permanently eliminated conifers, especially larch, they would be detrimental. However, scattered larch are frequent in the central interior which has a history of fire.

There is no easy generalization that will allow a clear conclusion on the role of fire and food abundance for all sites. A large fire on a key winter range would cause the animals to vacate. Yet I have no evidence thats such displacement would result in winter starvation. I believe that many past forest fires in Newfoundland have benefited caribou in the long view of forest succession. Such fires reduced closed-canopy forest and permitted lichen and shrub strata to develop. On subalpine sites fires reduced prostrate spruce and fir; this removal improved the availabilty of lichen and shrub stands that later developed.

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Birds of Resolute, Cornwallis Island, N.W.T.

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The Char Lake Project is one of Canada's contributions to the International Biological Program and is a study of the biological energetics of an artic lake; Char Lake itself is located about two miles south and east of the Resolute airport base and about one mile north of Resolute Bay. While working for the Char Lake Project from May 14 to September 26, 1969, I had many opportunities to observe the birds of the area. Previously published bird observations from Cornwallis Island are essentially limited to two accounts, both published in the United States: in 1947 A. J. Duvall and C. O. Handley, Jr. (1948) visited the area from August 16 to 22 and from August 30 to September 13; and in 1956 E. K. Urban (1957) was at Resolute from July 21 to August 24. Thus, largely because of Resolute's remoteness, it seems no ornithologist has ever spent an entire summer there, and of the thirty species which I recorded there are eight for which no previous record exists from Cornwallis Island.

My work with the Char Lake Project naturally limited the time available for bird observations, and therefore a complete picture of the breeding season cannot be given: certain productive areas could seldom be visited, little time could be spent searching for nests, and those nests which were discovered could not be checked frequently. The area which could be covered was also limited: most of the observations were made within three miles of Char Lake, although one trip was made on foot fifteen miles east along the south coast to Assistance Bay, and excursions northwest of Resolute by Bombardier vehicle reached twelve miles once and about five miles several times. Nevertheless, the following list probably contains most of the species that can be expected near Resolute. Included are the five species which I did not observe but for which previous records exist.

Red-Throated Loon. *Gavia stellata.*

This species was seen frequently near most of the lakes near Resolute throughout the summer. It was first identified on June 27, when two pairs were seen on Meretta Lake; however, reports of "small black geese" near this lake had been received for two or three days previous to this sighting, and I feel that these reports probably referred to loons. On this date Meretta Lake had a strip of ice-free water(less than 50 yards wide) along the north and east shores, but no other nearby lake had any significant area of open water.

On August 6, one of our party reported that a loon on the north shore of Meretta Lake had been acting as if it had a nest there, and two days later the nest was found. It was a small mound of mud and vegetation in shallow water about two feet from shore, and the two eggs in it were being splashed continually by spray from waves caused by a strong southeasterly wind. The nest was empty on August 15, but no young loons were ever observed on Meretta Lake.

On September 7, two adults with two large but flightless young were found on a fairly large pond on the east side of the road from the airport to the harbour. The water was a maximum of three to four feet deep and presumably contained no fish, but many crustaceans could be seen swimming about. On September 11 only one adult was with the young birds, and the pond was frozen over except for a long narrow strip of water near the north shore. On this date the two young birds were caught in gill nets; they were later taken to the Royal Ontario Museum by Mr. J. E. "Red" Mason and are now Nos. 105508 and 105509 in the Museum's collection. In view of Urban's (1957) observation of a pair of loons with two young on August 12, 1956, the dates for the Meretta Lake nest, and the nearness of freezeup, September 11 seems a very late date for young loons to be still flightless; possibly they were the result of a second nesting attempt made after a failure at Meretta Lake. However, Duvall and Handley (1948) report a fairly large but downy young loon near Allen Bay on September 3, 1947; they believe that this loon hatched about August 15. They also saw many loons on the ocean, although they were observed only in fresh water in 1969.

Loons were common until about the first week in September of 1969, after which they were rarely seen. On September 14 the last was sighted on partly-frozen Resolute Lake and shortly after this all the lakes were completely frozen over.

NORTHERN FULMAR. *Fulmaris glacialis.*

Although we visited the open sea on June 29 and 30, 1969, and walked along the coast to Assistance Bay on July 7 and returned on July 8, no fulmars were seen. However, a great many (probably about 1000) were seen on the open water between Cape Martyr and Griffith Island on July 26. Most of these were far out on the water, but some were feeding just a few feet off shore. From this date until September 26 fulmars were usually seen on walks along the coast, and were frequently in Resolute Bay after the ice was gone. The only other large concentration was observed on September 11, when at least a thousand were found along the coast from Resolute Bay to Cape Martyr. The phase of most of these birds was light, while some were moderately dark and a few were distinctly dark.

Duvall and Handley (1948) and Urban (1957) also saw many fulmars during their visits to Resolute.

SNOW GOOSE. *Chen caerulescens.*

Although there are breeding records for many places to the north, east, and south of Cornwallis Island, there has apparently been no record at all of Snow Geese on Cornwallis itself. In 1969, however, a flock of eleven landed near the northeast corner of Char Lake on June 5. They fed busily on moss and grass where the snow had melted, allowing some of our party to approach within fourteen yards. The flock was photographed that evening but could not be found on June 6. This species was sighted on only two other dates: on the morning of June 13 a pair flew north over Char Lake, and about noon that day a pair was seen feeding near the same spot where the larger flock had been on June 5; and on June 18 another pair flew north over Char Lake.

BRANT. *Branta bernicla.*

This species was not identified in 1969. Reports of "small black geese" near the end of June almost certainly referred to Red-throated Loons, but two other sightings may have been Brant. On June 14 one of our party observed seventeen "large dark ducks" flying north along the shore of Char Lake, and about September 5 one of the mechanics from the base (who seemed fairly knowledgeable of waterfowl) reported a "small flock of small black geese" in the grass along the shore of the pond from which the two young loons were taken.

Preble (1908) says, "Sutherland recorded [Brant] as common and probably breeding at Assistance Bay, July 7, 1851." Six of our party walked to Assistance Bay on July 7, but we saw no Brant; however, we did not reach the low part of the shore at the very bottom of the bay, and thus would have missed any that may have been there.

Duvall and Handley (1948) report possible sightings of Brant on August 31 and September 4, 1947.

OLDSQUAW. *Clangula hyemalis.*

Only two Oldsquaws were seen in 1969. These were a male and a female in a small pond just north of Meretta Lake on June 24. Apparently in other years it has been more common: Urban (1957) in 1956 saw fifty east of Resolute Bay on July 15, two in Resolute Bay on July 17, and a female flying two miles inland on July 22; Duvall and Handley (1948) observed a flock of twenty, consisting of adults and nearly full-grown young, near Allen Bay on August 17 and September 3, and eight off Cape Martyr on September 7, 1947.

COMMON EIDER. *Somateria mollissima.*

This species is a locally common breeder. In 1969 it was first seen on our first trip to the open sea near Prospect Point on June 29, when two flocks, each consisting of one female and two males, were seen flying along the edge of the sea ice. On July 7 and 8, eight nests were found just west of Assistance Bay: one was about two hundred yards from Victory Lake, and the others were about half a mile from the ocean quite high up the sloping rocky coast. This slope was generally very barren of plants, but the nests were either in a clump of *Dryas* or on a small mound of vegetation gathered by the bird. The amount of down lining the nests seemed to vary with the number of eggs: two nests with only one egg each had no down, a nest containing two eggs had only a little down, and the others (2, 4, 5, 5, and 6 eggs) had a considerable amount. In all cases the female left the nest when we were about a hundred yards away, and the nests were fairly hard to find; in one instance, the female defecated as she flew off, and we were able to find the nest by smell. On the ocean near these nests on July 8 was a flock of about thirty-five Common Eiders of which about thirty were males, and many individuals and small flocks were scattered along the coast for some distance west of Assistance Bay.

In 1956 it seems this species may have bred closer to Resolute. Urban (1957) saw fifteen adult males east of Resolute on July 15, a female with four young on Resolute Lake on July 28, and fifteen females with ten young on Resolute Bay on August 12. Duvall and Handley (1948) found about 115 eiders of undetermined species (females and nearly grown young) in Assistance Bay and along the beach to the west on September 7, 1947.

KING EIDER. *Somateria spectabilis.*

This species was much less common in 1969 than was *S. mollissima.* A male and a female were seen at the edge of the sea ice near Prospect Point on June 29, and another pair was observed in this same area on July 7. Urban (1957) reported that eight adult males were seen near Assistance Bay on July 15, 1956. Duvall and Handley (1948) saw a female with three downy young on a pond near Allen Bay on August 17, 1947, and on September 3 the two remaining young (one having been collected) were well feathered; these same observers also report two females and seven young three-quarters grown on a pond near Resolute Bay on September 9.

GYRFALCON. *Falco rusticolus.*

The Gyrfalcon apparently occurs occasionally at Resolute, for two were seen there by A. H. Macpherson and S. D. MacDonald in late September, 1954 (Manning, Höhn, and Macpherson, 1956). None was seen in 1969, nor do Duvall and Handley (1948) or Urban (1957) report seeing this species.

ROCK PTARMIGAN. *Lagopus mutus.*

On the basis of flushing a pair of Rock Ptarmigan on August 5 and 11, 1956, from the Eskimo ruins on the south side of Cape Martyr and their reluctance to leave the area, Urban (1957) suggests this species may nest near Resolute. In 1969, however, none was seen during the nesting season, although Mr. D. Hussell reported one between Char Lake and the airstrip about June 7. The next sign was a track at Cape Martyr seen by Mr. J. E. "Red" Mason on September 13, at which time one of the Eskimos told us that they hunt ptarmigans a little later in the year. On September 23, three ptarmigans flew north along the Cape Martyr coast and landed just north of the cape; a little later that day fresh tracks and droppings were found near the south end of Cape Martyr. Duvall and Handley (1948) found two Rock Ptarmigan on the east side of Resolute Bay on August 18, 1947.

RUDDY TURNSTONE. *Arenaria interpres.*

Although there are no previous records of this species from Cornwallis Island, in 1969 turnstones were fairly common spring migrants, and one was seen in the fall; apparently none stayed to breed near Resolute. They first appeared on June 5, when six were at the town dump. The next day four were seen near the stream (still frozen) which enters the northeast corner of Char Lake. From this date until June 18, from one to six could usually be found at the dump or along the stream running south from it to Meretta Lake. One more individual was seen on June 27, but the species was not sighted again until one bird was found on the sea coast about three miles north and west of Resolute on September 14.

KNOT. *Calidris canutus.*

One very brightly coloured Knot and two in somewhat duller plumage were seen beside the stream that ran south from the town dump on June 27, 1969. The only previous record for Cornwallis Island is a sighting by Duvall and Handley (1948) of an adult in summer plumage on September 3, 1947.

PURPLE SANDPIPER. *Erolia maritima.*

In 1969, one was seen by Mr. D. Hussell on June 7 at the town dump, but it could not be found the next day. Later in the spring many migrants passed through, seen mostly along the stream flowing south from the dump: two were seen on June 24, about twenty on June 27, and about a dozen on July 2. Most of them apparently then moved on, for on my next visit to this area, only one was seen. Three summer observations were made: on July 14, two were on the north shore of a small pond just south of Resolute Lake; on July 26 possible distraction behaviour was performed by a single bird south-west of Resolute Lake (however, these birds were normally quite tame); and on July 31 a lone bird was seen on the ice along the east coast of Resolute Bay. The last sighting of the year was a group of three, in fall plumage, on the sea coast about three miles north and west of Resolute on September 14. It should be noted that most of the inland water was frozen by the time these fall migrants were seen, and since little time was spent along the coast at this time of the year, this species may be more common as a fall migrant than this one observation might indicate.

Duvall and Handley (1948) found Purple Sandpipers comon along the coast throughout their visits to Resolute in late August and early September of 1947. Most of the birds they observed were in immature plummage, but some were adults in winter plumage or with traces of nuptial plumage. Urban (1957) saw this species "uncommonly" during late July and the first three weeks of August, 1956.

WHITE-RUMPED SANDPIPER. *Erolia fuscicollis.*

There is no previous Cornwallis Island record of this species, and only one individual was seen in 1969. This one bird was beside the stream south of the town dump on June 27 with a flock of Purple Sandpipers, Knots, and Sanderlings.

BAIRD'S SANDPIPER. *Erolia bairdii.*

This species is probably an uncommon breeder near Resolute, but it was not seen in 1969 until July 24 when a single bird was observed near a small stream which flows into the northeast corner of Char Lake. This bird would allow me to approach fairly closely, then it would call and run away, but if I walked away from it, it would fly and land in front of me; however, no nest was found. A Baird's sandpiper was also seen on the north shore of Char Lake on July 25.

On August 12, an adult and three young were found on the northwest shore of Char Lake. The adult feigned injury and attempted to lead me away from the young birds, which stayed close together. The young had distinctly buffy upper breasts and the plumage of their heads was somewhat downy, but they could fly well.

Duvall and Handley (1948) saw this species later in the year, counting as many as nineteen on August 18, ten on September 4, and one as late as September 9, 1947. Urban (1957) captured two young by hand on July 28, 1956, and saw occasional small flocks near the middle of August.

SANDERLING. *Crocethia alba.*

In 1969 Sanderlings were first seen on a cold and snowy June 5 when a flock of about twenty was at the town dump. This same flock apparently stayed until June 8, but on June 10 only eight were seen, and on June 11 there were only three. Two birds which always were seen together and may have been a nesting pair were observed near Meretta Lake on June 24, June 27, July 2, and July 9. No sanderlings were seen after this date.

However, Duvall and Handley (1948) report that during their visits to Resolute in 1947 this species was the most abundant shore bird. Their peak counts were 37 on August 18 and 25 on September 4 at Resolute Bay, and 16 on August 17 and 10 on September 3 at Allen Bay; their latest observation was of two individuals on September 9. All these birds were seen along the coast.

RED PHALAROPE. *Phalaropus fulicarius.*

The only previous Cornwallis Island record of this species is one adult seen by Duvall and Handley between Resolute Bay and Assistance Bay on September 7, 1947 (Duvall and Handley 1948). However, on June 24, 1969, a male and a female were seen in a marsh where the stream from the town dump enters Meretta Lake. On July 9 a nest containing four eggs was found in this marsh; the eggs were still unhatched on July 14. On July 20 the nest was empty, but, although one eggshell lay near the nest and the male was nearby acting "tame" and nervous, no young were seen. One young bird, which could fly well, was seen near the marsh on August 6.

No more Red Phalaropes were seen until September 11, when three were observed in the ocean near the Eskimo village. Two of these were quite pale with grey patches on the back, while the other was darker with a dusky upper breast.

POMARINE JAEGER. *Stercorarius pomarinus.*

The only Cornwallis Island record of this species is one individual seen by Urban (1957) on August 11, 1956, one hundred yards inland from Allen Bay.

PARASITIC JAEGER. *Stercorarius parasiticus.*

This species was not positively identified in 1969 until June 30, when five were seen on the coast near the Eskimo village. However, a jaeger at the town dump as early as June 13 was probably a Parasitic, as were two about a mile inland from Allen Bay on June 15. Throughout July and August Parasitic Jaegers were seen regularly everywhere we went. Although no nests were found, it seems probable that they did nest in the area; specimens from Resolute in the National Museum of Canada include a flightless juvenal (Manning, Höhn, and Macpherson 1956). The last positive identification of this species was a sighting on September 2 of the pair that was normally near the town dump and Meretta Lake, but two unidentified jaegers in this same area on September 7 were probably parasitic. Much time was spent looking for birds both inland and along the coast on September 11, 12, and 14, but no jaegers were seen. About one-third of the Parasitic Jaegers observed were in the dark phase. Only one intermediately coloured individual was seen.

Duvall and Handley (1948) and Urban (1957) also found this species common near Resolute.

LONG-TAILED JAEGER. *Stercorarius longicaudus.*

Long-tailed Jaegers were rare near Resolute in 1969: on June 15, three flew towards the northwest about a mile inland near Allen Bay, and one was seen on July 7 near Prospect Point at the edge of the open sea. One member of our party, however, reported at least two pairs of this species near Snow Blind Creek (on the east coast of Cornwallis Island) on August 12.

Urban (1957) reports only one individual (on July 15, 1956), and Duvall and Handley (1948) saw only three (on September 3, 1947).

GLAUCOUS GULL. *Larus hyperboreus.*

The first gulls identified in 1969 were about 90 adult Glaucous Gulls at the town dump on May 28, although two "seagulls" reported by a bus driver on May 23, and a few other individuals seen between these dates, may have been this species. The flock at the dump grew to about 125 by June 5 and remained at this size until it began to disperse in the third week in June. All the birds seen were adults, until on June 27 two white second year birds were seen. On July 8 a few were observed on the cliffs forming a river gorge near Victoria Lake, where it appeared they may have been nesting. By July 14 only a few remained at the dump, and the species was rarely seen throughout the rest of July and August. In the second week in September many were again seen, on the ocean now. On September 14 several juvenal birds were observed apparently begging to be fed, but they were ignored by the adults. On my last walk along the coast on September 23 about twenty were seen, most of which were immatures.

Duvall and Handley (1948) found Glaucous Gulls common throughout their visits. They suggest possible nesting on the ground at Allen Bay on September 3, 1947, and report that the first juvenile birds were seen on September 7. Urban (1957) also recorded the species as common during his visit.

THAYER'S GULL. *Larus thayeri.*

Three individuals sitting near Resolute Bay on June 3 were the first of this species seen in 1969. On June 5 about half a dozen had joined the Glaucous Gulls at the dump, and from June 7 to July 14 there were usually about forty in this flock. The first immatures seen were two near Meretta Lake on June 27. On the same cliffs near Victory Lake where Glaucous Gulls were observed on June 8 were some Thayer's Gulls; it appeared that they also may have been nesting. This species also was seldom seen during the rest of the summer, probably due to a lack of visits to the proper habitat. In the second week in September some were seen on the ocean, but they were always outnumbered by Glaucous Gulls. The last adults were seen on September 14 about four miles north and west of Resolute, at which time some dark immatures were also present. On September 23, on a walk around Cape Martyr, only a few immatures were found.

Duvall and Handley's (1948) *Larus argentatus* ("Thayer gull") and Urban's (1957) *L. argentatus* ("herring gull") both probably refer to *L. thayeri*. Duvall and Handley report the species to have been common during their visits; they first observed young of the year on September 3, 1947, and migrant flocks were seen on September 4. Urban found the species common throughout the summer of 1956.

IVORY GULL. *Pagophila eburnea.*

About half a dozen were found apparently feeding on seal carcasses on the sea ice near the Eskimo village on June 30, 1969. The species was not seen again until September 9, when one was seen flying over Resolute Bay. On September 12, six adults and one immature were observed resting on a small ice floe grounded on the west shore of Resolute Bay.

Urban (1957) saw one Ivory Gull at Allen Bay on August 11, 1956. Duvall and Handley (1948), however, recorded many more in 1947. They saw four flying over Resolute Bay on August 16, but did not see others until September. They then report seeing them on several occasions, including an immature on September 3, at least 200 on September 8, and many on September 13, all near Resolute Bay. They also saw at least 50 resting on the water between Resolute and Assistance Bays on September 7.

BLACK-LEGGED KITTIWAKE. *Rissa tridactyla.*

Kittiwakes were first seen in 1969 on June 29, on our first visit to the open sea, when several were flying along the edge of the sea ice. A few were also seen along the coast on June 30 and July 7. None was seen for about six weeks thereafter; in particular, a walk around the entire shore of Cape Martyr on July 26 failed to produce any. On August 21, however, about 50 were diving like terns (possibly feeding on the many amphipods which could be seen swimming in the water) in a bay about three miles north and west of Resolute, and the species was fairly common from that date on. One young bird was seen on September 7, and about ten immatures were with a mixed flock of gulls on September 14. Kittiwakes were last observed on September 23, when several small flocks flew south along the coast of Cape Martyr and apparently gathered offshore near the Eskimo Village in two larger flocks totalling about 150 birds.

Duvall and Handley (1948) found this species common throughout their visits; their counts included one immature at Allen Bay on August 30, at least 300 adults in Resolute Bay on September 4, and 100 adults at Assistance Bay on September 7, 1947. Urban (1957) saw only one kittiwake, an adult at Allen Bay on August 19, 1956.

SABINE'S GULL. *Xema sabini.*

In 1969 only two Sabine's gulls were seen. The first was an adult feeding just a few feet off shore on the west coast of Cape Martyr on July 26. The other was an immature seen with a flock of Kittiwakes, Glaucous Gulls, and Thayer's Gulls on the coast about four miles north and west of Resolute on September 14.

The only other record of this species for Cornwallis Island is of one adult reported by Duvall and Handley (1948) in Resolute Bay on September 8, 1947.

ARCTIC TERN. *Sterna paradisaea.*

This species was common throughout the summer of 1969. Many were seen on our first walk to the open sea on June 29, and they often fed in fresh water lakes and ponds later in the year. At Char Lake the first one was observed diving in the narrow strip of open water along the shore on July 7, and up to thirteen were seen on other occasions until about the end of August; these were invariably feeding in the shallow water at the edge of the lake or in a shallow pond into which the lake emptied.

One nesting colony was discovered on the east coast of Resolute Bay. On July 7 about 100 were flying about at this location, but a brief search for nests failed to reveal any. On July 16 I returned to the same spot and found four nests. Two of these had two eggs each and the others each had one. The nests were simply rounded depressions in the sand, and a great many such hollows were found without eggs. Again about 100 terns were in the area; they appeared only somewhat excited by our presence. One was found dead in the colony, and it is now No. 105506 in the collection of the Royal Ontario Museum. On July 31, three of the nests previously discovered were empty, but the fourth still contained two eggs.

Terns were seen on almost every walk along the seacoast and often were inland at fresh water. Of about thirty seen on the coast about three miles north and west of Resolute on August 21, four showed some excitement as I approached, but no nests or young were found. In the third week in August about thirty were observed flying about an island in a small shallow lake a mile or two inland about six miles north and west of Resolute; this may have been a nesting colony. On September 11 terns were still common over the ocean, and one bird was seen which was either an adult in winter plumage or an immature. However, only about half a dozen were seen on a walk along the coast on September 14, and none was seen while walking around the whole of Cape Martyr on September 23.

Duvall and Handley (1948) found Arctic Terns common near Resolute in 1947, counting 200 at Allen Bay, 100 at Resolute Bay on August 18, and 15 at Assistance Bay on September 7. Their latest sighting was ten birds on September 11. Urban (1957) observed this species commonly in 1956 as well, and he reports a young bird on August 12.

THICK-BILLED MURRE. *Uria lomvia.*

In 1969 this species was recorded only early in the summer. Hundreds were found along the edge of the sea ice near Prospect Point on June 29, and while walking to Assistance Bay on July 7 and returning to Resolute on July 8 many birds were seen which were probably this species, but only one was close enough to shore to be positively identified. No other murres were seen although I walked considerable distances along the seacoast on July 26, August 21, and September 11, 14, and 23.

Urban (1957) observed over a hundred murres east of Resolute on July 15 and one on August 11, 1956. Duvall and Handley (1948) did not record this species.

DOVEKIE. *Plautus alle.*

The only Cornwallis Island record for this species is one individual seen by Duvall and Handley (1948) on September 7, 1947.

BLACK GUILLEMOT. *Cepphus grylle.*

Black Guillemots were seen on only three occasions in 1969. Several were observed at the edge of the sea ice near Prospect Point on June 29, two were east of Prospect Point on July 7, and six were found off the west coast of Cape Martyr on July 26. None was seen during walks along the coast on August 21 and September 11, 14, and 23.

Urban (1957) also reports guillemots on three dates: July 15 (two birds east of Resolute Bay), August 5 (fifteen), and August 11 (six at Allen Bay). Duvall and Handley (1948) did not record this species.

SNOWY OWL. *Nyctea scandiaca.*

Only one was seen in 1969. On August 30 it flew over Char Lake, pursued by a jaeger, and disappeared to the northwest after landing briefly at two spots on the shore of the lake. There appears to be no previous record for Cornwallis Island.

HORNED LARK. *Eremophila alpestris.*

This species was seen on two widely separated dates in 1969. One individual was found along the stream flowing south from the town dump on June 27, and one was among a flock of about 35 Snow Buntings at the mouth of the Meecham River on September 11. There is no previous record for Cornwallis Island.

BARN SWALLOW. *Hirundo rustica.*

On June 24, 1969, a Barn Swallow too weak to fly strongly enough to avoid capture by hand was found in the town garage. Its weight at the time of capture was 11.1 grams; other details may be found in the Canadian Field-Naturalist (James and Barlow, 1970). This is the first record for this species on Cornwallis Island.

COMMON RAVEN. *Corvus corax.*

Only three ravens were seen in 1969. On June 7 one flew north over Char Lake, on June 8 one landed briefly on the shore of the lake, and on June 13 one flew north over the town dump. There is no previous record for the species on Cornwallis Island.

SAVANNAH SPARROW. *Passerculus sandwichensis.*

A specimen collected at Resolute on September 4, 1954, by J. A. Crosby (Godfrey, 1956) is the only Cornwallis Island record for this species.

LAPLAND LONGSPUR. *Calcarius lapponicus.*

One individual at the dump on June 5, one along the stream south of the dump on June 24, and one in a small marsh west of this same stream on June 27 were the only sightings of longspurs in 1969. All three were males. There is no previous Cornwallis Island record.

SNOW BUNTING. *Plectrophenax nivalis.*

Snow Buntings were by far the commonest land birds. For the first week after my arrival at Resolute on May 14, 1969, this was the only species seen, but a few individuals (all males) were observed on several days during that week. They were usually found feeding on gravelly ridges blown bare of snow. The first larger flocks consisted of about a dozen birds at the town dump on May 29 and about twenty near Char Lake on June 6, and from this date onward they were seen relatively commonly almost everywhere near Resolute. Singing became noticeably more frequent during the second week in June.

On June 26 a female was seen building a nest under a rock on the shore of Char Lake. This nest contained two eggs on the evening of June 29, four on July 1, and six on July 7. On July 14 one of our party reported that in late afternoon at least one egg had hatched, and in the evening of July 15 the nest contained at least four young and one egg; since only one egg was later found unhatched, there were probably five young. The young left the nest on July 27, and it is interesting that in September a lemming moved into the nest, remodeling the feather lining to suit his own needs.

Three other nests were found. One was under a small piece of plywood on the ground near the town dump; on July 2 it contained six eggs, of which two hatched about July 8 and four did not hatch although the female apparently tended them until at least July 20. Another was in an upright oil drum filled with gravel to within about four inches of the top, which was partly peeled upwards; the seven young, which were well-developed on July 14, left the nest about July 20. The third was under a flat rock high up on a barren hill north of Char Lake; there were at least two young in the nest on July 24, but they were out on the hillside near the nest on July 26.

By the middle of August, the Snow Buntings seemed to be congregating in relatively large flocks, usually near dumps and the Eskimo village. The largest single flock consisted of about 100 birds at the town dump on September 2, but smaller flocks could be found until my departure on September 26.

Duvall and Handley (1948) and Urban (1957) also saw many during their respective visits to Resolute.

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Notes

The Recent Status of the Marten, *Martes americana americana* (Turton), in Nova Scotia

Abstract. The history of marten in Nova Scotia is traced from 1672 to the present. A re-introduction in 1956 apparently met with limited, if any, success. Records indicating the presence of a few animals are presented for the period 1957-1967.

Marten were first mentioned in the literature by Denys (1672: 382) who noted "As for Marten, it is sufficiently well known; it is seen in France. They keep themselves as rule rather far in the woods". Denys further observed that Indians used marten for robes.

According to the Minutes of Hudson's Bay Company for the years 1679-1684 (1945: 28 and 73), over 1500 marten skins were handled in a single shipment. Marten were also mentioned by Le Clerc (1691: 285) and by Dierville (1708: 129). Gilpin (1867: 11) stated that at the time about one thousand skins were exported annually from Nova Scotia. Hagmeier (1956: 158) noted that according to Coues (1877) and Bailey (1896) they were once common in the Province, and that according to Rowan (1876) they were present on Cape Breton Island.

Apparently their numbers dropped rapidly after this and no mention was made of marten in the 1912 Report of the Game Commissioners of Nova Scotia. Rand (1933: 45) stated that he heard of one being taken some years earlier and Smith 1940: 226) noted that marten were still found in restricted areas and were reported from the Liscomb Game Sanctuary in 1932. Rand (1944: 90) stated that one skin had been exported in 1931-32 and that tracks were seen in the Liscomb Game Sanctuary during the winters of 1930-31 and 1931-32. Rand (*Ibid.* after Anderson, 1941) noted that a few marten still existed in Cape Breton Highlands National Park in 1935, although they were close to extinction in most parts of the province. According to Anderson (Clarke, 1942), Warden John Roach felt that there was a good nucleus of breeding stock in the park in 1941, and Rand (1944: 90) felt they would persist. Hagmeier (1956: 158) reported that Benson said two were trapped in the park in 1954.

In April, 1956, five male and seven female marten, wild trapped in Ontario, were released in the Liscomb Game Sanctuary by Forestry Division personnel of the Department of Lands and Forests.

TABLE 1. — Observations, collections and track sign of Nova Scotia Marten 1957–1969.

Year	Month	County	Area	Collected	Observed	Tracks
1957	January	Halifax	Dog Lake		1	
1959		Victoria	Ingonish	1		
1961	March	Queens	Porcupine Lake			1
1961	April	Cumberland	Chignecto Sancturay			1
1964	January	Annapolis	Parkers Cove		1	
1964	August	Halifax	Musquodoboit Harbour		1	
1965	January	Annapolis	Dargie Lake			1
1965	January	Annapolis	Victoria Beach			2
1965	January	Annapolis	Evans Brook			1
1966	December	Yarmouth	Spring Haven			1
1966	February	Cape Breton	North side of East Bay			1
1967	February	Cumberland	Big Lake			1
1969	December	Inverness	North East Margaree	2		
Total				3	3	9

No effort to effectively evaluate the introduction was made.

In 1961 an effort to systematically record marten observations and reports of marten sign made by Wildlife Conservation Division personnel of the Nova Scotia Department of Lands and Forests was begun. Table 1 presents data accumulated by this means. The 1957 observation may have been an animal released in 1956 since it was seen a few miles from the release site. The pelt from the specimen collected in 1959 is presently in the Acadia University Museum (museum number MA 711). The pelts of the two specimens collected in 1969 are also in this Museum (MA 813 and MA 814).

Besides the data presented here, numerous reports suggest the occurence of local populations, particularly on Cape Breton Island where they were reported as being present in the Forest Glen area of the Upper Margaree Valley in 1961 by Wildlife Conservation Division personnel.

It appears that a few marten still exist both on mainland Nova Scotia and on Cape Breton Island and that these animals are sparsely distributed in major areas of continuous woodlands. The fact that this mammal is particularly easy to trap, along with the known extensive trapping pressure existing in years past in Nova Scotia, may well be a partial cause for the decline in marten numbers. Extensive burning, logging and settlement must also be considered as probable causes for the decline.

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The Recent Status of the Fisher, *Martes pennanti pennanti* (Erxleben), in Nova Scotia

Abstract. The history of Fisher in Nova Scotia is traced from 1708 to the present. Re-introductions in 1947-1948 and 1963-1966 are discussed. Release data 1947-1966 and collection-observation records 1961-1968 are presented. It appears that fisher are now successfully re-established in the Province.

Dierville (1708: 129) noted that fisher (Peccan) occurred in Nova Scotia. In 1760, the Minutes of His Majesty's Council fixed the price of a fisher pelt as being equal to one pound of spring beaver, or three marten pelts. Gilpin (1867: 9) stated "Never very plenty, they are rapidly becoming

TABLE 1. — Fisher Release Data, Nova Scotia 1947–1966

Year	County	Area	Males	Females	Total
1947	Queens	Tobeatic Game Sanctuary	2		2
1948	Queens	Tobeatic Game Sanctuary	4	6	10
1963	Guysborough-Halifax border area	Liscomb Game Sanctuary	1	2	3
1963	Pictou		1	1	2
1963	Colchester	Glenmore	1	1	2
1964	Colchester	Glenmore	2	7	9
1964	Cumberland	Chignecto Game Sanctuary	3	8	11
1965	Lunenburg		1	1	2
1965	Colchester	Otter Brook	1	2	3
1965	Hants	Stanley	3	8	11
1965	Guysborough-Halifax border area	Liscomb Game Sanctuary	3	5	8
1966	Guysborough-Halifax border area	Liscomb Game Sanctuary	10	10	20
1966	Annapolis	North Mountain	2	4	6
1966	Colchester	Glenmore	1	2	3
Total			35	57	92

TABLE 2. — Nova Scotia Fisher Collected August, 1961– April 1970.

Year	Month	County	Area	Sex
1961	August	Queens	Flinn Lake	Male
1964	December	Digby	Margo Lake	?
1964–65	(winter)	Queens	West Caledonia	?
1965	December	Cumberland	Joggins	Female
1965	December	Cumberland	Collingwood	?
1966	January	Colchester	Stewiake	Female
1966	January	Cumberland	Westchester	Female
1966	February	Cumberland	Round Lake River Hebert	Male
1966	March	Cumberland	Collingwood	?
1966	December	Cumberland	Collingwood	Male
1966	December	Colchester	Lansdowne	?
1966	December	Colchester	Camden	?
1967	February	Digby	South Range	?
1967	February	Digby	Grande Lake	?
1967	December	Pictou	Union Center	?
1967–68	(winter)	Queens	No data	?
1968(2)	March	Annapolis	Milford	
1968	March	Digby	Bador Lake	
1968	March	Annapolis	Dalhousie	
1968	December	Annapolis	Dalhousie	
1968	November	Cumberland	Parrsboro	Female
1968	November	Cumberland	New Annan Mt.	?
1969	January	Halifax	No data	?
1969	January	Guysborough	Caledonia	?
1969*	January	Cumberland	Parrsboro	?
1969	January	Yarmouth	Forest Glen	?
1969(2)	February	Halifax	Middle Musquodoboit	?
1969	November	Yarmouth	Forest Glen	
1969	December	Cumberland	Springhill	
1970	April	Yarmouth	Richfield	

*Trapped alive and released.

TABLE 3. — Fisher Observations and Track Sign Recorded 1961–1969.

Year	Month	County	Area	Observed	Tracks
1961	July	Yarmouth	Clyde Lake		1
1962	May	Queens	Milton	1	
1962	December	Queens	6th Lake, Tobeatic Sanctuary		1
1964	May	Shelburne	Roseway Lake, Tobeatic Sanctuary	1	
1964	September	Queens	Lake Rossignol	1	
1964	June	Halifax	Musquodoboit Harbour	1	
1965	November	Pictou	Loch Broom	1	
1966	February	Cumberland	Collingwood	1	
1966	March	Pictou	Glengary		2
1966	March	Pictou	Cross (Drug) Brook		1
1966	March	Cumberland	Parrsboro	1	
1966	April	Cumberland	Kelly Road, Chignecto Sanctuary	1	
1966	May	Guysborough	Island Lake Road, Liscomb Sanctuary	1	
1966	July	Queens	Smith Lake Brook		1
1966	October	Lunenburg	Franey's Brook		1
1966	December	Cumberland	Collingwood		1
1967	February	Halifax	Granted Lake Road		1
1967	February	Colchester	Mount Thom		1
1967	March	Pictou	Dryden's Lake		1
1967	March	Cumberland	Moose River		1
1967	May	Shelburne	Jordan Falls	1	
1967	May	Cumberland	Kirkhill	1	
1967	June	Colchester	Riversdale		1
1967	June	Cumberland	Kirkhill	1	
1967	June	Cumberland	Collingwood	1	
1967	August	Colchester	Kemptown		1
1967	August	Cumberland	Chignecto Sanctuary	2	
1967	August	Cumberland	Collingwood	1	
1968	February	Antigonish	Browns Mt.		1
1968	February	Colchester	Riversdale		1
1968	February	Colchester	Burnside		1
1968	March	Cumberland	Ramshead River		1
1968	March	Pictou	Lorne		1
1968	June	Hants	Nine Mile Road		1
1969	February	Antigonish	Maryvale		1
1969	February	Colchester	Riversdale		1
1969	March	Annapolis	Harry Lake		1
1969	August	Cumberland	West Brook	1	
1969	October	Pictou	Dryden's Lake		1
Total				17	24

extinct in our province; from a hundred and fifty to two hundred are the utmost now taken yearly—". Rand (1933: 45) quotes Tyrell as stating it still occurred in the province in 1888 and Smith (1940: 226) noted that he knew of no records since 1922. Rand (1944a: 79, 1944b: 87) and Hagmeier (1956: 159 after Allen, 1942) also noted that fisher were extinct.

In 1947 and 1948 a total of twelve fisher, from ranch stock, were released in the Tobeatic Game Sanctuary (Benson, 1959: 451). Benson (*Ibid.*) felt that two fisher trapped, in 1955 and 1958, and his notes on reports of fisher tracks and sightings indicated "that this species (though still rare) is reproducing in the wild and spreading from their point of release".

Systematic recording of fisher observations, collections, reports of sign, and releases were initiated in 1961. A second attempt to reintroduce fisher to Nova Scotia was begun in 1963 by the Forestry Division of the Department of Lands and Forests. These releases were of wild caught (Maine) stock or from young born in captivity, during quarentine, from this stock. Available release data are presented in Table 1. The fact that female fisher breed post partum and the extensive mobility exhibited by male fisher suggest that the release of low numbers of animals (2-11) per site might be less successful than releasing a large number of animals in one place. As the animals were not tagged on release, efforts to assess movement and productivity from specimens taken in traps are not possible. Records of thirty-two specimens, trapped accidentally, are presented in Table 2. That this record is far from complete is attested to by the fact that nine fisher pelts taken solely during the winter of 1965-66 were offered at auction by the Wildlife Conservation Division of the Department of Lands and Forests in the spring of 1966. In addition several fisher have been taken in the five westernmost Nova Scotia counties but exact data on these specimens are unavailable.

Observations of animals and sign from 1961-69 are presented in Table 3. These data, along with collection data presented and inferred suggest that the animals are widely distributed throughout much of the mainland at present. Bearing in mind that information recorded here comes only from 25 provincial wildlife rangers and that reports of fisher observations by woodsmen are common, particularly in western Nova Scotia, it appears that fisher may now be successfully re-established. Weckwerth and Wright (1968) reported a similar success at re-establishing fisher in Montana. Had better protection from indiscriminate trapping been offered this animal following release in Nova Scotia, the investment interest would probably have accumulated faster. It will doubtless remain undetermined whether fisher were ever completely extirpated prior to the recent attempts at re-establishment.

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Studies of the Byron Bog in Southwestern Ontario XLIII. Swarming of the Springtail *Hypogastrura harveyi* Folsom on the Snow

In a previous communication an account was given of springtails associated with fungi in the Byron Bog (Judd, 1965). The following account records a swarming of springtails on the snow in Zone B of the bog, a region of damp woods in which trees and thick shrubbery predominate (Judd, 1963).

On December 17, 1969 the temperature was 36°F, there was no wind, the sky was partly clouded with fractostratus cloud and in Zone B of the bog two inches of light powdery snow, which had fallen during the previous night, lay on crusted snow accumulated from previous snowfalls. At several places open water was present around the bases of trees. Between 12 noon and 1.00 p.m., springtails were found swarming on the snow adjacent to a trail extending through Zone B along the east side of the bog. They were identified by Dr. Kenneth Christiansen, Grinnell College, Grinnell, Iowa, as *Hypogastrura harveyi* Folsom. Some specimens were kept by Dr. Christiansen and others have been deposited in the collections of the Department of Zoology, University of Western Ontario. This species has been recorded previously from Ontario (Maynard, 1951).

To estimate the number of insects present, use was made of a rectangular plot of dimensions 250 by 50 feet laid out in Zone B for study of invertebrates in 1961 (Judd, 1963). Along the length of this rectangle twenty patches were marked out on the snow, each patch one square foot in area. The number of springtails in each patch were counted, the numbers from the twenty patches being 30, 36, 28, 27, 27, 33, 29, 37, 20, 25, 41, 46, 55, 36, 43, 52, 31, 43, 53, 32, totalling 724 springtails, i.e. 36.2 per square foot. The area of the rectangle was 12,500 square feet and the estimated number of springtails on the snow in it was thus 4,525,000. By December 20 six inches of new snow had fallen on the plot and on that day a few springtails were present, these being concentrated mainly on the snow encircling the open water around the base of trees.

Swarming of "snow fleas" on the snow has been frequently observed, the species most commonly involved being *Hypogastrura socialis* (Uzel) (Christiansen, 1964; Maynard, 1951). Christiansen (1964) lists several species which swarm, not including *H. harveyi.* Maynard (1951) records that during thaws this species is sometimes found wandering around on the snow. Christiansen (1964) records that the cause of these outbreaks is still uncertain but that it seems clear that they are associated with persistent, unusually damp conditions. Such conditions prevailed in Zone B in the Byron Bog around December 17, 1969 with the temperature above freezing and open water present around the bases of trees.

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An Unusual Display of Territorial Aggressiveness by Sandhill Cranes (*Grus canadensis* Linné)

Abstract. In June 1970, during a study of the causes of mortality in barren-ground caribou (*Rangifer tarandus*) calves in central Keewatin, Northwest Territories, an unusual display of territoriality was exhibited by a pair of sandhill cranes (*Grus canadensis*). These cranes were repeatedly successful in driving a maternal caribou off their nesting territory, where her calf had died.

In June and July 1970 we studied the causes of mortality in newborn barren-ground caribou (*Rangifer tarandus*), of the Kaminuriak population, in central Keewatin, N.W.T. In 1970 the calving ground of this population lay mainly within latitude 63°40′, on the north; by longitude 93°20′, on the east; latitude 63°00′, on the south; and longitude 95°00′, on the west.

On June 19, 1970, while searching for dead calves in a low flying Hillar 12-E helicopter, we spotted the carcass of a newborn calf about 75 m to the north. As we circled to land and examine it, we observed the dead calf's mother moving at a trot, about 100 m east of the calf, and a sandhill crane running along several meters behind it. We thought, at first, that both animals were fleeing from our helicopter, but then noticed that whichever way the female caribou turned the crane followed with flapping wings and extended neck.

We landed about 15 m from the dead calf and a second crane, which had been about 30 m from the calf, ran at the helicopter with wings and neck outstretched, passed some 10 m in front of us, and stopped about 30 m to the far side of the calf. As we walked to the calf, the crane made several short passes in our direction with neck extended and wings flapping, vocalizing loudly.

The cow appeared on a ridge about 50 m to the north of us and came toward us briskly, her head bobbing, and uttering the grunting calls that maternal caribou make to attract their calves. The cow had come only 25 m from the ridge when the pursuing crane flew over the ridge. Landing between us and the cow, the crane began calling loudly and charged at her. The second crane left its pursuit of us to help its mate chase the cow to the ridge. When the caribou reached the ridge, the first bird continued the chase and the second bird returned to repel us. When the cow was about 100 m beyond the ridge the pursuing crane flew back to the sedge meadow on our opposite side, about 30 m away.

While we were performing the postmortem examination of the calf, both cranes continued walking back and forth, vocalizing nearly continuously, occasionally flapping their wings briskly, and making short charges in our direction. Our work completed, Miller walked out to the wetter portion of the sedge meadow. Both birds followed, charging at him aggressively in an attempt to drive him away. We found their nest on a hummock, about 30 m from the helicopter and at the focus of the area they were defending.

During our research, we observed that the bond between cows and calves usually remains strong after the death of one of the pair. However, the attachment of a live cow to a dead calf can be permanently broken by the close approach of an established enemy, such as a man or a wolf.

The calf had apparently been dead for several hours. The drive to defend their nesting territory was so strong in these Sandhill cranes that they succeeded, throughout that period, in keeping the cow from her dead calf.

Margaret Altman (Journal of Mammalogy 41: 525, 1960) while observing moose in western Wyoming saw a pair of Sandhill Cranes drive a young cow and bull away from their only chick. She also noted that older bulls and even a cow with a calf cautiously detoured the crane family upon hearing their warning calls.

The aggressiveness of Sandhill Cranes is apparently a well developed species trait.

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Further Evidence of Tree Nesting in the Marbled Murrelet

On August 24, 1967, my curiosity was aroused by a telephone message that two young, flightless birds with webbed feet dropped out of a tree being felled by loggers on Vancouver Island. I asked my caller, Mrs. Belanski of Holberg, B.C., to ship the birds immediately. One bird killed in the fall had been destroyed, but the other was in Mrs. Belanski's home and was sent by air the next day.

The bird, a young Marbled Murrelet (*Brachyramphus marmoratum*) with egg tooth intact, arrived in good condition. Well advanced in maturity, but with primary feathers still sheathed, it would have been ready to leave the nest within 10 to 14 days.

We force-fed the murrelet on a wet mixture of fish, dried prepared dog food and milk. As the weather was warm we allowed it to bathe daily and to dry in the warm sun. However, on the third day it seemed unable to maintain body heat and died. The specimen was turned over to the Provincial Museum, Victoria, B.C.

We learned from Mrs. Belanski that the nest was approximately 60 ft. from the ground in a cedar, probably the western red cedar (*Thuja plicata*), about four miles from salt water.

The town of Holberg lies at the head of Holberg Inlet (50°128'NE), west of Port Hardy in the northern section of Vancouver Island. Climate is mild, with an average annual temperature of 48°F and an annual mean range of 41°F to 54°F. Average annual precipitation is 93 inches of which some 18 inches appears as snow. In such favourable conditions grow excellent stands of Douglas fir (*Pseudotsuga taxifolia*), western hemlock (*Tsuga heterophylla*), western red cedar (*Thuja plicata*) and, in lesser amounts, amabilis fir (*Abies amabilis*). Holberg is the centre of an extensive logging industry, but is otherwise little developed.

The American Ornithologists' Union Check-list of North American Birds (1957) states that the nest of the Marbled Murrelet is not known but the North American breeding range is believed to extend along the coast from eastern Alaska to northwestern California. Females with fully formed eggs in oviducts have been taken near Juneau, Alaska, and flightless young have been reported on the coast of Alaska.

Drent and Guiget (1961) provide an excellent review of the fragmentary data on evidence of nesting in British Columbia. A possible Marbled Murrelet nest was reported near Masset in the Queen Charlotte Islands. Two men felled a large hemlock close to the sea about half a mile east of Masset. From the debris, an adult Marbled Murrelet was taken alive. Egg shell fragments with blood on them indicated advanced incubation. Unfortunately, the bird was released before definite identification by an ornithologist. Shell fragments were sent to the British Columbia Museum and Guiget identified them as that of the Marbled Murrelet.

There is some confusion in the literature as to whether some of the eggs and shell fragments collected in the Pacific northwest belonged to the Marbled Murrelet or to its relative the Kittlitz's Murrelet (*B. brevirostre* (*Vigors*)). The latter nests in Alaska (A.O.U. 1957) but there are no nest records for British Columbia.

Examination of the Russian literature on murrelets proved interesting. A. A. Kishchinskii (1968) found a ground nest of Kittlitz's Murrelet in arctic tundra. He also provides information on a nest found by A. P. Kuzyakin on June 17, 1961. It was 7 m from the ground in a taiga larch tree, 6 or 7 km from the sea. Jacoby (personal communication) noted, from the original, that the murrelet had utilized the bearded lichen *Bryopogan* as nesting material.

Kishchinskii (1968) provides an excellent review of the biology of both murrelets. He deals at some length with the problem of young murrelets finding their way from the nest to the ocean and theorizes that as the nests are often far from salt water, and as the birds are ill-equipped for walking long distances, they must make their way to streams and rivers and thereby reach the sea. This might account for reports of flightless young birds found in the forest, miles from the ocean (Drent and Guiguet 1969). One would think, however, that more flightless sea birds in rivers and streams relatively closer to the ocean would be reported.

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Marking and Recapture Techniques for Adult Odonata

Adult Odonata are suitable subjects for a wide range of ecological studies because of their relatively large size, abundance, ease of capture, and their occurrence in open habitat where they can be easily observed (Moore, 1957). One of the most useful tools in such studies has been the marking and subsequent observation or recapture of identifiable individuals. Several techniques which have been used by the author and others to mark dragonflies will be summarized below.

Marking Materials and Methods

India ink, oil paints, cellulose paints, and model airplane dope have all been used with some degree of success. India ink has a minimal effect on behavior and survival (Borror, 1934) but is not easily seen. Oil adheres well but is heavy and dries slowly (Moore 1952, 1960). Quick-drying cellulose has been used successfully and has been applied by painting with a pointed object or a "camel's hair" brush, and by squirting with a small squirt gun or hyperdermic syringe. Capturing dragonflies for painting sometimes damages the wings or the balance mechanism, but squirting may get paint on the eyes, spiracles, or joints and thereby affect survival and behavior. Paint applied by the latter method may also tend to flake off.

Marking Codes

A rather complex system of dots on the wings was used by Borror (1934), Kormondy (1959), and Johnson (1962) to permit identification of recaptured individuals. Jacobs (1955), Bick and Bick (1961, 1963), and Pajunen (1962) used a somewhat simpler system of dots and/or streaks which permitted identification of marked individuals without recapturing them. When individuals were marked by the squirting method, the pattern of spots was simply recorded as the identifying mark of that individual.

New Techniques

Connor (1968) captured mature *Libellula quadrimaculata* (usually when they were perched) with an insect net, and net damage seldom occurred. The dragonfly was held beneath a metal shield so that only the wingtips were visible from above, and the wingtips from the stigma outward were then sprayed with Testor's 'Pla' model enamel from an aerosol can. The marking pattern could easily be made more elaborate by using a perforated shield. Each of five colors was systematically assigned a different number for each of the four wings (see Table 1) and the numbers coded on all wingtips were added to give the number of the individual. A period of disoriented behavior usually followed marking, but several individuals were seen back on territories within one-half hour after marking and the behavior of all marked individuals sighted the day after marking seemed normal. The marks persisted well, and dragonflies could readily be identified for at least 15 days after marking. This limit probably represents a disappearance of the marked individuals from the population rather than a loss of the mark, for detached and painted wings glued to a board and left to weather in the study area from July to June of the following year did not loose their marks. *L. quadrimaculata* are large dragonflies, and when marked in the manner described they could be identified as being marked at a distance of 70 to 80 feet with the naked eye, and their code could easily be read at that distance with the aid of binoculars.

TABLE 1. — Code used in color-marking adult *L. quadrimaculata*. Table figures are the numbers represented by each 'color+wing' combination. The coded number of an individual is the sum of the values indicated on separate wings. Of the combinations possible with this system, only the first 99 were used. The two or three wingtips thus left unpainted were colored in each individual as follows to indicate hundreds and to make individuals more uniformly conspicuous: 0 – 99, yellow; 100 – 199, silver; 200 – 299, copper (from Connor, 1968).

Wing	Color				
	Black	White	Green	Red	Blue
L. Front	1	2	3	4	5
R. Front	6	7	8	9	—
L. Rear	10	20	30	40	50
R. Rear	60	70	80	90	—

A 2½ cc disposable plastic syringe has been found to be a useful marking tool. The brush part of a single quill "camel's hair" brush is inserted from the rear into the plastic base of a disposable hypodermic needle from which the metal needle has been cut, and this assembly is then fitted to the syringe. Use of the brush avoids the slight amount of damage to the wings which may occur if the needle is used to apply the paint. Almost no pressure is applied to the wings, and so no support is needed for the wings during marking. Esterbrook 'Flo-master' opaque ink is preferable to model airplane dope and cellulose enamel for application by this method because the ink resists the tendency to flake shown by the latter two materials. A small amount of absorbent cotton is placed in the tip of the tubular plastic cover in which the disposable needle is sold, and is saturated with a thinner appropriate to the paint being used. Xylene should probably not be used, for it dissolves many disposable syringes and makes the wings of insects brittle. After each dragonfly is marked, the cover with its solvent is replaced over the brush which in this way is kept soft and ready for instant use. The syringe can be stored in this manner, partially filled with paint, for days without drying, and can be used for extended periods in the field without difficulty. This method of marking has the advantages that it is clean and fast, several marking tools can be carried in a shirt pocket ready for instant use, one person can work alone and mark and release individuals at the point of capture, and the mark is durable and adaptable to many different codes, some of which can easily be read while the dragonfly is in flight.

If the individuals are to be identified without recapturing them, the code of marks applied using the above technique may be made relatively simple and the marks rather large. One way in which this can be done is to use a modification of the 1-2-4-7 method of marking Lepidoptera wings used by Ehrlich and Davidson (1960). On dragonflies, transverse bars can be painted on the undersurface of the wings in the following code: right front, distad to the nodus = 1; right front, proximal to the nodus = 2; right rear, distad to the nodus = 4; right rear, proximal to the nodus = 7. The code on the left wing forms a mirror image of that on the right, except that it is in tens rather than in units. A single color used in this way has a total capacity of 154 individuals; the color can be changed for numbers beyond 154. The precise position of the marks can be adjusted to avoid interference with or by any natural spots on the wings.

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New Common Murre Colonies for British Columbia

Triangle Island, one of the Scott Islands, located 45 miles off the northwest tip of Vancouver Island, British Columbia, was reported to contain the only authenticated nesting colony of Common Murres *Urea aalge inornata* Salomonsen in British Columbia. (Drent and Guiget, 1961. A Catalogue of British Columbia Sea-bird Colonies. Occ. Paper, B.C. Prov. Mus. No. 12, pp. 173).

The Provincial Museum staff conducted extensive ecological surveys of the Scott Islands in 1949 (Carl et al. Ann. Rept. B.C. Prov. Mus. Nat. Hist. 1959: pp B21-B63). They did not report sighting murres on Sartine Island or the islets between Sartine and Triangle Island. Their verification of the zoological records for Triangle Island appears to refer only to murres nesting on the isolated promontory rock (elevation 325′) of the southwestern peninsula (Guiguet, 1950, Murrelet 31(1): 12-13; and Carl et al., *op. cit.*).

Between 18-21 July 1968, Lyn Hancock, Bob Wright, Willy Egeland, and I conducted a live collecting and photographic expedition on the outer Scott Islands. Four new groups of Common Murre nesting colonies were located as follows.

a) Sartine Island. 18 July. Two colonies. The first, consisting of about 20 birds, only 1 egg seen, is located on the northwesternmost point of island. The second colony was located in a steep westward facing gully midway between the northwest and southeast points. I saw eight very fresh clean eggs on a ledge from which the birds had flown and 31 additional adults were standing over an undetermined number of eggs on an adjacent ledge.
Working westward from Sartine there are three unnamed islets or cluster of islets. The first group westward contains two dominant rocks — here named Rocks A and B. The second group, one dominant rock here named Rock C, and the third consists of 2 dominant rocks here named Rocks D and E. Two of these islet groups contained nesting murres as follows.

b) Rock B. 18 July. 28 fresh eggs seen on east facing rookery. About 125 adults present.

c) Rock D and E. July 19. 50-60 adult murres were perched on Rock D but no landing was made to verify eggs. Rock E contained 54 eggs plus 30 broken shells spread over an area 150′ in radius. Three murre heads were found on the rocks but no dead bodies. Cause of disruption is not known but otter depredation is suspected. Rookery was located on south and east facing slope.

d) Triangle Island 20 July. Approximately five hundred adult murres were perched on the cliffs of two southernmost pinnacles of the southeastern peninsula of Triangle Island. Over 125 eggs were seen on the northernmost of these two rocks along with two newly hatched chicks. Of two eggs that safely reached the Wildlife Conservation Centre one hatched 26 July and the other 28 July. Several other less developed eggs were broken in transit.

The above records greatly extend the number of Common Murre colonies in British Columbia though most of these new colonies are small in size. I suspect these colonies were missed by the Museum expedition because that investigation was earlier in the season when many birds might not yet be on eggs.

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A Note on the Early Season Food of Arctic Migrants

Of the species of birds which migrate to the high Arctic to breed, a number arrive before the snowmelt and live for some time before their normal summer food supplies become available.

The feeding of Ruddy Turnstones (*Arenaria interpres* (Linn.)) on insects overwintering under dry plates of mud has been reported by MacDonald and Parmelee (1962), who remarked that this feeding habit exploited a food resource unavailable to other bird species. The limited data presented below suggest that such discovery of insects in their overwintering shelters is not confined to this species.

An examination of possible insect overwintering sites was carried out on Bathurst Island, N.W.T. (at 75°43′N, 98°25′W) during June 1969. Searches of the barren ridges free of snow revealed occasional adults of an Ichneumonid (of an undescribed species) and a few larvae of the Geometrid moth *Psychophora sabini* Kirby, which were overwintering beneath flat stones. By far the commonest arthropods on these barrens were spiders and Collembola, however, and the moth larvae and ichneumons were confined beneath some of the larger flat pieces of stone (greater than 4 or 5 inches in diameter). Unlike the larvae of some species (e.g. *Byrdia*) which may overwinter exposed, these Geometrids seem to be restricted to such sites. Hibernation of adult Ichneumonidae in this type of concealed site is common in temperate regions (Rasnitzin 1964).

On 10th June, four Purple Sandpipers (*Erolia maritima* (Brunnich)) arrived, and two of these were seen pecking over one of the bare ridges, as if feeding on spiders. Examination of the stomach contents of one of the birds, collected on the same day, revealed that spiders had indeed been eaten, but more than half the contents were composed of the ichneumonids and moth larvae. Since none of these left their overwintering sites until after about 20th June, they could have been obtained only beneath the larger plates of stone. Details are given in Table 1.

A Long-tailed Jaeger (*Stercorarius longicaudus* Vieillot) collected on 16th June also was examined; Geometrid larvae were again present in the stomach, and also spiders, though only the larger specimens of the latter had been taken. A Red

Table 1. — Stomach contents of birds collected on Bathurst Island, N.W.T., in Spring 1969.

Bird Species	Date Coll-ected	Animal remains in stomach		
		Psychophora sabini larvae	*Ichneumon* sp. adults	Arachnida
Purple Sandpiper	10/VI	4	3	7
Long-tailed Jaeger	16/VI	2	0	7
Red Phalarope	20/VI	0	0	18+

Phalarope (*Phalaropus fulicarius* (Linn.)) collected on 20th June had apparently been feeding almost exclusively on small spiders. Spider fragments were also present in the stomachs of a Turnstone and a Sanderling (*Crocethia alba* Pallas) collected on 28th June.

No traces of Collembola were found in any of these samples (they would probably have been too small to be selected by the birds), although a pair of Snow Buntings (*Plectrophenax nivalis* (Linn.)) were seen feeding on the Collembola on a remaining patch of snow on 30th June. The amount of plant material in the samples was negligible.

These few observations suggest that several species of birds may be able to exploit 'concealed' food resources in this habitat. That they do so efficiently is indicated by the long search by entomologists which had proved necessary to discover relatively few individiuals of the species on which the birds had fed. Insect species such as these occurring in low densities seem to be characteristic of Arctic habitats (Downes 1962, p. 148). Furthermore, many species — in Arctic localities with a richer fauna — appear to select exposed areas free of snow for hibernation, rather than lower lying ground which is subject to spring flooding (Deichmann 1896; Johansen 1911, p. 40; 1921, p. 8).

The ability of unrelated bird species (jaeger, shore-birds) to utilize such a source of food may indicate that arthropods which have overwintered on the ridges are important to arctic migrants in the period before their normal summer food becomes available with the exposure of the valleys.

Acknowledgments

My thanks are due to Dr. G. M. Sutton for providing the bird stomachs for examination, and to Dr. J. R. Byers for much of the searching of possible insect overwintering sites. The Canadian Polar Continental Shelf Project and the National Museum of Natural Sciences provided living accommodation on Bathurst Island.

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A Recent Introduction of Frogs to Newfoundland

It is generally established that the island of Newfoundland has no native anurans and that the only species previously recorded, the Green Frog, *Rana clamitans*, was introduced at St. John's about 1850 (Johanson 1926; Bleakney 1958; Cameron and Tomlinson 1962). Bleakney (1958: 43-44, 47) has concluded that cold salt water has barred the spread of both amphibians and reptiles to this island and that there has been no land connection with the mainland at least since the last Wisconsin glaciation. It is apparent from the survival of the Green Frog and from data contained in Bleakney (1958) that neither climate nor available habitat would exclude all northerly ranging species from the entire island.

Cook (1965: 148; and personal communication) although cautioning against introductions generally because our knowledge of amphibians and reptiles in Canada is far from complete as yet and introductions could obscure scientifically important natural variation and distribution patterns forever, has stressed that when introductions are made, for whatever reason, this information should at least be forwarded to a museum where a permanent record of it can be kept. In addition it should be published. Such a record will allow future assessment of the success or failure and other effects of the introduction to be studied as well as preventing erroneous conclusions being drawn from the later discovery of these animals if they are successful. It should include the source of the introduced animals, the number originally introduced and the date of introduction.

This report is based on introductions between 1960 and 1967 of four species not previously recorded from Newfoundland. They were made in the hope that these amphibians would find the area suitable for survival and contribute to the control of the large numbers of insects and other invertebrates which thrive in the area, particularly sow bugs and slugs which appear to grow to a larger size and occur in greater abundance here than I have observed in regions where frogs are abundant. I once counted 60 slugs while standing in one spot in the summer of 1966. During fifteen summers in the area from the time I was 10 to 25 years old, I did not observe amphibians of any species, although the country appears ideal for them and my searching was quite thorough.

The area where the introductions were made is in the vicinity of Corner Brook on the western side of Newfoundland. The species involved were the Wood Frog, Leopard Frog, Western Chorus Frog and the American Toad, all originally collected in the Toronto, Ontario, region and introduced as tadpoles, juveniles, or adults depending on the species, during the period 1960-1966. The individual introductions, including numbers of individuals and subsequent observations of their success or apparent lack of it are discussed below by species.

Studies on the long-term results and possible spread of the successfully introduced species in this area are being continued.

WOOD FROG, *Rana sylvatica.*

On May 16, 1963, 60 or 70 Wood Frog tadpoles were collected from a small creek about 0.2 miles north of Highway 7 beside Keel Street, Toronto, Ontario. These were kept in an aquarium until leaving for Corner Brook (by car) on June 8. They were transported in gallon bottles, about 20 to bottle. Unfortunately, at Sackville, New Brunswick, June 9 I used tap water in one of the bottles and killed 10 or 12, but fresh pond water was used in the other jars. After arrival in Corner Brook the weather was cold during June 11-19, and the tadpoles were kept at my father's home. Approximately 50-55 survived until they were liberated on June 15. The site was a small pool in the ditch on the north side of the Trans-Canada Highway (between the highway and the Humber River) 1.4 miles northeast of where Steady Brook crosses the highway. On July 4, 1966, the site was revisited and Wood Frog tadpoles were abundant, some about ready to leave the water. Again, on June 13, 1967, the area was examined and tadpoles were numerous. At this time I was afraid that the pond would be filled in by the construction underway to widen the highway so I moved 42 tadpoles to a little pond just south of Corner Brook. On June 24 and 27, 1968, I found Wood Frog tadpoles in most of the pools as far as 0.5 miles from the oiriginal pond. In some of the pools they were abundant. During June 16-27, 1969, a careful check of 325 tadpoles showed them all to be Wood Frogs. At Steady Brook, June 24, I met a Hydro worker who had an adult Wood Frog in a milk carton. He had never seen a frog before and had found it while inspecting a transmission line. It appeared healthy and vigorous.

The 1967 transfer of 42 tadpoles from the original introduction site to a small pond near a high school (Herdman Collegiate) in Corner Brook has also proven successful. In June 1968 no tadpoles were seen during a careful inspection of the pond. However, on June 21, 1969, there were an estimated 5,000 to 10,000 tadpoles. A collection of about 100 of these proved to contain only Wood Frogs.

Interestingly enough there was one Green Frog calling at this pond on June 21, 1969. It appeared to be a much paler green than individuals of this species that I have observed in the Toronto region. The first introduction of this species apparently came from the Maritimes and it is now abundant in portions of the Avalon Peninsula of southeastern Newfoundland, the area of original introduction, as well as a few other scattered localities, apparently from secondary introductions (Cameron and Tomlinson 1962). I would guess that this particular individual had been released there by the school.

To date, the introduction of the Wood Frog has apparently been successful at Corner Brook and it seems well on its way to establishing permanent residence in this area.

WESTERN CHORUS FROG,
Pseudacris triseriata triseriata

At the same time as the Wood Frog introduction was made, about 50-55 tadpoles of the chorus frog were also collected from the same area in Toronto and released in the Corner Brook area June 15, 1963. Because cannibalism had been noted only about 18 were released in the original Wood Frog introduction site. Another 18 were liberated about half way back to the bridge, also on the north side, and the remainder in a roadside ditch 0.1 miles west of the bridge on the south side of the highway. On none of my subsequent visits have I identified any tadpoles of this species, although, particularly in 1969, a careful inspection was made for them. Unfortunately, I am not able to visit the area earlier in the year and listen for their calls, which would be certain verification of their presence or absence. In this area there are many pools in which the water is so dark and shaded that it is difficult to check positively for tadpoles. Next year screen traps will be placed in these pools to attempt to establish if this species has survived to reproduce in the area.

LEOPARD FROG, *Rana pipens*

On July 1, 1966, twenty-five adult Leopard Frogs were released in a swamp 0.4 miles south of Herdman Collegiate. Five more were kept in a wire box and released July 7 in a pond on the south side of the highway 3.9 miles northeast of the steady Brook bridge. On June 14, 1967, I saw one Leopard Frog at the swamp near Herdman Collegiate, but it quickly disappeared. I have not observed any Leopard Frogs at either place since. The water at the swamp is very cold, and it may be spring fed.

AMERICAN TOAD, *Bufo americanus*.

In June 1960 about 100 newly metamorphosed toads were released on the shore of a small pond one mile south of the three mile dam (a local landmark) on the east side of the Trans-Canada Highway. No trace of them was found on my visit in 1963, nor in 1969. Subsequently, additional small toads were sent by air mail to my father who released them in his yard at 23 Valley Road in Corner Brook. The years and numbers released were: 1963 (60), 1964 (45), 1965 (41), 1966 (55). My father found two toads in the summer of 1966, one about 2½ inches in length and the other 3 inches, and several each year since. Three of his neighbours have found at least one in their yards. Apparently they can overwinter successfully in the area. Because there are no suitable breeding areas on my father's property, on June 13, 1967, 3 adult toads collected in my father's yard and 29 one-year-olds from Toronto were moved to a site 1½ miles east of Steady Brook bridge on the south side of the highway. In 1968 and 1969 no toads or tadpoles were seen in this area.

Acknowledgments

I would like to express my appreciation to Francis R. Cook, Curator of Herpetology at the National Museum of Natural Sciences, Ottawa, Ontario, to whom I first wrote about these introductions in August 1966 and who has encouraged their continued observation and assisted in the preparation of this paper. Thanks are also due to Dr. J. Sherman Bleakney, Biology Department, Acadia University, Wolfville, Nova Scotia, for reading the first draft.

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A Sight Record of the Curlew Sandpiper in Alberta

Birdlife in the Canadian prairies in spring is always interesting, especially to a native easterner. During three years in Alberta I became well acquainted with many western species and made some exciting observations.

The evening of June 18, 1969 was no exception. Early in the evening I drove out to the Chain Lakes, a group of small alkaline lakes lying between Dowling and Farrell Lakes northwest of Hanna, Alberta. A small colony of Baird's Sparrows were nesting in the short grass bordering these lakes. Locating a nest of this species as well as that of Sprague's Pipit which also nests here was my objective.

The sandy beaches and flats bordering the east side of the lake known locally as "Clear Lake" are a favourite haunt of migrating shorebirds. At 7:30 p.m. my attention was attracted by a medium sized shorebird which from the very first was noticably dark on the underparts. After close examination it proved to be an adult Curlew Sandpiper (*Erolia ferruginea*) in full spring plumage. All field marks were in evidence including long legs, dark rufous throat, breast and underparts, decurved bill, lighter mottled back, wings, nape and head. In flight the bird plainly showed white upper tail coverts and light wing stripe. I was able to approach to within 45 feet of the bird and observe it for 15 minutes through 7 by 35 binoculars as it fed in the shallows. It was in close company with an Avocet, two Piping Plovers, and several "peep" sandpipers so that a size comparison could easily be made.

The bird was not present at this location the following evening or thereafter.

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News and Comment

Preservation of Terrestrial Communities in the Taiga of the Yukon and Northwest Territories

Introduction

The International Biological Programme (IBP) can trace its origins to the late 1950's when biologists began discussing the possibility of organizing a world-wide plan of research concerned with "The biological basis of production and human welfare". As a result of discussions and planning by biologists from around the world, the IBP set goals to study organic production in the earth's major biological regions and to determine the uses and potential uses of existing biological resources.

In Canada, as in 54 other countries around the world, a number of scientists and other interested persons are involved in various IBP projects, one of which comes under the CT (Conservation of Terrestrial Biological Communities) subcommittee. Because human welfare in an ultimate sense depends upon the conservation of our natural environment, the CT subcommittee is concerned with conservation of typical landscape units or ecosystems. Nicholson (1968, p. 15 and 16) outlines the rationale for this statement as follows:

> "The preservation of natural and semi-natural areas is important for the future of biology and for human welfare because they provide for:
> (a) the maintenance of large, heterogeneous gene pools;
> (b) the perpetuation of samples of the full diversity of the world's plant and animal communities in outdoor laboratories for a wide variety of research;
> (c) the protection in particular of samples of natural and semi-natural ecosystems for comparison with managed, utilized, and artificial ecosystems;
> (d) outdoor museums and areas for study, especially in ecology;
> (e) education in the understanding and enjoyment of the natural environment and for the intellectual and aesthetic satisfaction of mankind."

Obviously, ecological reserves must serve a great many interests.

Taiga Panel

In Canada the greatest emphasis is being placed on natural areas, but both natural and man-modified ecosystems are being studied and plans are underway to have them protected as reserves. Fuller (1970) has outlined the organization of the IBP-CT in Canada where ten panels representing ten regions have been set up by the CT subcommittee. The taiga panel is concerned exclusively with the forested and montane regions of the Yukon and Northwest Territories.

The taiga panel first met in June 1969 then contacted other persons with knowledge of the area to draw up an initial list of possible reserves. The lists were studied at the next meeting of the panel in April 1970, and plans were prepared to have field studies made of some of the potential reserves and to have justification including IBP-CT check sheets (inventories) completed for those studied. As a result of visits to regions with representative or unique ecosystems during the summer of 1970, a number of check sheets were completed and others are in various stages of completion. During the summer of 1971, the panel hopes to arrange for the completion of field studies for several more proposed reserve sites.

At present 51 sites are considered for possible inclusion in a system of ecological reserves. Some are small areas containing unique plant or animal communities, others encompass modest pieces of representative landscape and their ecology, while a few aim at preserving total ecosystems that will guarantee the existence of all the native biota, including representative populations of our large carnivores and herbivores. Such units must contain a fortunate combination of features that will permit them to maintain their ecological integrity, despite man's activity in the surrounding land.

The reserves aim at preserving the unique ecology of our only glacial refugium in Canada; the "solar bowl" of the Old Crow Flats with its teaming marshlands, an area perhaps suitable for the introduction of whooping cranes; the periglacial ecology of the St. Elias Range, unique in the northern land masses for its diverse plant and animal life within sight of huge glaciers; the relic biota of hotsprings; a flooding river whose actions guarantee moose, wolves and tall forests to flourish; and to extending protection to such uniquely Canadian animals as the giant mountain caribou, and black Stone's sheep, as yet nowhere guaranteed a home.

The following list of proposed reserve sites includes the name of the site and a brief description of it. For approximate location of the proposed reserve sites see Figure 1.

List of Proposed Reserve Sites

1. BLACKWATER RIVER MOUTH: A square mile of a white spruce stand on the Mackenzie River.
2. VIRGINIA FALLS: Mountain valley with lodgepole pine and occasional hybridizing of lodgepole and jack pines.
3. GRAND DETOUR: Prairie-like area inhabited by bison.
4. EAST ARM OF GREAT SLAVE LAKE: An area where tundra and taiga meet. Includes the McDonald Fault and Artillery Lake.
5. OLD CROW FLATS: Large marshy area of unusually high productivity in wetland wildlife.
6. FIRTH RIVER AREA: Represents the biota of the northernmost once glaciated mountains facing the Arctic Ocean.
7. RAT RIVER: A small, probably unglaciated area with unique vegetation.
8. SOUTHERN MACKENZIE DELTA: Representative sample of the flora and fauna of the southern part of the delta.
9. CARIBOU HILLS: Unique floral communities on steep eroding slopes have made this region a joint submission of panel 9 and 10.
10. CROSSLEY LAKES: This area is representative of the tree line flora on rocks of Devonian age.
11. PORTER LAKE: A representative sample of of flora and fauna found on the Precambrian shield; includes excellent examples of eskers.
12. SALT RIVER ALKALI FLATS: This area is characterized by unique plant communities growing on areas washed by brine springs.
13. WHOOPING CRANE NESTING AREA: Protects the nesting grounds of a rare species.
14. ALEXANDRA FALLS: A representative sample of biota on Palaeozoic rocks.
15. LIARD RIVER: A sample of a wild river's ecology, characterized by productive forests and a diversity of wildlife. This is primarily a forest reserve.
16. ST. ELIAS RANGE: Several sites are under investigation in this range whose ecology is dominated by the largest continental glaciers in America and the greatest faunal diversity in the subarctic regions.
17. AISHIHIK LAKE: An area of considerable faunistic and floristic diversity with extensive relic grasslands, a nonmigratory caribou population, and geologic diversity.
18. WOLF LAKE: A region suitable for the conservation of the Cassiar fauna and flora of the southern Yukon including mountain caribou, Stone's sheep, several populations of large predators, several rivers, a diversity of small lakes, and a delta; this area would maintain its ecological integrity if established as planned.
19. DAWSON RANGE: A representative sample of an area untouched by glaciers during the Ice Ages.
20. OGILVIE MOUNTAINS: A sample of the old glacial refugium with great floristic diversity, unique soils and rare plants.
21. MCARTHUR RANGE: A region of great geologic diversity, characterized by high lightning activity and relatively high precipitation, extensive areas of unproductive slabrock, a hotspring, fens, and highly localized populations of native birds and mammals. Includes a small, relic population of gray sheep.
22. GREAT SLAVE LAKE, NORTH SHORE: Here in a region of meadows and swamps one finds wood bison and woodland caribou.
23. CARIBOU POINT: A cross section of habitats from tundra to boreal forest are found here.
24. BRACKETT LAKE: An area of marshes and diverse bird life.
25. TATHLINA LAKE: A marshy basin with diverse bird life.
26. PLAINS OF ABRAHAM: A flat topped, undulating plateau with a sparse vegetation cover in the midst of an otherwise highly dissected mountain range; contains Dall sheep.
27. DAWSON CITY: The reserve would preserve part of the tailings left by gold mining activity to illustrate the colonization of these tailings by native and introduced flora.
28. BRITNELL LAKE: Typical plant communities from forest to alpine tundra surround this glacial lake in the Mackenzie Mountains.
29. REDSTONE RIVER: An area untouched by glaciations with a unique flora.
30. SNAKE RIVER: This area preserves a land as altered by mining activity.
31. Lakes in the Mackenzie Mountains which have been formed by glacial morrains of various ages.
32. HORN PLATEAU: A high plateau noted for its woodland caribou and extensive deep lichen cover over raised peat.

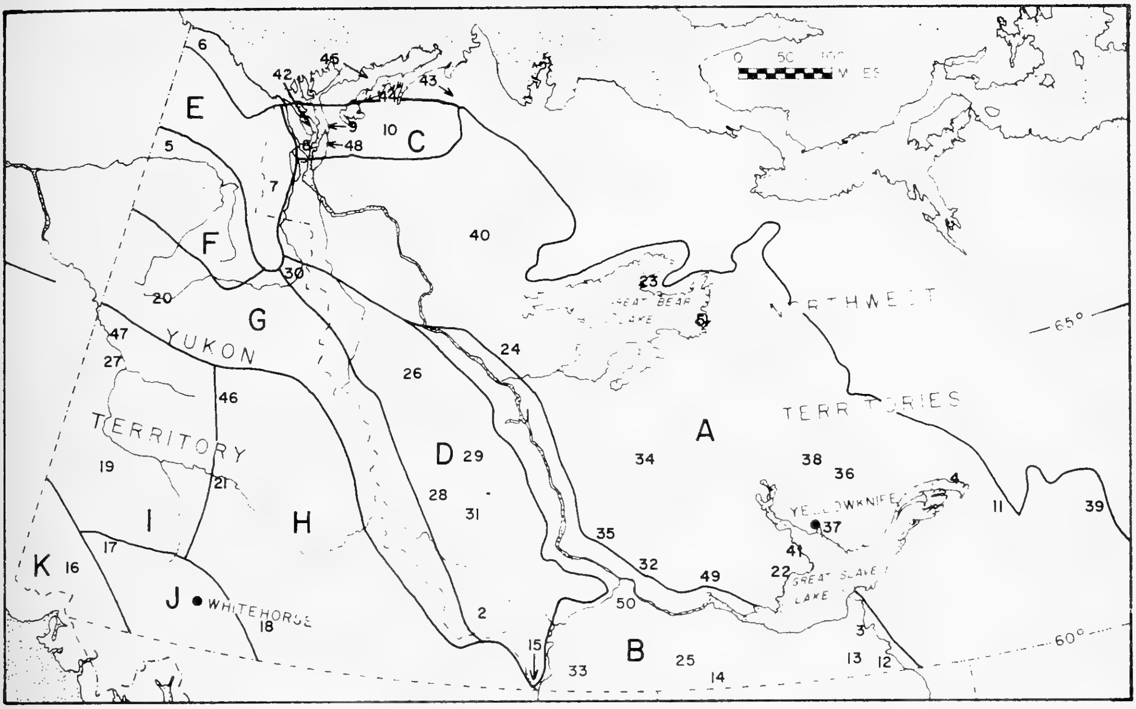

FIGURE 1. Approximate location of proposed reserve sites in the taiga region of the Yukon and Northwest Territories with approximate limits of phytogeographic provinces and other areas (A. Open subarctic woodland, B. Closed mixed and coniferous forest, C. Mackenzie River Delta and Reindeer Grazing Preserve, D. Mackenzie Mountains, E. British Mountains and Richardson Mountains, F. Peel Plateau and Porcupine Plain, G. Ogilvie Mountains and Selwyn Mountains, H. Southeastern Yukon, I. Western and Central Yukon Plateau, J. Intermontane Plateau, and K. St. Elias Range.)

33. TROUT LAKE: A high plateau and a possible alternative to 32.
34. "CARTRIDGE" LAKES: A spruce-lichen complex in an exceptional drumlin field with glacial fluting, with talus between drumlins.
35. EBBUTT HILLS: A high plateau rising from the Slave Lowlands of exceptional floristic interest.
36. BENIAH LAKE: Representative spruce-lichen forest with adjacent burned land.
37. YELLOWKNIFE: A region disturbed by man's activities and of interest to students of floral successions.
38. DISCOVERY MINE: A region once disturbed by mining and of similar interest as 37.
39. COLVILLE LAKE: A sample of representative flora on the east side of the lake, to be used for comparison with floras on Paleozoic and Precambrian rock.
40. ENNADAI LAKE: A sample of the transition from tundra to taiga.
41. WEST MIRAGE ISLANDS: These islands are home to many bird species normally found along the Arctic Coast and in the tundra, and are hence ecologically unique.
42. MIDDLE MACKENZIE DELTA: A representative sample of the zone between tundra and taiga.
43. ANDERSON RIVER DELTA: transition from spruce forest to tundra includes northern range extensions of many species.
44. KUGALUK RIVER and ESTUARY: interesting area because of effects of fire on position of treeline.
45. TUKTOYAKTUK: an area which includes a remarkable range of surficial frost phenomena; area now subject to exploration by oil crews. It is recommended that the tundra panel consider this region.
46. MAYO: A low lying swamp-lake area from the glacial refugium which is rich in rare plant species and home to large moose.

47. YUKON RIVER: Areas as yet not specified; from glacial refugium.
48. DOLOMITE LAKE-CAMPBELL LAKE AREA: Plants of interest because of diversity of species and because they, as a group, may represent a living relic of a more widespread pioneer late-glacial assemblage.
49. MILLS LAKE-HORN RIVER: Old glacial lake bed containing a large shallow lake and marsh, aquatic vegetation, spruce-grass parkland and taiga.
50. FORT SIMPSON: Historic area where there has been agricultural activity over a period of many years.
51. PORT RADIUM: Of interest because of possible effect of natural radio-activity on vegetation.

Because of the vast area to be covered and because the distribution of biotic communities in the Yukon and Northwest Territories is vrtually unexplored, and hence little known compared to the provinces, the panel realizes that it may have missed important representative or unique areas; we would welcome suggestions regarding additional potential reserve sites. Biologists who can assist the panel in further description and field studies are urgently needed. Those who can help are asked to contact one of the undersigned co-chairman or secretary of the panel. Our panel has a small budget to help pay expenses associated with the preparation and completion of the check sheets.

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Marine Parks in Canada?

In view of current developments in Canada, the recent editorial by D. E. McAllister (C.F.N., April 1970) on aquatic parks and reserves was most timely. The following details are intended as informational reinforcement for the proposals made in that statement.

The idea of a marine park, similar in purpose to terrestrial national parks, seems to have developed in the U.S.A. in the 1930's and since that time a number of such parks have been developed along the margins of that country. Attention was focussed on such reserves at the First World Conference on National Parks, in Seattle eight years ago. A resolution was then passed inviting: "the Governments of all those countries having marine frontiers, and other appropriate agencies, to examine as a matter of urgency the possibility of creating marine parks or reserves to defend underwater areas of special significance from all forms of human interference and further recommends the extension of exisiting national parks and equivalent reserves with shorelines, into the water to the 10 fathom depth or the territorial limit or some other appropriate offshore boundary."

Although Canada has a very extensive marine frontage, marine park potential and increasing recreational demands often focussed on water, little has been done by federal or provincial authorities to round out a complete park system that includes underwater areas. Although the country has a number of coastal national parks, such as Fundy and Prince Edward Island, and is developing new ones, like Long Beach, the suggestion made at the above conference has not been implemented. In fact, it is in the underdeveloped countries, such as Kenya and Ecuador, where recreational possibilities are being recognized, that most of the recent developments have occurred.

As on land, time is running out for creating parks at sea, though this is seldom appreciated by the general public. Already more than half of this country's submerged continental margin is covered by oil and gas exploration permits, and elsewhere many activities like fishing, recreation and shipping are well established. Recent oil spills on the Canadian coast indicate another of the threats to our marine resources and the development of areas as marine parks.

Investigations for marine park development are now under way in the Gulf Islands area, off Vancouver. The problems encountered there indicate some of the difficulties that may be encountered in developing marine reserves, especially within easy reach or large population centres. Apart from establishing totally new areas serious attention should be given to expanding our coastal national parks seawards as has been done in countries abroad. The desirability of such action needs stressing at all the public hearings on the provisional master plans for our coastal national parks. So far, at the hearings in the Maritimes, there has been little evidence of such thinking.

Attention should also be directed to developments elsewhere in the world as considerable expertise in marine parks management is being built up in countries like Japan, Australia and the U.S.A. Sound legislative and management techniques need to be developed for Canadian marine parks if many of the pitfalls encountered in our terrestrial parks are to be avoided. Already, the problems of heavy recreational usage of marine parks are becoming evident in places like the Caribbean and Great Barrier Reef. Many specialised personnel will be required to develop, research and manage underwater reserves, hence existing agencies involved in park development should be considering training and research programmes right now.

Compared with the volume of literature available on land parks and their problems the published material on marine reserves is rather scanty. The following few references, however, may be of interest to readers. An annotated bibliography on marine parks, prepared by the author is now available from the Council of Planning Librarians, Monticello, Illinois.

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November 26, 1970

East Coast Tern Watch

This summer volunteers from Nova Scotia to South Carolina will band young Common and Roseate Terns with a colored plastic band in addition to the U.S. Fish and Wildlife Service band. The plastic band will be placed on the leg opposite the aluminum. Each province and state will use a different color so that observers can recognize birds from different areas.

Through observations of these color banded birds we hope to gain information regarding the following questions. How far do birds banded from different areas along the coast as well as inland range from their breeding colonies during their post breeding dispersal? Do birds from different areas along the coast concentrate at particular places in the fall? How late are these species seen at different points along the coast?

The following people will participate in color banding this summer, using the listed colors: Nova Scotia — I. A. McLaren — yellow; Main — Libby, Hatch, Gobeil — red and white horizontal stripe; Massachusetts — Howard — orange; Connecticut — Procter — green and white horizontal stripe; Lake Michigan — Hodess — yellow and green horizontal stripe; Ontario — Clarke — red; Lake Erie, New York — Clarke — light blue; Western Long Island, N.Y. — Heath, Gochfeld — royal blue; Eastern Long Island, N.Y. — Wilcox — black and white horizontal stripe; New Jersey — Savell — green; Maryland — Van Velzen — white; Virginia — Byrd — black; North Carolina — Davis, Sussel — green and brown horizontal stripe; South Carolina — Beckett — orange and blue horizontal stripe; Great Gull Island, N.Y. — Hays — color combinations using U.S. Fish and Wildlife Service band and three color bands, two bands on each leg.

Please watch for color banded terns and send observations to the bander in your area or to:

Miss Helen Hays
Great Gull Island Project
American Museum of Natural History
Central Park West at 79th St.
New York, N.Y. 10024

We would also like to compile a list of places along the coast where concentrations of Common and/or Roseate Terns can be seen in late summer and early fall. If you know of any such places send them to Miss H. Hays at the above address. Any information you can supply on color banded terns or concentration points along the coast would be of great help.

DDT Closes New Brunswick Woodcock Season

On the advice of the Food and Drug Directorate, Department of National Health and Welfare, closure of the 1970 New Brunswick woodcock season was announced jointly on September 17 by the Minister of Indian Affairs and Northern Development and the Provincial Minister of Natural Resources. This action was taken because of high levels of DDT in the breast muscle of some of the birds collected during a pre-season survey by the Canadian Wildlife Service and the New Brunswick Fish and Wildlife Branch.

Thirty-nine analyses of 46 birds were made at the Ontario Research Foundation by L. M. Reynolds, with whom the CWS contracts for toxic chemical analyses. Total DDT + DDE + DDD residue levels, when expressed on a fat basis, ranged from 3 to 771 ppm with a weighted mean of 60 ppm. The highest tolerance level set by the Department of National Health and Welfare for human food is 7 ppm, also on a fat weight basis. In the period 1952 to 1968 about 6,363 tons of DDT were sprayed over New Brunswick forests during operations to control epidemic populations of spruce budworm, a serious defoliating pest. The most highly contaminated woodcock were collected from the most intensively sprayed central region of the province. The least contaminated birds were from unsprayed areas. Lack of adequate knowledge concerning woodcock movements prompted the closure of the hunting season throughout the province, rather than in the intensively sprayed area alone.

Reynolds also found low levels of dieldrin in 21 of the samples. He carried out general screening for all the other common organochlorine pesticides but none were detected. PCB (polychlorinated biphenyl) separation was not carried out because there was no indication that the samples contained such residues. Mirex (dodecachloropentacyclodecane) was detected in 4 of the samples. It was the first time residues of this chemical have been found in Canadian wildlife tissues. One possible source of Mirex is the southeastern United States where it is used as a bait for fire ant control.

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JOHN C. BAIRD

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Department of Fisheries and Forestry

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December 31, 1970

Reviews

Pacific Northwest Ferns and Their Allies

By Thomas M. C. Taylor. Illustrated by Katherine Jones. 1970. University of Toronto Press, Toronto 181. 248 pp. 97 figs. 97 maps. $15.00.

Dr. Taylor's book on the ferns and fern allies of western North America from Oregon north to the Yukon Territory and Alaska will be welcomed by amateur and professional pteridologists both in the area and around the world. The pteridophyte flora of this area is not large — only 97 species are known to occur — but it is a group of plants which attracts much attention and hence certainly warrants a special treatment such as this.

Keys and descriptions to families, genera and species are provided. For each species there are additional notes on habitat, overall range and special comments which include known chromosome numbers. A dot map which depicts the distribution of each species within the area, follows the descriptive text for that species. Line drawings, which are with one exception by Katherine Jones, are adjacent to the related text. They are for the most part very well executed and will be most useful as an aid to identification; that of *Botrychium virginianum*, however, does leave much to be desired.

The treatment is essentially conservative, and is an attempt "to bring together in convenient form the critical judgements of experts who have written about the pteridophyte flora of the Northwest." The order followed is alphabetical throughout. Thus it is rather disconcerting to find the filmy fern family, Hymenophyllaceae, with its single genus *Mecodium*, sandwiched between the fern allies, Equisetaceae and Isoetaceae. For ease of reference, the "true ferns" are all treated as members of the family Polypodiaceae, although the author says, "he is well aware that modern pteridologists divide this large family into a number of smaller ones."

Limited synonomy is provided for each species, a most helpful feature when comparing earlier treatments of ferns of the region to the present one. A list of references to those earlier texts is also given; these references would however be more useful if they were correlated to the synonomy.

Addenda include a list of excluded species, a list of chromosome numbers with source references, lists of species grouped by distribution patterns, a glossary of descriptive terms, literature cited, and an index to botanical names. The list of chromosome numbers is most useful, but would be easier to consult if it was in strict alphabetical order rather than in the order of the text. It should be noted too that the chromosome counts published in Volume II of the Queen Charlotte Island Flora by R. L. Taylor and G. A. Mulligan were somehow missed, even though Volume I with which it appeared simultaneously, is cited throughout the book.

The easily read type, organization of the text, together with the drawings and maps, all on glossy paper make up a most presentable book. The price of $15.00 is perhaps however a little high.

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The Flora of Nova Scotia

By A. E. Roland and E. C. Smith. Part II. The Dicotyledons. Proc. N.S. Inst. Sci. 26, part 4: 277-743. 1969.

This reviewer had the privilege of examining Part I of this flora (Can. Field-Nat. 83: 290. 1969). Most of the comments made concerning Part I apply equally well to part II.

The treatment of the Dicotyledons, of course, constitutes the larger portion of the flora, and this is revealed in the greater thickness of the manual (nearly 2 cm., 466 pages versus 1 cm., 238 pages in Part I). Because of its weight and light binding it will be subject to the same progressive deterioration as the first edition, such as loss of cover and separation of the signatures. Now that both parts have appeared perhaps a hard-covered printing uniting the two parts is in order. I have heard that such is the intent of the authors.

Following the 1½ page introduction is a lengthy and very interesting, completely rewritten account of the physical characteristics of Nova Scotia, an historical account of early collectors with the location of their collections, an account of each of the various floristic elements and a short section on introduced plants and weeds. In Part I a tabulation of the number of species, varieties and forms was given up to the end of the monocots. No such tabulation appears in Part II. Out of curiosity

I counted the species only. There are 982 numbered species of dicots (514 species of ferns to monocots in Part I).

A nine-page indented mixed key to families and some genera follows. Each family and most genera are given brief descriptions. Species identification, as in Part I, leans heavily on the keys, on comments given under the species, and to some degree on geography where significant. Maps to the species include David Erskine's P.E.I. localities and a few are given for that portion of New Brunswick visible on the outline map. Illustrations are selected. For example, in the Corylaceae, taxonomic characters are shown for *Betula populifolia, B. papyrifera* and *B. allegheniensis,* for *Alnus rugosa* and *A. crispa,* for *Ostrya virginiana* and *Corylus cornuta,* but *Betula pendula, B. alba, B. cordifolia, B. occidentalis, B. pumila, B. glandulosa, B. Michauxii* and *Alnus serrulata* are not illustrated. On the whole, illustrations are more successfully reproduced than those in Part I and athough not works of art, are simple and sufficient to portray taxonomic points to the reader.

The Flora of Nova Scotia is printed on high quality glossy paper. The type is clear and the bold-face capitals for genera and bold-face lower case for species is eye-catching. Common names are capitalized. A glossary is given at the end (p. 719) and entries are in bold-face, but to head the entries commencing with P, for example, with the letter P seems somewhat superfluous.

Following the glossary are 5 pages of references reduced only to the authors and journal entries (personally I prefer the titles as well). Then follows an index to families (caps), genera and species, but as the flora is published in the Proceedings, there then follows the volume Index of Authors. Although I found this distracting, it is perhaps fortunate that it is given because the full reference to Part I does not appear in Part II at all.

This flora suffers somewhat from conservatism. Many treatments by various specialists are cited (the list is anything but exhaustive) but the tendency has been to leave well enough alone. However, in spite of these short-comings, I am personally very pleased to see this edition completed. The identification of local species is always that much easier with the aid of a good area flora than with one covering half a continent.

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Biology of Coregonid Fishes

Edited By C. C. LINDSEY and C. S. WOODS. The University of Manitoba Press. 1970 560 pp. Price $8.00

The whitefishes are the most widely distributed and speciose group of freshwater fishes in Canada and it was, therefore, most fitting that the first international gathering of biologists especially interested in coregonid fishes should occur in Canada. The International Symposium on Biology of Coregonid Fishes was held at the University of Manitoba in Winnipeg, Manitoba, August 25 to 29, 1969. The volume under review is a direct result of that gathering since the majority of the papers presented at the symposium are included. (Only two authors requested that their papers be omitted.)

This is an excellent and long overdue text, but it rather defies a reviewer since it is composed of 29 distinct and separate papers, each reporting on one or more aspects of coregonid biology. North American coregonids are the subject matter of 13 papers, Eurasian coregonids are treated in 12, while evolution and genetics are considered in four papers.

Classified on the basis of subject matter, the papers may be assigned to the following categories: systematics (6), evolution and genetics (4), zoogeography and distribution (4), general biology (14), populations (3), spawning and fecundity (5). One paper reviews commercial aspects of coregonid fisheries in Poland.

It is, perhaps unfair to suggest that some papers are more significant contributions than others, but such disparity is inevitable. The comprehensive nature of the papers by the following will make these reports of special interest to students of coregonid fishes: Cavender—A comparison of coregonines and other salmonids with the earliest known teleost fishes; Svardson—Significance of introgression in coregonid evolution; Norden—Evolution and distribution of the genus *Prosopium,* (but the map on page 70 is incorrect for northern Ontario); Maitland—The origin and present distribution of *Coregonus* in the British Isles; Himberg—A systematic and zoogeographic study of some North European coregonids; Nilkolsky and Reshetnikov—Systematics of coregonid fishes in the USSR.

As one would expect from the title, the overriding emphasis is upon systematics, evolution, genetics, and distribution. Life history and behavioural studies are covered only incidentally or not at all , and similarly commercial fishery aspects are not considered except for a paper by Leopold *et al* on Polish fisheries.

We are indebted to C. C. Lindsey for conceiving and laying the original plans for the symposium that produced the papers published in this volume. Another exceedingly valuable by-product of the symposium is a bibliography of coregonid fishes that is being published as Technical Report No. 151, Fisheries Research Board of Canada.

The editors are to be commended for the quality of production and the relative freedom from typographic errors. This book is excellent value for the price.

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A List of Common and Scientific Names of Fishes from the United States and Canada

By R. M. Bailey, J. E. Fitch, E. S. Herald, E. A. Lachner, C. C. Lindsey, C. R. Robins and W. B. Scott. American Fisheries Society Special Publication, Washington (6): 1-149. 3rd edition, 1970. Paper $4, cloth $7 (US).

The value of the AFS list, as it is commonly called, is too well established to require comment. The present edition differs from the second in several respects. More species, 2131 instead of 1852, are included. Certain common names have been modified to bring them into conformity with the principles governing their selection. Scientific names have been updated to include even in some cases changes suggested by papers in press. Reasons for both types of changes are documented in a newly added appendix. This is a most useful addition. Instead of Olympian pronouncements one is presented with reasons or citations for name changes. It is thus an authoritative up-to-date source of names for the non-taxonomist.

The book is set in a lighter faced type than previous editions, making it more pleasant to read. The common and scientific names, previously in separate indices, have been combined into a single index, a highly desirable change.

The editors are to be congratulated for their efforts. One might ask only where it should go from here. Should an A.O.U. type list be developed next?

As far as Canada is concerned the need has long been apparent for a similar list but with French-Canadian names.

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The Wolf: The Ecology and Behavior of an Endangered Species

By L. David Mech. Natural History Press, Garden City, N.Y. 1970 pp. xx + 384. Price $11.95.

There are only two kinds of people in this world — wolf-lovers and wolf-haters. Mech's book is for both kinds. For the wolf-lover it explains so many aspects of behaviour and ecology that up to now have seemed inexplicable. For the wolf-hater it might, in its dispassionate way, influence a re-evaluation of long-held and widely-cherished dogma.

In twelve chapters Mech covers The Wolf Itself, Wolf Society, Social Order and Communication, Reproduction and Family Life, Wanderings, Food Habits, Hunting Habits, Selection of Prey, Effects of Wolf Predation, Relations with Nonprey Species, Harmful Factors and the Wolf's Future. Mech not only draws heavily on the results of his own extensive research with wolves on Isle Royale and in Minnesota but he brings together much widely-scattered literature.

At first glance the frequent citations to the entire gamut of wolf papers disturbed me, since I knew from personal experience how horribly biased and non-scientific some of the professional "wolfers" had been (and still are!) But as one reads on, one can see a pattern emerging. The observations by biologists who are uncommitted to support of "predator control" programmes are in case after case at variance with the published observations of professional "wolfers". Mech does such a skilful job of understatement and juxtapositioning of the discrepancies that the reputations of several old "classics" should dwindle.

One of the important ideas advanced in the book is the use of predator:prey ratios in terms of biomass. Thus the available data show that at p:p ratios of one wolf per 24,000 pounds of prey or less wolves can control the prey populations but at p:p ratios of over 25,000 pounds per wolf little or no control is evident.

Mech also concludes that a wolf population can compensate, by increased reproduction and survival,, for animal losses of 50% or possibly more to animals aged 5 to 10 months or older. It is vital, therefore, that biologists and interested groups keep close watch on the kill statistics of various "control" programmes and ensure that the critical survival threshold is never exceeded in any wolf population.

Mech stresses a point first made, I believe, by Doug Pimlott, namely that virtually all biological field observations on large mammals such as wolves, moose and caribou are now distorted because natural populations of such critters have ceased to exist. The hand of man has modified populations and environments over so much of the world that only biased data are available. Thus we must be exceedingly careful about conclusions based on data from such populations. Nowhere is this more evident for example than in some of the IBP studies in northern Europe and Alaska where a combination of lack of natural predation and excessive reindeer or caribou populations will, without doubt, result in distorted ideas of ecosystem productivity. Once again we are faced with the desperate need for large, inviolate wilderness areas to act as scientific controls for our management schemes.

The book is directed at the informed layman. A copy should be placed in the hands of every MP and MLA and in every school library across the land. I also would like to see it in the library of every sportsmans club. I hope someone sends a free copy to that wolf-hater down in Ontario who, a couple of years ago, agitated for extermination of this valuable species.

My only criticism is the author's failure to cite that admirable exposé of false wolf stories called "Adventures in Error" by the late Vilhjalmur Stefansson (1936).

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Life, Land and Water

By W. J. Mayer Oakes (Ed.). University of Manitoba Press, 1967. 414 p. Illus.

Life, Land and Water sets out the proceedings of the 1966 conference on environmental studies of the glacial Lake Agassiz region. This report is edited by William J. Mayer-Oakes. The conference developed from the 165 INQUA sessions in Boulder, Colorado and started as a workshop but developed into a full-grown conference due to the interest shown by the Quaternary community. The meeting brought together a body of scientific specialists in a variety of disciplines to study what effect man has had on this particular environment. Lake Agassiz was the largest Pleistocene proglacial lake in North America occupying large areas in Manitoba, Ontario, Saskatchewan, North Dakota and Minnesota. A broad range of topics are covered. One of the principal contributions is a discussion of the geology of glacial Lake Agassiz in considerable detail. Elson sets out the geological evidence for Lake Agassiz and includes descriptions of the various phases of the lake. He sets out the topographic setting and the deposits of glacial Lake Agassiz with examples of stratigraphic and geomorphologic evidence to permit a hypothetical history of the lake involving four high water phases separated by three low water phases. The eastern and the southern outlets are described by other authors entering into discussions of the advances and retreats of the ice. There is also field evidence of postglacial uplift which is discussed in another chapter. The Paleo Ecology of glacial Lake Agassiz is discussed in a separate section of the publication describing the vegetation history of the area in terms of the trees, herbs, pollen and forests. These investigations set out the climatic changes during the life cycle of Lake Agassiz. The species of the mollusc and the vertabrate fossils found in the area are described in considerable detail. The final section of the publication deals with the human population history of the area and the history of the nineteenth century is most interesting. The archaeological programs carried out in Manitoba have unravelled the history of the prehistoric (pre-European) human population.

One might ask why these studies have been made. They do have important practical applications. Our knowledge of environmental factors is still inadequate especially where such factors are an integral part of our natural resources. Man is making changes to the land that normally would require thousands of years to be made under normal conditions; we should be curious to learn whether there might be subtle, indirect results that might harm people.

Much effort has gone into this publication to set out the studies dating back to the time of Upham and Tyrel. Modern day studies are included and it is pointed out that some of the statements made in the publication have not been researched adequately and that some of these statements are perhaps a little premature. It is the kind of publication however that encourages readers to supply more evidence for better interpretations of the hypothesis put forth for glacial Lake Agassiz. It is hoped that anyone reading the publication will communicate with the authors of the various papers and in their own way make a contribution. This publication is one of the more complete environmental studies of any area in North America and the editor is to be congratulated upon such a useful, well coordinated and timely publication.

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Population, Resources, Environment. Issues in Human Ecology. Ehrlich, P. R., and Anne H. Ehrlich. W. H. Freeman and Co., San Francisco. 1970. 383 p. $8.95.

The Prairie World. Costello, D. F. Thomas Y. Crowell, New York. 1969. 242 p. $7.95.

Problèmes d'Ecologie: L'Echantillonnage des Peuplements Animaux des Milieux Terrestres. Lamotte, M. Paris. 1969.

Red Data Book 5: Angiospermae. Melville, R. [ed.] International Union for the Conservation of Nature and Natural Resources. Morges, Switzerland. 1970. unpaged. $7.00.

***The Sea-Beach at Ebb Tide.** A Guide to the Study of the Seaweeds and the Lower Animal Life Found Between Tide-marks. Arnold, Augusta Foote. Dover Pub. Co., New York. 1968. 490 p. $3.50. reprint of 1901 Century Company edition.

Seeds of Change. The Green Revolution and Development in the 1970's. Brown, L. R. Drager Publishers, New York. 1970. 205 p. $2.95.

The Solid Waste Fact Book. Glass Container Manufacturers Institute Inc. 330 Madison Ave., New York. 1970. 22 p.

The Tapeworms. Pictures Key Nature Series — How To Know. Schmidt, G. D. Wm. C. Brown Co., Dubuque, Iowa. 1970. 266 p. $4.00.

To The Arctic! The Story of Northern Exploration From the Earliest Times to the Present. Mirsky, Jeannette. Univ. Chicago Press, Chicago. 1970. 356 p. $10.00 cloth, $3.45 paper. Reprint of 1934 edition.

***Use and Conservation of the Biosphere.** Proceedings of the Intergovernmental Conference of Experts on the Scientific Basis for Rational Use and Conservation of Resources of the Biosphere. UNIPUB, New York. 272 p. $6.00. A UNESCO Publication.

The Wasps. Evans, H. E., and Mary Jane West Ebhherhard. Univ. Michigan Press, Ann Arbor. 1970. 265 p. $7.95 cloth, $3.45 paper.

***Wild Pets.** Firsthand Acounts of Wild Animals as Pets, Guests, and Visitors, With Information about their Feeding and Care. Leslie, R. F. Crown Pub. Inc., New York. 1970. 240 p. $7.50.

Wonders of the World of Wolves. Berrill, Jacquelyn. Dodd Mead Co., New York. 1970. 80 p. $3.50.

***World Wildlife: The Last Stand.** Crowe, P. K. W. B. Saunders Co., Toronto. 1970. 308 p. $8.75.

*Assigned for Review.

Proceedings of the Ottawa River Conference. Pollution Probe, Carleton University, Ottawa, 1971. 94 pages. This conference held at Carleton University, June 12 and 13, 1970 deals with the many facets of pollution of the Ottawa River. Contributors to the proceedings include scientists, political leaders, representatives of industry, community organizations and an historian. Available for $2.00 plus 14 cents postage from the Ottawa Field-Naturalists' Club, Box 3264, Postal Station C, Ottawa and from Pollution Probe at Carleton University.

Report of Council to the Ninety-Second Annual Meeting of The Ottawa Field-Naturalists' Club December 8, 1970

During the past year, thirteen meetings of Council were held at the National Library and in Centennial Tower: January 8, January 21, February 19, March 5, March 25, April 2, May 14, June 22, August 4, September 9, October 8, November 6 and November 24, 1970. The Club's business was conducted in the usual orderly manner.

Appointments for 1970 were made as follows:

Editor, The Canadian Field-Naturalist
— T. Mosquin

Business Manager,
The Canadian Field-Naturalist
— W. J. Cody

Chairman, Publications Committee
— J. M. Gillett

Editor, Trail & Landscape
— Anne Hanes

Chairman, Public Relations Committee
— W. A. Holland

Chairman, Bird Census Committee
— F. M. Brigham

Chairman, Macoun Field Club Committee
— I. M. Brodo

Chairman,
Excursions and Lectures Committee
— E. C. D. Todd

Chairman, Natural Areas Committee
— H. N. MacKenzie

Chairman, Finance Committee
— Luella Howden

Chairman, F.O.N. Affairs Committee
— Elva MacKenzie

Chairman, Education Committee
— T. J. Cole

Chairman, Membership Committee
— H. E. Sweers

Chairman, Committee on Shirley's Bay
— F. M. Brigham

Report of the Publications Committee

Since the last report of Council, three numbers of The Canadian Field-Naturalist have been published. These include Volume 83, Number 4, October-December 1969, containing 148 pages, Volume 84, Number 1, January-March 1970, containing 94 pages, and Volume 84, Number 2, April-June 1970, containing 112 pages. The breakdown of items by subject for the three numbers is as follows:

	Articles	Notes	Reviews
Botany	7	3	6
Herpetology	1	0	0
Ichthyology	1	3	3
Mammalogy	4	3	0
Ornithology	9	22	1
Miscellaneous	4	4	10

In addition to the above items there were two editorials by our editor and one guest editorial, three letters to the editor, thirteen items of news and comment, and six pages of other new titles. Of particular interest was a Directory of Natural History, Conservation and Environment Organizations in Canada which was prepared by Theodore Mosquin and M. T. Myres.

Volume 84, Number 3, July-September, 1970, is an advanced state of preparation, and should be mailed to members and subscribers early in December. Much of Volume 84, Number 4, October-December is also in galley, so it is hoped that this number will appear early in the New Year.

Beginning with the first number for Volume 84, The Canadian Field-Naturalist took on a new look which has been welcomed by the readership. This new look included a larger page size, a new type face (Times Roman), better headings and a white cover with a black and white photo depicting some natural history subject. These and the Editorial Policy are described in the editorial which appeared on page three of this volume.

During the spring an effort was made to secure new institutional subscribers by circularizing the chairmen of many of the Biology

Departments of American Universities. This has been quite successful. We have also recruited a substantial number of new members, mainly from outside the Ottawa District, as a result of the membership application form which was included in the first number for this year.

Again the publication of the Canadian Field-Naturalist was supported by a grant of $500. from the Conservation Committee of the Canadian National Sportsmen's show. This assistance is gratefully acknowledged.

Expenditures for the Canadian Field-Naturalist are recorded in the financial statement of the Club.

Report of the Editorial Committee for Trail & Landscape

Volume Four of TRAIL & LANDSCAPE contained five issues with a total of 156 pages, the same size as Volume Three. We continued to publish articles on local flora and fauna, written by knowledgeable club members for the most part, in non-technical fashion. Other features included descriptions of places of natural history interest, reports of activities, meetings and projects of our own and related organizations, letters and book notices. A new feature, the Nature Puzzle, was added this year, and more space was given to recording some highlights of a few of our field trips. Expenditures for Trail & Landscape are recorded in the financial statement of the Club.

Report of the Public Relations Committee

The United Trust Company kindly allowed us the use of a corner window for the display of birds loaned through the courtesy of the National Museum. The selection of birds exhibited was good although there would have been some improvement if appropriate species had been reserved much earlier.

A new bird feature column written by George McGee was run in the Guardian newspaper of south-east Ottawa. Again we extend special thanks to John Bird of the Ottawa Journal and Wilfred Bell of the Ottawa Citizen for their columns and for their reports of our club activities.

Report of the Bird Census Committee

There were no formal meetings of the committee this year. Major activities included the Christmas Bird Count, May Run and Fall Run.

Christmas Bird Census

The Ottawa Christmas Bird Census was held on December 21st, 1969. The count was an unprecedented success with a new count high of 72 species. New species added to the alltime accumulative total were Lesser Scaup, American Coot, Rufous-sided Towhee and Chipping Sparrow. One unusual highlight included two Screech Owls both recorded within viewing distance of Chicken Villas one at each end of the city. In fact one was discovered as one member of the compilation group went out to purchase food! It was estimated that between 50 and 75 bird feeders were under observation during the count day which contributed substantially to the total individuals of 13,484.

May Run

The Club's second May-Run was held on May 24th within the thirty-mile radius. A new record for the most species ever recorded in the area in one day was established at 175. This included two new birds to the Ottawa list which were Glossy Ibis and Western Kingbird. Other highlights included Wilson's Phalarope and Yellow-breasted Chat.

Fall Run

The first September bird census was held on September 7, 1970. Within the 24 hour period, 174 species, and 35,700 individuals were compiled by thirty observers. Although the count did not yield any exciting species some useful data on departure and arrival dates, as well as information on total individuals, was obtained.

Some progress has been made on the revision of the Ottawa Check list. It is hoped that the new check list will be available by March of the following year.

Report of the Macon Field Club Committee

1. *Membership.* At the moment (Nov. 1970), all three groups of the Club (Juniors, Intermediates, and Seniors) have full rosters. This is the first year in many that the Seniors

have had full Membership. When we closed last season in June, the Juniors had 35 members (full roster), the Intermediates had 28 members, and the Seniors had 31 members.

2. *Activities.* The Juniors and Intermediates, besides having the regular program of "observations", natural history games, and films, had several interesting speakers and excursions. Highlights were a January trip to "Reptile Haven", a visit to the Museum's Paleontology lab to see dinosaur displays being constructed, and Mrs. Fenja Brodo's talk on the "Senses of Insects".

   The Intermediates had their first winter birding trip, and the younger group had a successful full-day Spring trip to Ramsay Lake in the Gatineau. In the fall, two trips were taken: one to the Bells Corners Study Area where a nature "Scavenger Hunt" was held, and another led by Dr. Nelson Gadd to search for "Ice Age Fossils".

   The Seniors had their regular program of invited speakers, too many to list here. In April, the Club's second annual symposium was held, this time on the subject of "Environmental Pollution". Eight members participated by giving papers on different aspects of pollution. Discussions followed the papers. Other short talks by various members, films, and discussions filled out the year's program.

   During the summer, two camping trips to Parc de la Vérendrye were taken by the Seniors. This marks the first time official summer activities were held by the Club. Both trips were well attended (15-19 members on each) and were very successful. Other field trips were held by the Seniors on almost every weekend, mostly to their Study Area near Bells Corners. Other areas visited include Mary Stuart's farm (a snowshoe and skiing trip), Blind Lake, and Luskville Falls.

   In June, the Juniors and Intermediates had an Environmental Pollution poster contest that was judged by the Seniors. After judging, the posters were placed in schools and store-fronts around the city. The project received good press coverage, and was considered to be successful.

3. *Library.* The Library did not increase greatly over the past year, although a number of books were purchased to fill in specific gaps. On the other hand, an inventory showed a significant number of missing books, and this matter is being pursued further. It seems likely that the members are not entirely responsible for the loss.

4. *Liaison with National Museum.* This fall, the Club was fortunate in the appointment of Mr. Alex Fournier of the Museum's Education and Extension Division as a liaison officer. Mr. Fournier is actively participating in organizing the bookkeeping aspects of the Club affairs, and helps in many other ways, including aspects of the weekly program.

5. *Scholarship winner for the F.O.N. Red Bay Camp.* Stephen Darbyshire, past president of the Senior Club, was chosen as the 1970 recipient of the O.F.N.C. Red Bay Camp Scholarship. Stephen is now in Grade 13. He is interested in many aspects of biology, as is evidenced by his impressive collection of living snakes, and his article in the Little Bear on ferns. Stephen is still active in the club, serving this year as editor of the Little Bear.

6. *The Little Bear.* The 1970 edition of the Little Bear (Number 28) was the biggest and probably the best ever. It was 75 pages long, half again as big as last year's, which was twice as big as the previous year's. Included were 46 articles, poems, puzzles and reports, all written by Club members, plus seven symposium reports by Seniors who contributed to the Symposium on pollution.

Report of Excursions and Lectures Committee

During the year there were 45 excursions, 11 lectures, one film evening and the annual dinner. The excursions comprised of: 7 general interest, 26 ornithological, 7 botanical, 2 entomological, 1 herpetological, 1 of geological interest and one of social significance — the collection and removal of trash from Luskville area of the Gatineau Park. In addition there were 8 non-scheduled ornithological outings which were well attended; two, of the general weekend trips. On one of these in May, 29 members travelled by coach to Hamilton and Niagara area; the co-operation of members of the F.O.N. and local natural history societies was appreciated. It was heartening to see an attendance of 60 persons in October at our first geological excursion for some years, and this indicates a need for further rock-hunting outings.

The annual dinner, held in May, at the RA Centre, had an attendance of 196. Our guest speaker was Mr. D. H. Fullerton, Chairman of the National Capital Commission. His topic was "Building a National Capital Region — Problems and Priorities"; a lively, stimulating question period followed.

Report of the Natural Areas Committee

The committee met five times during 1970 and started to lay the groundwork for long range planning on behalf of your Club. This consisted of two principal actions: development of a natural areas inventory form and preliminary discussion of a recommendation to the Council regarding Club policy on the acquisition of land.

It is regretted than only one member of the Club has requested inventory forms. If this is a clear indication of how much our membership really wants to conserve natural areas it is feared that we will rarely, if ever, have the information needed to convince the right people at the right time. Members who are especially interested in the conservation of any specific area are urged to take one or more of these forms, complete it and give it to next year's Chairman of this committee. If you provide facts on this relatively simple form, the Club will have a good start on assessing its natural history values.

To date a recommendation on land acquisition has not been submitted to the Council. This should be a high priority task for next year's committee. Your President and the Chairman attended a seminar in Hamilton on Nature Reserves which served to make both of us strongly aware of the implications of holding land and of some of the problems involved.

The Committee reviewed and finalized the Club's submission to the Ottawa-Carleton Regional Government. This document entitled "Preliminary Recommendations Regarding Zoning for Natural Areas and Wildlife Sanctuaries in the Regional Municipality of Ottawa-Carleton" was sent in November in response to an invitation from the Planning Branch. It identifies nineteen areas for conservation ranging in size from Ottawa Beach to the Mer Bleue and the Richmond Bog. The pressures of land developers in the entire Regional Municipality are constantly increasing and our Club was fortunate to have the opportunity to present its views before some of the planning decisions are made.

This Committee will perform a key role in determining how effective naturalists can be in rescuing our natural gems from "development". The incoming Council is urged to ensure that it is one of the strongest Committees, if not *the* strongest, committee. This means that our best brains *must* be available at least on a consultative basis. It is also suggested that any member of the Club who feels that he or she could make a significant contribution, call the Secretary or the President and offer his services.

Report of the Finance Committee

No changes were made in the Club's holdings during the year. See the financial statement.

Report of the Federation of Ontario Naturalists Affairs Committee

Your F.O.N. Committee has been laying the groundwork for our club's part in the F.O.N. annual meeting which is to be held here in Ottawa, April 23rd, 24th and 25th, 1971, at the Skyline Hotel.

We held four meetings during the year, one of which Mr. Gerry McKeating, Executive Director of the F.O.N. attended.

As host club, at the annual meeting, we are responsible for the Friday night coffee party, manning the registration and information desks, displays, projection and projection equipment, a special issue of our publication, Trail and Landscape and field trips on Sunday.

We have therefore set up activity groups and have leaders for these. The activity leaders will call on the general membership for help.

We hope all the members of our club will take this opportunity to attend the meetings and the dinner. We know you will enjoy the program and the opportunity to meet fellow naturalists.

We will need a lot of help so if there is any field in which you would particularly like to work volunteer now! Don't wait to be drafted.

Report of the Education Committee

In the Ottawa papers on January 21st, 1970, was a notice concerning the collection of DDT during the following 3 weeks. The Education Committee wrote to the Medical Officer of Health, suggesting that a further collection be held during the early summer when people were more garden conscious. This met with the M.O.H.'s approval, and collections were again made in May.

In order to be able to deal with requests for speakers from various societies, organizations and groups (e.g. Scouts, Old Peoples Homes) a list of persons willing to donate their time and knowledge was prepared so that we are now in a position to supply a speaker on almost any facet of natural history.

The main outlet of ideas and energy has been the publication of the O.F.N.C. Conservation Calendar for the first time. Many unforseen snags occurred which could be avoided in the future — should this initial venture prove a financial success.

Report of the Membership Committee

The Club's membership increased by almost 20% during the past year. Individual membership now stands at 873, versus 723 last year, and institutional membership at 461, versus 418 last year. Interesting to note is the great interest shown in the family membership category, which increased to 141 from 78 last year. More than half of the individual members reside in the Ottawa Valley, about 10% outside Canada. Of the institutional members almost half reside in the U.S.A., the remaining are spread out over all provinces of Canada in approximate ratio to their number of inhabitants, and about 71 reside elsewhere in the world. The number of Trail & Landscape subscribers has remained almost constant, and is now 47; with 12 additional reduced subscriptions being given to members of the Macoun Field Club.

In addition to the above members, the club has 5 honorary members: Herbert Groh, Dr. H. F. Lewis, Stuart Criddle, Hoyes Lloyd and Wilmot Lloyd.

A sad note is the decease of Dr. George Turner, Fort Saskatchewan, Alberta, honorary member since 1959.

Report of the Shirley's Bay Committee

This committee was formed with the objective of looking into the possible development of Shirley's Bay as a nature interpretation area. One formal meeting was held and the members discussed the plausibility of constructing a lookout tower at the east end of Shirley's Bay near Watt's Creek along with strategically placed trails and parking lot. However, there seems that some sort of arrangement could be made with the DND for access into area No. 5, the west side of Shirley's Bay and the development in this area has been considered by this committee.

In view of the fact that Shirley's Bay could be converted into third stage sewage-lagoon, all the previous objectives were held in abeyance. The Chairman then took on the responsibility of investigating the ecological effects on wildlife. Tertiary treatment of sewage is an expensive and relatively uncommon practise for waste treatment. Essentially it is the stage at which water is rejuvinated and much of the basic food supply of waterfowl created. It would appear that such a sewage lagoon might be beneficial. It is the concensus of this committee to defer further action at this time.

The Ottawa Field-Naturalists' Club Statement of Income and Expenses

for the Year Ending November 30th, 1970

Income				
Fees from Subscriptions			$ 4,536.00	
Fees from Memberships and Affiliations			4,711.00	
Sale of Back Numbers			4,205.01	
Sale of Reprints & Magazines		$2,574.55		
Less: Cost of Materials Sold				
Inventory of Reprints (Dec. 1, 1969)	$1,482.00			
Purchases	2,401.00			
	$3,883.00			
Less: Inventory of Reprints (Nov. 30, 1970)	2,081.75	1,801.25	773.30	$14,225.31
Less Cost of Publications				
Canadian Field-Naturalist			$11,132.64	
Trail and Landscape			834.05	11,966.69
				$ 2,258.62
Less Expenses				
Advertising			$ 142.47	
Bank Charges and Interest			13.81	
Committee Expenses:				
Bird Census		$ 23.90		
Bird Feeder Project		57.15		
Education Committee		17.31		
Excursions & Lectures		14.18		
Delegation Expenses		21.73		
Macoun Field Club		142.42	276.69	
Honoraria			400.00	
Incidentals			154.75	
Postage			760.69	
Printing & Stationery:				
General Supplies		276.97		
Car decals		439.01	715.98	
Salaries			688.00	3,152.39
Net Deficit on Operations				$ (893.77)
Less Other Income:				
— Donations			500.00	
— Interest and Dividends			1,211.96	
— Miscellaneous			18.79	
— U.S. Premiums			206.29	1,937.04
Surplus				$ 1,043.27

The Ottawa Field-Naturalists' Club Balance Sheet

as at November 30th, 1970

Assets

Current

Cash in Bank and on Hand		$ 5,942.33	
Cash in Savings Account		91.08	
Bills Receivable		1,649.25	
Accrued Interest Income		879.18	
Prepaid Expenses		456.36	
Inventory of Reprints		2,081.75	$11,099.95
Fixed (at cost)			
Furniture, Fixtures & Equipment			902.96
Investments & Securities			
Bell Telephone Company of Canada			
35 Common Shares (Market value 1,601.25)	$1,617.20		
2 preferred shares (Market value 104.50)	94.00		
Microsystems International Ltd.			
2 shares (Market value 8.20)	20.00		
		$ 1,731.20	
Canada Savings Bonds		10,700.00	12,431.20
			$24,434.11

Liabilities & Equity of Surplus or Deficit

Current Liabilities

Income Received in Advance		$ 1,864.00	
Accounts Payable		4,946.30	$ 6,810.30
Equity of Surplus or Deficit			
Balance, Dec. 1st, 1969		$16,480.54	
Add: Donation Refunded from 1969	$ 100.00		
Net Surplus for the year 1969–1970	1,043.27	1,143.27	
Balance, Nov. 30th, 1970			17,623.81
			$24,434.11

Note: Estimated Inventory of CFN is $25,000.00

(Original signed by) (Geoffrey Wasteneys) Auditor
(Anthony J. Erskine) Auditor
(F. M. Brigham) Treasurer

Information Governing Content of The Canadian Field-Naturalist

Feature Articles

Beginning with the 1970 issues, the Canadian Field-Naturalist will be open for the consideration of major feature articles whose purpose is to make authoritative reviews of outstanding natural history and/or environment issues of our time. If possible, feature articles should be illustrated. Publication costs are open for negotiation between the author, editor and the business manager of the club.

Articles

The Canadian Field-Naturalist is a medium for publication of research papers in all fields of natural history. Reviews, compilations, symposia, controversial or theoretical papers, historical researches, etc. can also be published. Environmentally related papers are given priority in publication sequence.

News and Comment

Informed naturalists, biologists and others are invited to present documented narratives and commentaries upon current scientific and political events that affect natural history and environment values. This section deals with activities, policies, and legislation relating to land and resource use, national and provincial parks, pollution, natural science education, conservation, natural area and species preservation activites and so on. Contributions should be as short as possible and to the point.

Notes.

Short notes on natural history and environment written by naturalists and scientists are welcome. Extensions of range, interesting behavior, pollination observations, reproductive phenomena, oil and pesticide pollution statistics and many other kinds of natural history observations may be offered. However, it is hoped 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 environment values are welcome. These should be brief, clear, pertinent and of interest to a wide audience.

Reviews

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

Special Notices and other items

The Canadian Field-Naturalist has a flexible publication policy. Hence an item not falling under any of our traditional sections can be given a special place provided that it is judged suitable.

(See Instructions to Contributors inside back cover)

S-C 2.12

AUG 20 1971

The CANADIAN FIELD-NATURALIST

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

Volume 85, No. 2 Ottawa April-June, 1971

The Ottawa Field-Naturalists' Club

FOUNDED IN 1879

Patrons

Their Excellencies the Governor General and Mrs. Roland Michener.

The objectives of the Club are 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 co-operate with organizations engaged in preserving, maintaining or restoring quality environments for living things.

The Canadian Field-Naturalist

The Canadian Field-Naturalist is published quarterly by the Ottawa Field-Naturalists' Club with the assistance of affiliated societies and of a contribution from the Canadian National Sportsmen's Show. All material intended for publication should be addressed to the editor. 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.

Membership and Subscription

The annual membership fee of $5.00 for individuals covers subscription to the journal. Libraries and other institutions may subscribe at the rate of $10.00 per year (volume). Applications for membership, subscriptions, changes of address and undeliverable copies should be mailed to: Treasurer, Ottawa Field-Naturalists' Club, Box 3264, Postal Station "C", Ottawa, Canada, K1Y 4J5. Return postage guaranteed. Second class mail registration number 0527.

Back Numbers

Prices of back numbers of this journal and its predecessors, (TRANSACTIONS OF THE OTTAWA FIELD-NATURALISTS' CLUB, 1879-1886, and the OTTAWA NATURALIST, 1889-1919), are obtainable from the Business Manager.

Cover Photograph: Rocky Mountain Bighorn Sheep rams foraging in springtime at the Palliser Range, Banff National Park. See article "Bighorn Sheep in the Canadian Rockies: A History 1800-1970" in this issue. Photo courtesy John G. Stelfox.

I would like to become a member of THE OTTAWA FIELD-NATURALISTS' CLUB and to receive the quarterly journal THE CANADIAN FIELD-NATURALIST

Name (Dr., Mr., Mrs., Miss) ______________________________

(In block letters)

Address ______________________________

____

____

____

(Include postal code)

I would like my membership to start with

January of 1970 ☐

January of 1971 ☐

My membership fee of $5.00 is enclosed.

____

(Signature)

(Mail to) Treasurer,
Ottawa Field-Naturalists' Club,
Box 3264 Postal Station 'C',
Ottawa, Canada K1Y 4J5

Please note that all library and institutional subscriptions to THE CANADIAN FIELD-NATURALIST are $10.00 a year (volume)

The Canadian Field-Naturalist

VOLUME 85 APRIL-JUNE, 1971 NUMBER 2

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Oil under the Tundra in the Mackenzie Delta Region

There is justifiable concern about the effects of industrial man's activities on the tundra. For over 20 years the oil industry has explored the western arctic mainland, but only recently has exploration been in earnest. Oil-seeps along the Alaska north slope became known to white-men in 1917, and Naval Petroleum Reserve No. 4 was established there in 1923. It was not until 1943-44 that exploration started with heavy military vehicles initiating the sort of tundra damage which has caused present alarm and awareness. Yet, in summer 1965, Imperial Oil bulldozed away the active layer (thawed in summer) of soil along miles of seismic exploration lines on the Tuktoyaktuk Peninsula. Public outcry, scientific concern, and industrial sensitivity has since gone far to stem the 'boomer' scorched earth attitude. Exploration has succeeded: in 1968 the Prudhoe Bay field was discovered, in 1970 and 1971 pools were found on the Tuktoyaktuk Peninsula, and a recent discovery, on Richards Island is just across a channel from a bird sanctuary in the Mackenzie River Delta.

The use of tracked vehicles is the cause of real concern. Driving over ice-rich permafrost often seriously alters or displaces insulating vegetation and initiates thermokarst which may lead to chronic erosion as water flows in the subsided tracks. The process may be initated by one track, or even by a foot-path. Most areas seem more resistant but disruption may be subtle. For example, on gently sloping wet meadows vehicles may merely press the vegetation into shallow troughs, which then direct water that would normally percolate over a wide area, thus draining all or part of the meadow and reducing its biotic productivity over many years. All cross-tundra driving should be prohibited on unfrozen tundra and when air temperatures at the ground exceed freezing.

Seismic exploration is now restricted to winter, but continues should a chinook melt the first snows. Nevertheless, at the present intensity, exploration seems to have only minor localized effects. In marshy areas of low-centered polygonal ground cotton grass is lusher along seismic lines: presumably the tussocks are spread apart, allowing more new growth. The 1965 lines through similar terrain support almost no vegetation and are often shallow canals and intermittent black pools for long distances. Over drier high-centered, heath and shrub-covered polygons disruption is greater. The lugs of the bulldozer tracks cut the aerial part of the vegetation into sections and separate them from the roots so that small mats lie loose along the lines. Little is known about regeneration on healthy tundra. The 1965 lines in that terrain support lush stands of native grasses on the exposed mineral soil. In the Mackenzie Delta seismic lines leave a swath of broken willows and spruce. No doubt the willows will regenerate: spruce will have to recolonize, and then will take several hundred years to grow to the same size. The repercussions of widespread disruption on the natural vegetation are almost impossible to predict as it is hard to assess what has already happened. Nevertheless, it is safer to act in future on pessimistic projections.

Revegetation of different types of tundra with native and exotic plants with and without fertilizer is being studied. The value of exotics is in emergencies, and emphasis should be directed as to how to encourage rapid colonization of disturbed sites with native adventives.

Exploration also entails wild-cat drilling, and with it the problems of oil rigs. Each rig blasts two sumps out of the permafrost, one about 15 to 20 feet square is for camp wastes, the other about 75 feet square and 8 to 10 feet deep is for the rig and used drilling mud. The latter is lined with polyethylene in summer to protect the frozen ground. Problems may arise when rig sumps overflow and drilling mud freezes on the tundra; otherwise drilling muds, complete with additives are probably innocuous except in water where the gel may clog fishes' gills. Once wells have been completed the frozen sumps are covered with ground hopefully deep enough to prevent thawing in summer. Revegetation is vital on these artificial pingoes and the surrounding three acres of badly disrupted ground of the rig site. In high winds half-cooked and burned garbage blows for miles, and snow buries equipment and materials. In digging out after blizzards, fuel drums are punctured, and bags of cement and mud additives such as caustic soda and salt are burst. Clearly more care is needed to reduce pollution and litter at these sites.

Access roads for rigs and equipment depots share problems with seismic lines, but seem more disruptive as vegetation along them on all types of tundra tends to be completely destroyed. Rhizomes under roads over low-centered polygons may regenerate given time. Roads are built in winter, supposedly from packed and wetted snow. Sparse snow in early winter, then extreme cold render that method of construction ineffective in some places. Standard heavy trucks rumble along, pot holes develop, and graders may cut the road surface down to the ground. New concepts in vehicle design show promise for minimizing disruption, but there is resistance to innovations.

Drilling for oil, like any mechanized operation on tundra, requires gravel pads to prevent equipment and materials from sinking into the ground in summer. Vast quantities of gravel will be needed for the Dempster Highway and the proposed Mackenzie Valley Pipe-line. Gravel is scarce in the Mackenzie Delta. Much is in the river valleys and may be fish spawning grounds. Other gravel is old glacial deposits and is important habitat for foxes and ground-squirrels, the latter a staple food of predators including the rare Barren-ground Grizzly Bear. Gravel should not be simply regarded as a ready made material conveniently deposited by nature for man's roads, air-strips, pads, and berms.

Many problems I have mentioned may be resolved through adequate care and planning or properly directed research efforts or both. The problems associated with wildlife are more thorny. Caribou may or may not cross seismic lines or roads, depending on their temperament which changes throughout the year: what may be a barrier during calving, may be a pathway at the height of migration. It is foolhardy for industrial representatives and others with vested interests to offhandedly claim that caribou are, or will be unaffected. Grizzly bears, in digging for ground-squirrels on man-made berms may remove protective layers on buried pipes, displace supporting gravel, and weaken pipe-lines. Grizzly bears have been known to burst fuel bladders. For bears and foxes, improperly treated garbage is a great attractant. Already grizzly bears have been shot on garbage dumps because they became beligerent when chased. Foxes are tame and attractive, but carry rabies. Bored aircraft pilots illegally harrass game, and I have heard of helicopter pilots herding Dall Sheep off cliffs. The drone of aircraft disturbs some nesting birds, and increases nest predation. Some disturbance by aircraft is inevitable, but restriction on flight altitudes over different regions and seasons are needed.

Social problems are developing in the north. White-man's ways have cast scorn on professional trapping. The trend of native people to wage earning is resulting in the loss of skills and arts pertinent to living from the land, and simultaneously increases the social and economic dependence of native people on white society's patronage. Native people, with opportunity to advance, work for oil operations, but tend to remain at the lowest levels and quit. Sometimes signs of feeling inferior appear. Some natives on oil exploration crews also trap; but this seems unfair to the professional trappers in the area. Other problems correlated with the presence of whites, wages, and alcohol are no more attributable to the oil industry than any other foreign institution. Even if one accepts the thesis that wage earning is best for the people, it must be remembered that oil field development and exploration do not employ many people.

The portents of the future are difficult to decipher. At the present level of activity, if practices improve over the next few years, environmental hazards seem minor. But presumably the discoveries of the last two years are important and we can expect accelerated exploration and greater pressure for building pipe-lines. If that premise is correct several tens of thousands of miles of seismic lines will be run and hundreds of wild-cat wells drilled. The area which will be directly affected is said to be 0.3% of the sedimentary basin of about 470,000 sq. miles. Ecologically such a proportion is meaningless. An oil field may be discovered in a small area critical to the survival of a wide-ranging species, so the elimination of that species would affect the total area of its range. Numerous rigs will be moved onto proven fields, and all the associated problems multiplied accordingly. Once the oil is tapped, a maze of above-ground feeder pipes and pumps would be installed to take the oil to a major pipe-line.

Misleading and ecologically invalid proportions of land use are touted for the proposed Mackenzie Valley Pipe-line (e.g. 0.0002% of the area of the Yukon and N.W.T.). The chance of a pipe-line breaking is small, but exists. Earthquakes occur along the mountains in the Yukon, albeit not as frequently as along the trans-Alaska route. The pipe-line could break anywhere, so the ecologically valid area from this stand-point is the total area of water-sheds, coastal seas, and land which could be affected. The fanfare over the voyages of the Manhattan have ceased abruptly, and just as well. The forces of moving sea-ice are formidable. Off-shore crude oil spills in the arctic would be many times more devastating than in

(*Continued on page 122*)

Bighorn Sheep in the Canadian Rockies: A History 1800-1970

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Abstract. Population fluctuations of bighorn sheep (*Ovis canadensis canadensis* Shaw) on the eastern slope of the Canadian Rockies and on the western slope in Kootenay National Park are discussed for the period 1800 to 1967. During pristine times bighorns underwent sporadic fluctuations caused by severe winters, disease, and changes in the condition of their ranges influenced by weather, fire and interspecific competition. Between 1860 and 1910, thousands of railway builders, miners, traders, settlers and resident Indians depleted numbers, by heavy indiscriminate hunting with firearms, from an original 10,000-plus to 2,600. Between 1910 and 1915, an extensive preservation program closed to hunting 7,500 square miles established as dominion reserves (now national parks) and reduced hunting to a low level on 6,500 square miles of sheep range in Alberta. This, together with improved range conditions resulting from fires and low sheep and elk numbers, tripled populations over the next 20 years to an estimated 8,500 by 1936. Between 1937 and 1949, a series of die-offs reduced populations to 2,500 by 1950. These die-offs were attributed to a pneumonia-lungworm disease, deteriorated ranges, heavy elk and livestock competition, decrease in grassland ranges caused by forest succession, and three severe winters between 1946 and 1949. By the summer of 1960, populations gradually increased to 10,100. Low numbers of sheep and elk during the early 1950's, mild winters, and a continued low level of hunting contributed to the increase. During fall and winter 1966-67, populations declined by 75% in Kootenay National Park because of deterioration of winter range, a pneumonia-lungworm disease and possibly, the after effects of the severe winter of 1964-65. However, populations on the eastern slope of the Rockies continued to increase in 1967, despite high loads of internal parasites and deterioration of winter range. On provincial lands, increased harvesting of bighorns and elk may avert a die-off. Future population levels will probably be determined by pneumonia-lungworm disease, harvests, and by range carrying-capacities, which will be affected by forest successional trends, climate, interspecific competition, and man-made modifications to the habitat.

Introduction

In Canada, the Rocky Mountain bighorn sheep (*Ovis canadensis canadensis* Shaw) occupies mainly the east slopes of the Rocky Mountains between latitudes 51° and 55°, and both slopes south of latitude 51° (Cowan 1940; Clarke 1941). Concern for its welfare has resulted from a recent population decline along the west slopes of the Rockies in southern British Columbia. Similar declines in herds along the east slopes may deplete populations to such an extent that they may not naturally return to their former abundance. The nature of past population trends, and associated environmental factors, was studied so that current conditions could be interpreted and future population trends forecast.

Area

The study area included the Rocky Mountains' eastern slope in Alberta — 13,500 square miles (Figure 1) comprising Jasper, Banff, and Waterton Lakes National Parks (4,200, 2,564 and 204 square miles respectively or 6,968 square miles) and provincial lands (6,532 square miles); and the 543-square-mile Kootenay National Park on the western slope in British Columbia.[1] Rocky Mountain bighorns in the East Kootenay region to the south will be referred to only briefly as Bandy (1966) and Demarchi (1967) have already recorded recent population trends of those herds. A few animals are found almost as far as Golden, to the north of Kootenay. And there is a small herd north of Golden at the head of Sheep Creek near the British Columbia-Alberta boundary at latitude 54° (Cowan and Guiget 1956).

The bighorn's range in the Canadian Rockies occupies a strip approximately 30 by 450 miles. East of the Continental Divide are pervious shale, sandstone, and limestone mountains with steep eastern escarpments, and gentle westerly slopes (McKay 1952) which have developed into the productive grasslands so essential for the bighorn's winter range (Figure 2). Prevailing westerly winds and winter sun-

[1]In the text the four National Parks will be referred to as Jasper, Banff, Waterton, and Kootenay.

FIGURE 1. The locations of Jasper, Banff, Waterton Lakes, and Kootenay National Parks within the northern Rocky Mountains.

light prevent deep snow and make them suitable for sheep winter habitat (Cowan 1940; Clarke 1941; Banfield 1958).

To the west lie hard, rugged, resistant quartzite and limestone mountains (MacKay 1952). Here, limited grassland and rocky alpine regions drop rapidly into coniferous forests. Bighorn sheep are ordinarily absent from this region, except for an area south of latitude 51 where winter climatic conditions are less severe (Cowan 1940; Clark 1941), and where less resistant geological formations extend west of the Continental Divide (Mackay 1952).

Methods

Historic and recent records of population levels, trends and distribution, and factors in-

FIGURE 2. Rams in the spring foraging along southwestern exposures of the Palliser Range in Banff National Park. The remnants of previous forests destroyed by fire can be seen, June 1967.

fluencing them, were compiled and analyzed. Fortunately, many travellers during the period 1800-1915 recorded in their daily journals much general information on abundance and distribution of bighorn sheep. In addition, park wardens and wildlife specialists have recorded annually much data on the 7,500 square-mile national park area, established as dominion reserves between 1910 and 1915. An intensive federal study of big game populations in the Rocky Mountains prepared between 1913 and 1915 provided detailed data of populations and distribution (Millar 1915). Aerial surveys have been used since the early 1950's to determine populations within the national parks and on Alberta provincial lands. These counts, along with those taken annually by wardens in the parks and reports from hunters outside the parks, were used to estimate bighorn sheep numbers and distribution over the past 15 years. I gathered population data from numerous aerial and ground surveys in western Alberta during an 11-year tenure with the provincial government. And in 1967, with the cooperation of park wardens, I completed extensive helicopter and ground censuses in the Rocky Mountain national parks.

Results and Discussion

1800 to 1860 — A period of high populations.

In 1800, Duncan McGillivray and David Thompson, collecting bighorn sheep on November 30, near Exshaw, Alberta, reported many sheep along the Bow River valley east of the present site of Banff (Thorington 1947). In 1808, a small herd was found near the western end of the North Saskatchewan valley near the junction of the Howse and North Saskatchewan rivers (Tyrrell 1916), presumably on Mt. Wilson, where they are still found today. According to local Indians this was the western limit of the species (Tyrrell 1916). In 1811, the valley, from the eastern extremity of the mountains at Gap Pass to the south end of the upper Kootenay Plains, supported bands containing more than 100 sheep (Coues 1897). In 1859, the Palliser Expedition found bighorns in the valley, including one band estimated at several hundred (Spry 1963).

To the south, bighorns were present along the upper valley of the Kootenay River in 1811 (Coues 1897); and along the upper Simpson River above Lake Minnewanka, and on Cascade Mountain along the Bow Valley in 1841 (Simpson 1931). Both Hector in 1858 (Spry 1963) and the Earl of Southesk (1875) in 1859 reported sheep along Pipestone Creek north of Bow Valley. During 1858-60 the Palliser Expedition reported large bands of sheep along the Bow, North Saskatchewan, and Athabasca valleys, as well as at several localities between these valleys (Spry 1963).

In the Jasper region, bighorns were abundant in 1827 (Douglas 1914). Early residents in Jasper reported that bighorns were restricted to the two eastern mountain ranges and did not occur on the continental divide or west of it (Hollister 1912). Henry Moberly reported that between 1855 and 1861 they were plentiful from the headwaters of the McLeod River northward to the mountains along the Big Smoky River between 1855 and 1861 (Moberly and Cameron 1929). Of the Athabasca Valley in 1855, he wrote (p. 52), "And here I enjoyed my first taste of the Rocky Mountain bighorn sheep, which were in flocks on the mountains in the vicinity." On a hunting trip between the Athabasca and Big Smoky rivers, he remarked, (p. 54), "Bighorn and caribou were almost always in sight, though not necessarily always to be stalked . . . We killed more than seventy moose on the trip, besides many bighorn, caribou and mountain goat." During a hunting trip south of the Athabasca Valley along Jacques Creek in November, 1857, he wrote (p. 95), "We followed the stream to the junction of four mountain spurs abounding with bighorn sheep, which were accustomed to seek the salt-licks below morning and evening . . . Hundreds of sheep were continually in sight." Bighorns were reported abundant along the Brazeau River in 1859 (Southesk 1875).

For the same areas, the 1800-60 and present population and distribution seem similar. The 1966 estimate was 10,075 bighorns; the 1800-60 population was probably little more than 10,000 animals.

The early writers did not refer specifically to periodical suppression of sheep population by environmental factors, but Indians told the Palliser Expedition (Spry 1963: 158) and Walter Moberly (1884) about depletion in 1947 of wapiti, moose, deer and bison along the upper North Saskatchewan Valley resulting from an extensive fire followed by disease. Many elk and bison in northern Alberta also died after a severe winter, sometime between 1938 and 1858 (Spry 1963; Soper 1942). Bighorns probably suffered occasional set-backs from severe winters, disease and fires. However, their comparative abundance after the the die-off along the upper North Saskatchewan Valley in 1847 suggests they suffered less than elk, moose, deer, and bison (Spry 1963).

Before 1860, substantial competition for forage from livestock was probably restricted to parts of southeastern British Columbia, where Indians kept many horses and cattle; and along the Athabasca, North Saskatchewan, and Bow Valleys, where white explorers and Indians used large numbers of horses. Along those valleys, competition must have been rather substantial as Hudson's Bay Company alone had at least 350 mares, wintering along the Athabasca Valley, and 150 horses, used during a hunting trip in the 1850's (Moberly and Cameron 1929).

No doubt, the many wolves in the prairies, parklands and mountains of Alberta served to limit bighorn numbers. In one winter in the 1860's "wolfers" poisoned 1,000 wolves in southern Alberta; and in just a few weeks took 120 wolves at one baiting (Brown 1914). Their abundance in the mountains was also recorded by Alexander Henry in 1811 (Coues

TABLE 1. — Bighorn sheep populations along the eastern slopes of the Rickies, 1915 (Millar 1915)

Locality	Not less than	Not more than
International boundary to Crowsnest Pass	500	1000
Crowsnest Pass to Rocky Mountains Park	400	800
Rocky Mountains Park*	500	700
Rocky Mountains Park to head of Athabasca River	200	450
Athabasca drainage	75	250
Brazeau drainage	100	200
Total	1775	3400

*Rocky Mountains Park was a 260-square-mile park along the Bow Valley. It was later enlarged to form the present Banff National Park.

1897) and by the Palliser Expedition in the 1850's (Spry 1963).

The Indians, particularly the Stoneys, hunted wild sheep with bows and arrows, snares and specially trained dogs; and they harvested larger numbers of bison, elk, moose and deer by driving them over cliffs (Coues 1897; MacGregor 1962). There was no evidence that wild sheep were overharvested (Spry 1963) until white men arrived with firearms. The depletion of game from the famous hunting grounds of the North Saskatchewan Valley during the late 1840's and 1850's was partly blamed on excessive killing with firearms (Moberly 1884).

The period 1800-60 was generally one of abundance for bighorn sheep. They apparently withstood environmental pressure of interspecific competition from elk, bison, caribou, mountain goats, deer, moose and, locally, horses and cattle; hunting by natives using primitive weapons and other forms of predation; adverse weather; fires; and disease.

1860 to 1915—A period of population decline.

Bighorns remained plentiful in isolated areas until the late 1800's (Preble 1908), but population declines were noted along the heavily hunted North Saskatchewan Valley as early as the 1850's (Moberly 1884). In 1871-72 sheep were reported scarce here and along the Athabasca Valley, both well-travelled by Indians, white traders and explorers (Moberly 1884). Of the Athabasca Valley in 1900, McEvoy reported (in Pfeiffer 1948), "Elk sparingly found in the foothills of the mountains, moose and deer throughout rather scarce, mountain sheep scarce in the first ranges of the mountains." By 1905, grave concern was expressed for the depleted populations in southwestern Alberta and southeastern British Columbia (Hornaday 1923). By 1911, they were reported scarce and with limited range in Jasper and Banff, but plentiful in the Waterton area (Hollister 1912). Depletion of game animals along the east slopes prompted the federal government to commission a three-year study (1913-15) of big game populations along the Canadian Rockies. Millar (1915) subsequently reported bighorn sheep populations along the east slopes to be light compared with previous numbers. His estimate of the 1915 populations is presented in Table 1.

Populations declined from probably more than 10,000 in the 1850's to one-fifth or one-third that number by 1915. The decline was more noticeable between the Bow and Smoky valleys, where only 375 to 900 sheep remained by 1915. Along the Bow Valley and south to the International Boundary, 1,400 to 2,500 bighorns remained in an area less than one-half the size of the northern region (Millar 1915).

Several writers blamed this major decline on excessive, year-round and generally non-selective hunting with firearms by Indians, explorers, miners and railway workers. (Moberly 1884; Preble 1908; Hollister 1912; Millar 1915; Williamson 1915; Department of Interior 1917; Hornaday 1923; McEvoy in Pfeiffer 1948; Tanner 1950; Rowan 1952).

Hunting played this major role in the population decline for four main reasons:

1. Primitive hunting methods were replaced by firearms.

Once firearms were introduced, bighorns became comparatively easy to kill and large numbers of this species were taken on each hunt (Moberly 1884; Preble 1908; Moberly and Cameron 1929; Spry 1963).

FIGURE 3. Between 1913 and 1915, Stoney Indians were annually shooting 650 to 1,000 bighorn sheep. Trophy rams such as the above were sold for 25 to 50 dollars each to big game hunters. Photo from Conservation of Fish, Birds and Game, The Methodist Book and Publishing House, Toronto, 1916.

2. Demand for meat increased.

From 1860 to 1880, several hundred prospectors, fur traders and railway exploration men moved into the area (Moberly 1884; Moberly and Cameron 1929, Scharff 1966). The influx of whites increased markedly between 1880 and 1915, as men engaged in railway construction, mining, agriculture and lumbering moved into the area. Since 400 to 600 resident Stoney Indians were annually taking 2,000 to 3,500 wild ungulates between 1913 and 1915 (Millar 1915), 10,000 miners and large numbers of other non-Indians must have been taking a considerable annual big game harvest from 1880 to 1915, when domestic meats were scarce.

3. Meat from bighorn sheep was preferred.

Early writers invariably attested to the superior quality of meat from bighorn sheep, compared with that from other ungulates in the area (Coues 1897; Moberly and Cameron 1929; Simpson 1931).

4. Ram heads had a high value on the trophy market.

Before 1860, trophy hunting of bighorns by non-residents was unknown, except for a hunt made throughout the east slopes in 1859 by the Earl of Southesk (Southesk 1875). However, when railways gave access into the mountains during the last decade of the 1800's, many non-resident hunters sought the prized bighorn ram. Unsuccessful hunters bought ram heads for 25 to 50 dollars apiece (Figure 3). Presumably, local hunters shot many rams solely for their horns. Depletion of bighorns along valleys served by transcontinental railways in the late 1800's and early 1900's was blamed on liberal game laws and general disregard for them. (Hornaday 1923).

Bighorns along the eastern edge of the Rockies, and along the Athabasca, North Saskatchewan and Crowsnest valleys were probably also affected by competition from livestock for grassland forage. During the winter of 1910-11, an estimated 15,000 cattle and 100 horses wintered within the 204-square-mile Waterton Lakes Park (Superintendent of Waterton annual report 1911). In the period 1880-1915, miners, Indians and government employees used large numbers of horses, probably more than 5,000 throughout the east slopes of the Rockies. Horses were commonly turned lose to graze on the open mountain slopes. Wild horses were also locally plentiful along the upper North Saskatchewan Valley and throughout the East Kootenays of British Columbia (Spry 1963). Cattle were kept by Indians along the North Saskatchewan and Kootenay valleys and by many miners and settlers (MacGregor 1962).

Fires caused by railway construction operations were blamed for driving big game away from some valleys (Millar 1915).

The effects on bighorns of all these factors was shown along the Athabasca Valley. Bighorns were plentiful and at times "several hundred" could be seen from one location in early-to-mid 1800's. In 1900 they were scarce. And during one wildlife survey in 1911, they were not seen and it was necessary to go south about 25 miles to the Maligne Lake area to obtain a specimen (Hollister 1912). By 1915, only 75 to 250 bighorns remained throughout the entire Athabasca drainage (Millar 1915). And it has taken 52 years of continuous protection from hunting to bring the 1967 winter population to an estimated 820 (Stelfox, unpub. data).

Weather was not reported to be responsible for sheep declines; and yet its influence during two periods should not be discounted. Two severe winters, 1886-87 and 1887-88, combining abnormally cold temperatures and deep snows, occurred throughout Alberta. In northern Alberta, the once abundant herds of bison and elk were wiped out from the Peace River region to the north (Soper 1962, Stelfox 1964a); and ranchers to the south reported losing most of their livestock (Jameson 1955). Similarly, the severe winter of 1906-07 resulted in the death of over 50% of all cattle in Alberta (Jameson 1955) and in the near extermination of elk from the province (Millar 1955; Stelfox 1964*a*). Undoubtedly these catastrophic winters affected bighorn sheep populations in a manner similar to that later reported for the period 1946-50 (Edwards 1956).

FIGURE 4. Forest fires along mountain slopes improve bighorn sheep ranges by converting the undesirable coniferous forests into productive grasslands on which sheep depend for their forage.

During the period 1860 to 1915, sheep numbers declined from an excess of 10,000 animals to about 2,600 animals. Certainly the primary cause was the indiscriminate hunting with firearms by resident Indians and an influx of traders, explorers, settlers, railway builders and miners. Of secondary importance were interspecific forage competition by several thousand horses and cattle, fires, railway and mining construction and three excessively severe winters. Wolves and cougars were not reported to have influenced this decline; in fact by 1915, they too had become scarce (Millar 1915).

1915 to 1936 — A period of rapid increase.

Sheep numbers rapidly increased during this period of protection. Populations in the southern region rose more rapidly, presumably because they had been less suppressed than those to the north (Millar 1915; Williamson 1915). In Banff, sheep were considered very numerous along the Bow Valley in 1919 and increased throughout the park from about 650 in 1915 (Millar 1915) to a peak of about 2,500 by the mid-1920's (Hewitt 1921; Anderson 1938; Cowan 1943; Green 1949). Minor die-offs due to disease in 1931, 1935 and 1936 (Cowan 1943; 1944; 1945) may have indicated that excessive numbers prevailed in Banff in the 1920's. Their numbers remained relatively high during the 1930's and sheep were still plentiful in 1939 (Clarke 1941).

Populations climbed steadily in Waterton to reach an estimated 500 to 600 in 1924 (Waterton warden counts 1924). They continued to increase until 1936 (Waterton files 1925-36), when they may have reached or exceeded 1,000 animals.

In Kootenay, numbers declined sharply about 1922. According to big game guide R., Lake of Invermere, British Columbia, the remnant herd then increased to about 30 animals by 1930 (pers. comm.) and to 140 head by 1938 (Cowan 1943).

The build-up of depleted herds was noticeably slower in Jasper and to the east of it. By the late 1920's, sheep were numerous in the vicinity of the Rocky and Fiddle rivers, along the east section of the park, and on adjacent ranges to the east (pers. comm. H. McLaughlin, formerly of the Geological Survey of Canada). By 1928, numbers had increased to approximately their original abundance (Kindle 1928). The population in Jasper may have climbed to about 1,300 by 1936, for it was known to have reached an estimated 2,250 eight years later (Cowan 1944). J. Baballa, big game guide of Cadomin, and H. Stelfox, naturalist of Rocky Mountain House, estimated that populations increased steadily on Alberta sheep ranges until they were considered plentiful in the late 1920's and 1930's. Since their numbers peaked in the mid-1940's (Huestis 1946-50), and the population in 1966 was estimated at 5,500 (pers. comm. Alberta Fish and Wildlife Div., 1967), it seems reasonable to estimate the 1936 Alberta population at 4,000.

The total 1936 population was therefore about 8,500 sheep: 4,000 on provincial non-park land, 1,300 in Jasper, 2,000 in Banff, 1,000 in Waterton and 125 in Kootenay. At that time, populations in Banff had passed their peak and had declined somewhat; they were at a peak in Waterton, nearing a peak in Kootenay, but almost 10 years away from a peak in Jasper and on provincial ranges.

The main factors in this build-up from 2,600 in 1915 to 8,500 in 1936 were apparently a protection program initiated during the period 1907 to 1915, when a total of over 11,000 square miles of mountainous range along the east slopes was closed to hunting — the Stoney Indians were made to comply with the Alberta Game Act on June 1, 1914; and restrictive provincial game laws were vigorously enforced (Millar 1915; Williamson 1915).

An improvement in quantity and quality of grassland ranges also contributed to the increase. Efforts were made to eliminate or reduce livestock from mountainous grasslands (Superintendent of Waterton annual report 1911). Bighorn and elk populations had been very low since about 1890, so that most mountainous grasslands had 25 years of light grazing from 1890 to 1915. By 1915 less than 400 elk were reported on the east slopes (Millar 1915). Similarly, bison, plentiful in the early 1800's, had been absent since about 1885 (Soper 1964). Range conditions should have been favourable when the protective policy began. Extensive fires in coniferous forests throughout the montane and subalpine zones in the late 1800's and early 1900's must have increased grasslands (Figure 4).

There is no evidence that sheep suffered from unfavourable weather conditions during this period, even during the unusually cold and deep-snow winter of 1919-20.

Cougar and wolf populations were very low during the early 1900's (Millar 1915). Their depredations on bighorns during this period must have been light.

The period 1915-1936 was therefore a time when depleted populations, enjoying protection from hunters and low interspecific competition, more than tripled from 2,500 to 8,500 animals. Southern populations increased from moderate to peak or excessive abundance, while northern populations increased from low to moderate abundance. Favourable range conditions due to previous fires and at least 20 years of low ungulate populations made this rapid increase possible.

1937 to 1950 — A period of high densities and rapid declines.

The period 1937-50 was one of the highest recorded populations followed by rapid declines. In Banff and Waterton, populations dropped below those estimated for the low population period of 1913-15. Although populations did not decline concurrently, those in each of the four national parks decreased by at least 75%.

The first major die-off occurred in Waterton in the spring of 1937, when about 50% of the

FIGURE 5. Pneumonia-lungworm disease in a bighorn sheep ewe in Kootenay National Park, October 1966. Note lumps on lungs infested with pneumonia-lungworm organisms, which convert these areas to a hepatized appearance.

sheep died (Superintendent of Waterton annual report 1937). However, since the population estimate 10 years later was only 125, losses throughout 1937 must have exceded 75% (Banfield 1947). Annual reports of the park for the intervening period showed steady population increases.

The second die-off occurred in Kootenay in the fall and winter of 1940-41, when an estimated 120 animals (85%) died of verminous pneumonia (Cowan 1943). The 1938 population was estimated at 140 by Cowan (1943).

The third die-off occurred in Banff in 1941-42. The count by the warden was only 241 in 1942, while the maximum total was 500 in 1943 (Cowan 1943). Numbers continued to decline until they reached 351 in 1950 (Tanner 1950). Green (1949) cited the following examples of population declines throughout Banff park:

1. Sawback — Vermilion range — 300-400 sheep some 20 years previously (1929); the highest count was 147 from 1942 to 1948 progressively declining from 1942.
2. Palliser range — 600-700 sheep in the summer of 1927 or 1928; the highest count was 43 from 1942 to 1948.
3. South of the Bow River, presumably on the Goat Range, 100 sheep in 1914; no sheep from 1942 to 1948.

The fourth major die-off occurred on provincial lands east of the parks. In 1945, bighorns were reported dying from an infectious lungworm disease in the Livingstone-Highwood range (Huestis 1946). Numbers generally declined throughout south-western Alberta during

TABLE 2. — Forage production, stocking rates (days – use/acre), lungworm loads, and overwinter weight losses from two bighorn sheep winter ranges in each of Jasper, Banff and Waterton Lakes parks (1967-69) compared to Kootenay park during the 1966-67 sheep die-off.

Park	Lbs. Forage Per Acre	Ungulate Days-Use Per Acre	Lungworms Per Gram of Feces	% Fecal Samples with Heavy Parasite Loads**	Ave. Ewe Wts. (lbs.)		% Winter Wt. Loss***
					Fall	Spring	
Jasper	133	71	2,375	48	169 (16*)	135 (11)	20
Banff	205	75	626	17	158 (8)	141 (6)	11
Waterton	428	29	594	0	144 (16)	166 (16)	13
Kootenay (1966-67)	—	—	3,580	92	132 (11)	127 (2)	—

*Sample size.
**Fecal samples with 1200+ lungworm larvae per gram of fecal material.
***Winter weight loss as a percent of fall weight.

1946, although they remained high adjacent to Jasper. In 1947, a general decline was noted in Alberta. From 1948 to 1950, populations generally increased on provincial ranges though they were well below those of 1944 (Huestis 1946-50).

The fifth major die-off was in Jasper from 1947 to 1950. Populations had climbed from an estimated 300 in 1915 (Millar 1915) to 2,250 in 1944 (Cowan 1944). Sheep were common in 1941 on both sides of the Athabasca Valley from the town of Jasper to the eastern boundary and all the way up the Snake Indian River to the headwaters of Blue Creek (Clarke 1941). They continued to increase through 1946 (Cowan 1947*a*) and may have reached a peak of 2,500 animals. The die-off occurred during a period of three successive winters of deep snow, from 1946 to 1949, which adversely affected wild ungulates all along the east and west slopes of the Rockies (Huestis 1946-50; Edwards 1956). By 1950 about 400 bighorns remained in Jasper (Jasper Park Service 1950-52), a decline of about 84% from 1946. Edwards (1956) reported an 85% loss near Mount Robson Provincial Park, west of Jasper, but he must have been referring to Jasper herds, as Cowan (1956) reports no bighorns in Mount Robson.

By 1950, the national parks contained only about 1,000 bighorns — approximately 400 in Jasper, 350 in Banff, 150 in Waterton Lakes, 75 in Kootenay. With 1,500 on provincial land, the total population was estimated at approximately 2,500 animals.

The die-offs in the national parks were not synchronized, but they were preceded by similar factors — high densities and heavy interspecific competition for forage, resulted in range deterioration, unusually severe weather and/or pneumonia-lungworm disease accentuated the nutritive stress load and triggered the die-offs. The importance of this combination in limiting bighorn sheep numbers is described by Buechner (1960: 150):

> If barriers such as restricted winter forage, deep snow, and drought do not limit levels of population, a point of high density is reached where disease causes a sudden and severe mortality. The principal disease involved is caused by lungworm. The triggering mechanism seems to be poor nutrition from temporary deterioration of forage on winter concentration areas . . . The lungworm-pneumonia complex is unquestionably the most significant disease in bighorn sheep. . . . Violent population fluctuations caused by lungworm disease is characteristic of Rocky Mountain herds only. There may be two reasons for this. One is that only in this range do habitats exist where climate and vegetation permit the establishment of high density populations. The other is that only in this range is there an abundance of im-

TABLE 3. — Helicopter classified counts and population estimates of bighorn sheep in the Canadian Rocky Mountain National Parks, December 1966 to February 1967.

District	Helicopter Counts					Est. Population	
	Totals	Lambs	Rams	Ewes	Unclass.	Winter	Summer
WATERTON LAKES (February 1967)							
Akamina	48	8	13	27	0	60	72
Belly River	71	21	20	30	0	95	107
Redrock-Waterton	132	29	40	63	0	176	198
Totals	251	58(23.0%)	73	120	0	331	377
BANFF (December 1966)							
Healy Creek	67	7	4	9	47	75	75
Goat Range	47	10	6	29	2	60	60
Cascade and Vermilion L.	59	9	5	13	32	100	100
Johnston, Hillsdale Crs.	73	9	17	12	35	75	75
Palliser Rge. to Panther R.	150	11	30	35	74	225	400
Panther R. to Red Deer R.	98					190	225
Tyrell and McConnell Crs.	19	22	31	44	79	75	125
S & N of Clearwater R.	59					100	180
Baker & Pipestone Crs.	–					0	10
Mt. Wilson	16				16	50	50
Totals	588	68(22.4%)	93	142	285	950	1,300
JASPER (January 1967)							
Athabasca Icefields	49	7	16	26	0	85	125
Maligne Rge.	22	5	10	7		40	40
Sampson Peak-Jacques Cr.	21					30	30
Jacques & Colin Rges.	190	–	22	71	118	300	300
Miette Rge.	83					135	135
Fiddle R. & Sulfur Cr.	119	40	24	109	29	245	295
Nikanassin Range	93					125	225
Cairn Cr. & Southesk R.	116	74	101	184	14	150	250
Brazeau R. & Isaac Cr.	164					150	175
DeSmet & Snaring Rges.	375					550	550
Rock Cr. to Natural Arch	77	111	115	226	0	125	175
Bosche & Bedson Rges.	142	36	24	82	0	210	335
Totals	1,451	273(21.2%)	312	705	161	2,145	2,635
KOOTENAY (December 1966, Die-off Occurring)							
Stoddart-Shuswap Crs.	68	12	11	45	0	70-75	0
Sinclair & Kindersly Crs.	11	1	3	7	0	12	150*
Edgewater	2	0	1	1	0	5	0
Totals	81	13(16.0%)	15	53	0	87-92	150*
Grand Totals	2,371	412(21.6%) for all but Kootenay lambs)	493	1,020	446	3,539	4,439

*1966 summer count.

portant intermediate snail hosts for the lungworm.

Recorded evidence can give reasonably accurate information on causes of die-offs. Disease in the form of pneumonia-lungworm (Figure 5), or "verminous" pneumonia was reported to have caused the population collapse in Banff, Waterton, and Kootenay (Cowan 1943). Marsh (1938) diagnosed an epidemic of "verminous" pneumonia in Glacier Park, Montana. This

FIGURE 6. A denuded winter range along the Athabasca Valley, Jasper National Park. This results from several years of overuse by more sheep than the range can support.
Photo Credit: A. Loewen, Jasper Park Warden Service.

disease was very likely the cause of the epidemic which occurred at the same time in Waterton. Deteriorated range conditions and poor nutrition undoubtedly predisposed the animals to the disease (Figures 6 and 7). Mule deer were estimated by wardens at 1,700 in 1947 (Banfield 1947). The elk population in Waterton was light before 1937 as they apparently did not migrate from the Belly River valley until 1932. Elk within the park in 1945 were estimated at not more than 500 (Banfield 1947). Thus, approximately 1,000 bighorns, 1,500 mule deer and elk and 2,211 livestock, (almost 5,000 ungulates) were foraging within this 204-square-mile park in 1936. Heavy snows in that year contracted the winter range to about 50 square miles, so the density must have approached 100 ungulates per square mile.

Buechner (1960) reported that on bighorn sheep ranges which had been stocked with domestic cattle, sheep and horses, the bighorns disappeared because they were unable to survive on deteriorated ranges. In addition, he believed that domestic stock probably introduced diseases harmful to bighorns. Studies during the Banff die-off revealed chronic actinomycosis and "verminous" broncho-pneumonia caused by lungworm (Cowan 1943).

Poor range conditions resulting from overstocking of bighorns and elk in the parks during the late 1930's and early 1940's were described by Clarke (1941), Green (1949), and Cowan (1950). In 1943, when the elk population in Banff was estimated at 3,500 to 4,000, Green (1949: 33) stated, "The elk pressure on all ranges, especially those of limited extent, has

FIGURE 7. Terracing and soil slippage along the Palliser Range, Banff National Park, May 1969. Intensive feeding and trampling by elk and bighorn sheep have created this situation.

had the effect of confining sheep to range edges where forage is inferior, or driving them to less favourable localities nearby where elk do not occur." (See Figure 8).

A rigid program of fire supression caused regenerating coniferous forests to encroach on montane and subalpine grasslands of pyrogenic origin (Green 1949; Banfield 1958). The south end of the Sawback Range in Banff, thickly covered with a young forest of Douglas fir (*Pseudotsuga menziessii*) in 1953, supported few bighorns (Banfield 1958). It had been open grassland with a few sentinel firs in 1921 when Hewitt (1921) observed 375 bighorns there. Green (1949: 34) reported that some sheep-grazing areas of the park were essentially fire-made alpine meadowland. He felt that fire protection and control could virtually eliminate range necessary for the support of the bighorn and other grazing animals.

The presence of numerous bighorn carcasses on winter ranges and the absence of disease symptoms suggested that a series of severe winters, between 1947 and 1950, had acted at least partly independent of the population density, to cause the major die-off in, and adjacent to, Jasper (Huestis 1946-50; Edwards 1956). Weather evidently hastened a die-off that was inevitable.

Cowan (1950: 587) remarked, "National Parks of Canada between 1943 and 1946 supported over-capacity populations of big game in which moose, elk, mule deer and bighorn were in competition for a declining food supply on the winter ranges." Flook (1964) stated that elk reached peak populations in Jasper and Banff in the early 1940's and adversely affected bighorn sheep by depleting south-facing grassy slopes in the subalpine zone that were critical bighorn range. He also believed that in 1948, a winter of unusually high snowfall, range depletion contributed to the heavy winter mortality of sheep and elk in Jasper. In referring to 1944 wildlife studies in Jasper, Cowan (1947A: 226) stated, "It is apparent then that the elk are in serious competition with both sheep and mule deer in the Athabasca Valley of Jasper Park." After range studies along the Athabasca Valley in 1946 and 1947, Pfeiffer stated (1948: 44): "Ungulates are so numerous in the general area studied that many of the ranges are in acutely overbrowsed and/or overgrazed condition . . . The ungulate chiefly responsible for the misuse of the area studied is the elk . . . It is competing for winter food supplies with bighorn sheep on certain ranges

FIGURE 8. Elk foraging on bighorn sheep winter range, Mt. Galwey, Waterton Lakes National Park, February 1967. Elk have been the greatest competitors for forage on bighorn sheep winter ranges in the National Parks from 1940 to 1970.

that are capable of supporting only a very limited amount of plant growth." However, elk were scarce on critical bighorn sheep winter ranges east of Jasper in the Coalbranch region during the 1940's (Stelfox 1964a), and the die-off may have taken place when ranges were still productive.

During the 1930's and 1940's, fire control caused coniferous forests in Jasper to encroach on grassland (Pfeiffer 1948). Regenerating forests were also evident on montane and subalpine grasslands east of Jasper (Stelfox 1964*b*).

Wolves, abundant in the Jasper region in the 1940's, were ineffective in controlling sheep populations (Cowan 1947*b*). The winter range contained one wolf per 10 square miles compared with 30 to 40 wild ungulates per square mile, or 300 to 400 ungulates per wolf. From 1943 to 1946, ungulates made up 80% of the wolf's annual diet, of which elk alone comprised 47% and mule deer 15%; bighorns were seldom hunted by wolves (Cowan 1947*b*).

Pneumonia-lungworm disease and severe winter weather were therefore responsible for the five major die-offs during the period 1936 to 1950. Underlying these factors was detioration of critical winter ranges by excessive ungulate populations.

1950 to 1966 — A period of rapid increase

An increase in numbers of sheep, earlier apparent in Waterton and Kootenay, became generally evident in all areas in the early 1950's. Populations rose slowly until 1955 then increased rapidly during the next decade. The increase was initially more rapid in the south, as during the 1915-35 build-up. In 1953, Banfield (1953) estimated slightly more than 600 in Banff, slightly less than that in Jasper. Counts made by various wardens before and after 1952 indicate approximately 150, for that year, in Waterton and 75 in Kootenay. A possible 2,000 on Alberta ranges outside the parks would bring the 1952 population to over 3,000 animals. Populations almost doubled during the next decade to reach about 6,000 in 1962 — 1,000 in Jasper, 900 in Banff, 235 in Waterton, 125 in Kootenay (Tener 1953; Ward 1956) and probably 4,000 on adjacent Alberta ranges, as I estimated 2,300 north of the Brazeau River in 1963 after winter aerial censuses. Extensive

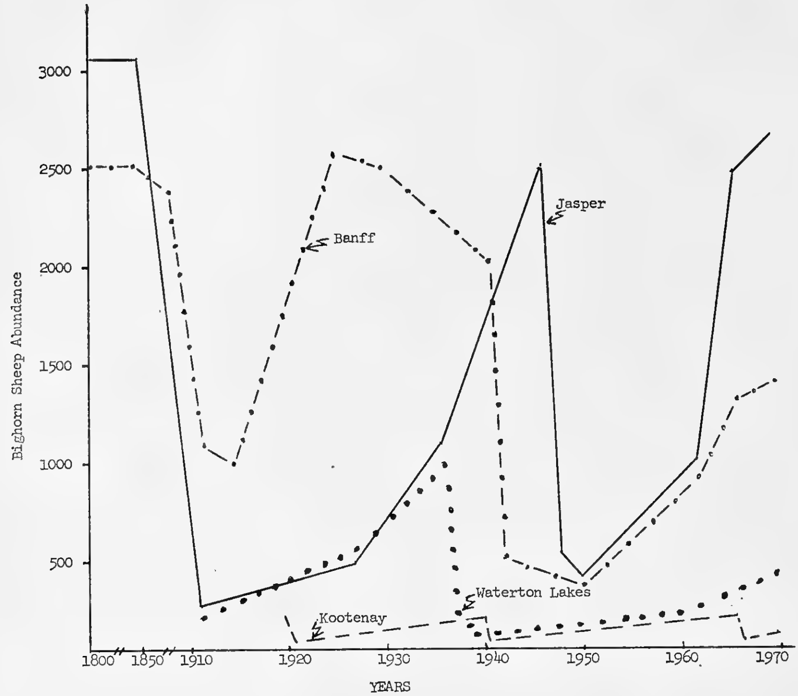

FIGURE 9. Trends in bighorn sheep numbers in Banff, Jasper, Waterton Lakes and Kootenay National Parks, 1800 to 1970.

aerial and ground counts placed the 1966 population at 2,600 in Jasper, 1,300 in Banff, 350 in Waterton and 175 in Kootenay (before the fall die-off), totalling 4,425 throughout the national parks. Aerial surveys from 1962 to 1967 on Alberta ranges place the estimated 1966 provincial population at 5,500 bighorns (Stelfox 1966; Wishart 1966; G. Kerr of the Alberta Fish and Wildlife Division, pers. comm.). The total 1966 population was therefore about 10,000, of which all but 175 were on the east slope of the Rockies.

Factors permitting the rapid build-up in sheep numbers from 2,500 in 1950 to 10,000 in 1966 were:

1. Improved range conditions due to light stocking rates of bighorns, elk and livestock following the previous die-off. Bighorn populations were low in southern Alberta from 1942 to 1955 and in, and adjacent to, Jasper from 1948 to 1955. Elk populations peaked in both Banff and Jasper in the early 1940's (Flook 1964) and were kept at a low level by annual slaughters and by severe winters from 1946 to 1950. For example, wardens in Jasper counted only 787 elk in 1953 compared with 1,634 in 1959. Livestock numbers in the parks were reduced to low numbers during the 1950's.
2. Weather. Mild winters of normal or below-normal snow depths prevailed throughout the 1950's and up to 1964. Unusually deep and crusted snow during the severe winter of 1964-65 combined with a pneumonia-lungworm disease and an underlying problem of deteriorated winter ranges to bring about a major die-off in the east Kootenays of southern British Columbia in 1965 and 1966 (Bandy 1966). Bighorn sheep populations continued to increase throughout the east slopes of the Rockies, because prevailing winds kept the west-facing slopes comparatively free of snow.
3. Disease. No serious diseases were reported until the die-off in the east Kootenays. Although common, actinomycosis did not cause significant mortality (Wishart 1958). Parasitism, a universal condition in wild mammals, usually acts in conjunction with disease to cause appreciable mortality when

animals have suffered from poor nutrition (Cowan 1951).

4. Predation. Populations of wolf and cougar were low from 1954 to 1966. This factor is considered of secondary importance. However, high populations of wolf, cougar and coyote in relation with depletion of ungulates north of the North Saskatchewan River in the early 1950's may have retarded the sheep build-up. Sugden (1953) suggested that this may have occurred among bighorns in the Churn Creek area of British Columbia. Extensive anti-rabies programs against predators on provincial lands in Alberta, from November 1952 to April 1955, killed an estimated 5,271 wolves, 50,781 coyotes, 9,927 lynx and 69 cougar (Ballantyne 1956). Populations of predators in the national parks of the Rockies were depleted during this period, but the exact numbers are not known. From 1954 to 1966, wolves and cougars were rare south of the North Saskatchewan River, and scarce in the mountains to the north.

1966 to 1970

A major die-off began in Kootenay in September 1966, when emaciated animals with symptoms of pneumonia-lungworm disease began dying when weather and forage conditions were favourable. After extensive autopsies, pathologists concluded that the disease was a pneumonia-lungworm complex (Choquette and Broughton 1967). Authorities generally agreed that deteriorated winter range conditions and inclement weather (severe 1964-65 winter of deep crusted snow, above-normal annual precipitation) had triggered this die-off (Stelfox 1966*a*, 1966*b*). Chronic pneumonia-lungworm lesions in Kootenay specimens suggested that the lethal phase of this disease had an earlier origin, perhaps in the same severe winter of 1964-65 that triggered the die-off in the East Kootenays (Bandy 1966). Bighorn sheep numbers declined from 175 in midsummer 1966, to 50-55 by the spring of 1967, and to 40-45 by December 1967.

Reproduction and/or lamb survival in 1967 and 1968 were subnormal as lambs comprised only 7.1% of the herd in April 1968 and 12.5% of the herd in April 1969. However, after three subnormal reproductive years of 1966, 1967 and 1968, productivity returned to normal in 1969 when 23.4% of the herd were lambs during the winter of 1969-70. Normal values for Jasper, Banff and Waterton for the November to January period from 1966 through 1970 was 23.1 lambs: 100 ewes. The Kootenay herd increased to 50 to 60 animals by the fall of 1969, and to 80 to 85 by the fall of 1970.

Following the die-off in Kootenay, lungworm and other endoparasite loads declined drastically whereas in Jasper and Banff endoparasite loads continued to increase with increasing population densities. Average lungworm loads in Kootenay declined from 3580 larvae per gram of fecal material in 1966 prior to the die-off to 930 larvae per gram of fecal material in 1967 following the die-off. Conversely, in the Lodge Turnoff herd in Jasper, where the population remained high, the lungworm load increased from an average of 1900 in 1966-67 to 2375 in 1968 and 1969 (Bandy 1968, Uhazy 1969).

In the other parks and in Alberta, populations remained high from 1966 through 1970 and were generally as high as they had been at any time during this century. Reproduction in 1966 and 1967 was above average in Jasper and Waterton; while in Banff it was above normal in 1966 but below normal in 1967. Sheep numbers increased in Jasper in 1967, but showed signs of levelling off in Banff and Waterton. From 1968 through 1970 populations have remained relatively constant, or increased slightly in Jasper, Banff and Waterton.

The slightly below average reproduction in Banff, in 1967, was probably due to abnormally deep snow conditions, which prevailed during the previous winter. These conditions did not prevail in the other regions. Proportionately, deer, elk and moose experienced greater winter mortality and noticeably lower reproduction, in 1967, than bighorns.

A detailed sampling and autopsy program in Jasper and Banff from late 1966 through 1970 revealed that bighorns were generally healthy. Body weights, measurements of fat reserves, and high reproductive rates in Jasper, Banff, and Waterton indicated good condition and vitality. The moderate-to-heavy loads of internal parasites in most specimens in Jasper and Banff appear symptomatic of an over-abundance of animals. Lungworms were numerous and pneumonia lesions generally present in Jasper and Banff specimens. The degree of infection was considerably lower than that in Kootenay specimens during the die-off in all but two cases.

Advanced range deterioration is evident on several critical winter ranges in Banff and Jasper. Coniferous forest encroachment on montane and subalpine grasslands was evident in Banff, Jasper and Kootenay. Population densities are considered to be very high on many winter ranges. For example, along the Athabasca Valley some 820 bighorns (41 sheep per square mile) winter for five to six months on 20 square miles along the Athabasca Valley. At least 600 elk and 200 mule deer also utilize this range extensively. The range shows advanced deterioration under a stocking rate which approaches 100 ungulates per square mile in some localities. Similarly, the February 1967 census in Waterton revealed 350 bighorns, 264 elk, 235 mule deer and 14 mountain goats wintering on 23 square miles of semi-open and open grasslands — a density of 37.5 ungulates per square miles. Elk numbers on both sides of the Rockies exceed those of bighorns. In the northern portion of the Rockies elk are expanding their range (Stelfox 1964).

Preliminary results from a five-year ecological study of bighorn sheep by the author, indicate a strong correlation exists among forage production, stocking rates (ungulate days — use per acre), lungworm loads and overwinter weight losses. Table 2 shows that although fall ewe weights are similar in Jasper and Waterton, the ewes in Jasper sustain a 20 percent overwinter weight loss while foraging on an unproductive range (133 lbs. air-dry forage/acre), under a high stocking rate (71 days — use/acre), and while supporting a high lungworm load (2375 larvae/gram of feces). Conversely, in Waterton where the range is more than three times as productive, the stocking rate only 41 percent as heavy, and the lungworm load only 25 percent as great, mature ewes lost only 13 percent of their fall weight. In Banff where forage production is somewhat greater than in Jasper, but where the stocking rate is similar, ewes lost only 11 percent of their fall weight. The greater weight loss in Jasper seems due in part to the lungworm load being four times greater than that in Banff. The heavy parasite load in the Kootenay herd during the die-off must have been an important factor in causing the fall ewe weights to average 132 pounds compared to an average of 165 pounds for ewes in the other three parks. This information may be valuable in assessing the health of both the sheep and their range and for predicting population trends.

On Alberta provincial ranges, range deterioration and excessive numbers of bighorns, elk and, in several cases, livestock on critical winter ranges have prompted the Fish and Wildlife Division to reduce stocking rates. Increased harvests of bighorn sheep of both sexes began in 1966, and reduction or elimination of elk and livestock from deteriorated ranges continues.

Figure 9 shows graphically the population fluctuations within the four national parks from 1800 to 1970.

Future Outlook

High densities of bighorn sheep and elk, high reproductive rates, deterioration of many winter ranges, a lack of fires and predators, a moderate-to-heavy infestation of parasite and disease organisms, the history of Canadian bighorn sheep populations — these all suggest that temporary widespread declines are imminent on Jasper and Banff ranges. Such declines are historically normal and a return to abundance should follow in about one decade.

An impending die-off is not evident in Waterton. Populations are considerably below those before the 1937 die-off; winter ranges look reasonably productive; and domestic livestock, prevalent before 1937, are no longer kept there. However, densities of mule deer and elk are very high on some winter ranges. Should these high densities continue, and bighorn sheep populations expand, grassland ranges will probably deteriorate.

In Kootenay, the present low population should continue to increase as deteriorated grasslands improve under the present light stocking rate. Slow recovery of the population and a lower long-term carrying capacity are expected for the following reasons:

a) Grasslands will diminish along the montane wintering slopes as a policy of forest protection encourages growth of evergreen forests,
b) This semi-arid range has a slower recovery potential than the more humid ranges along the east slopes of the Rockies,
c) Populations of mule deer, white-tailed deer and elk on the wintering ranges are moderately high.

On Alberta provincial ranges, increased harvesting of both sexes of bighorns and elk and the control of livestock numbers may avert a major die-off or at least delay it.

Without forage competition from elk and livestock, bighorns will probably increase periodically to numbers beyond range-carrying capacities. These increases will be followed by major declines resulting from deteriorated range conditions and increased parasite loads. The die-offs will likely be triggered by a pneumonia-lungworm disease, severe weather conditions, or both. These mortality factors should be recognized for their beneficial role in minimizing range deterioration.

Future sheep populations would probably benefit from reestablishment of widespread, abundant populations of wolves and cougars which would prey on inferior sheep and competitive elk.

The rates of population increase, following future declines, will undoubtedly vary considerably, depending on the influence of all factors discussed above. Specifically, the four main natural factors influencing population trends will be (a) the extent of range deterioration before die-off; (b) elk population trends; (c) forest successional patterns; (d) weather conditions.

In addition, man-made influences which will strongly affect future sheep populations are livestock grazing, forest cutting, burning and fire-control practices, and the development of water impoundments that inundate critical winter ranges.

Fortunately, the inclusion of most sheep range within national parks, boundaries, where wildlife management attempts to perpetuate pristine conditions, ensures the continuance of relatively high numbers of sheep. On Alberta provincial ranges the future looks promising under the current program of controlling sheep numbers within limits of range carrying capacities, and of restricting elk and livestock competition.

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(*Continued from page 100*)

the south where we are experiencing their destructiveness. Along the arctic coast huge of numbers of shore-birds, swans, geese, ducks would be eliminated, as probably also seals, whales, and polar bears. Oil tankers and offshore drilling in the arctic ocean could only lead to disaster.

With the history of arctic oil exploration riddled with errors, carelessness, and lack of planning, we should take a very critical look at present practices in the light of likely future developments. Greater efforts must be made to determine precisely what sort of disruption has already taken place and to find remedial measures for it. Simultaneously exploration methods should be modified to fully minimize disturbance. If we really think that that can be accomplished, we can discuss similarly the ramifications of exploitation. At the present rate of progess in solving the problems presented here, and the present blind zeal to extract non-renewable resources in the arctic, I regret that I see arctic oil not as a boon but a bane.

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[1]EDITOR'S NOTE: Dr. Kevan was working in the Mackenzie Delta region from June 1970 to March 1971. He is now at the Plant Research Institute, Department of Agriculture, Ottawa.

Fluctuations in Black Bear Populations and their Relationship to Climate

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Abstract. Bounty records for black bears in Northwestern Ontario for the period 1942-61 were investigated. Weather records for the same period were examined to determine if a correlation existed between temperature and precipitation and population fluctuations.

Warm temperatures and low precipitation in March, April, and May result in an increase in the numbers of black bears taken for bounty.

Introduction

The black bear (*Ursus americanus* Pallas) is one of the most familiar wild animals in North America. It is discontinuously distributed across the continent, occurring from the east to the west coast and from Alaska to Mexico (Hall and Kelson, 1959). Once considered almost entirely an undesirable predator and a nuisance, black bears are now a popular game animal in many areas. Its status as a game animal will be enhanced in the future as expanding human populations create a demand for huntable game species. We believe that it is one of the least understood big game species. Erickson (1965) states 'knowledge of its status, general biology and ecology is very imprecise'.

In this paper we report the result of an analysis of population fluctuations in black bears in Northwestern Ontario (Figure 1) for the period 1942 to 1961 to determine the relationship between fluctuations and climate.

Methods

We have used the number of bears offered for bounty as our bear population for each year. We consider the yearly bounty return to be adequate record of population change but have not considered it to be an index of absolute population.

Figure 1. Location map.

The bounty records for Kenora, Rainy River, and Thunder Bay districts of Northwestern Ontario were obtained from the Ontario Department of Lands and Forests.

Records of snowfall, rainfall and temperature were obtained from the Meteorological Branch of the Department of Transport, Thunder Bay, Ontario. The term 'precipitation' refers to rain plus snow, the snow measurement being converted to rain equivalent (division by ten) before inclusion in the total precipitation measurement. Four weather recording centers in each of the three districts were chosen so that there were records for most of the 20-year period, and so that an average of the data for the four centers would give a better picture of the conditions in the district as a whole.

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The months of March, April, and May were chosen as the period for concentrated study after a brief survey of the weather data indicated that if there were any correlation between population size and temperature and precipitation, it would be most evident during those months. We consider that the three spring months are critical since at this time adults emerge from winter dens, and the new cubs are first exposed to the environment outside the den.

It should be noted that, although the bounty data is for the fiscal year April 1 to March 31, we have treated it as though it were annual (calendar) since there are few or no bounties claimed in the January 1 to March 31 period (C. A. Elsey, Ontario Department of Lands and Forests, personal communication.)

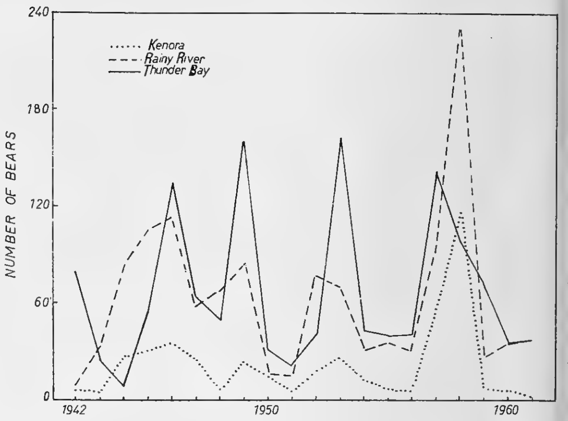

FIGURE 2. Number of bears offered annually bounty in Kenora, Rainy River and Thunder Bay districts.

Results

The numbers of bears offered for bounty in Kenora, Rainy River, and Thunder Bay districts are shown in Figure 2. It is apparent that there are four peaks in the 20 year period for each district, although the peak years of bear numbers are not consistent for each district. For Northwestern Ontario as a whole, the peak years are 1946, 1949, 1953, and 1958, (Figure 3).

Figure 4 shows the average snowfall for March, April, and May for 1942 to 1961 for each district. There were six peak snowfall years; 1944, 1948, 1950, 1954, 1956, and 1960. These peaks were consistent throughout Northwestern Ontario.

Precipitation for each district is shown in Figure 5. The peaks and lows of the three districts do not correspond well. For Northwestern Ontario, the years of maximum precipitation are 1943, 1950, 1954, 1956, and 1960. (Figure 3). The average daily temperatures for the three districts are shown in Figure 6.

General Discussion

(1) *Black Bears*

In Ontario, most of the bears' regular activity occurs between late May and early November. During the winter they exist in a state of dormancy or semi-dormancy from which they can be easily aroused. It is not uncommon for bears to venture forth in mid-winter to seek food. Cubs are born in the den to the dormant mother in January or February. There are usually two cubs, but singles, triplets, and quadruplets have been reported by Erickson *et al* (1964) in Michigan.

The most critical periods of the year for the black bear are probably at the commencement of denning (October-November) and at the completion of winter dormancy (April-May). For example, in the spring the safe emergence of the mother and cubs from the den depends on weather and food.

(2) *Weather*

Snowfall is an important consideration at three periods of the year. First, in the fall (October or November), as a possible triggering mechanism for denning. Erickson *et al* (1964) found snowfall was a factor determining when black bears enter winter dens in Michigan — early snow causing early denning. Early snow could bring on denning even though the bears were physiologically not ready. We believe mid-winter wandering may be caused by hunger resulting from early denning. As Spencer (1955) points out, satiety and obesity are necessary for successful winter denning. Secondly, a snow cover is favourable to denned bears because of the insulating nature of snow

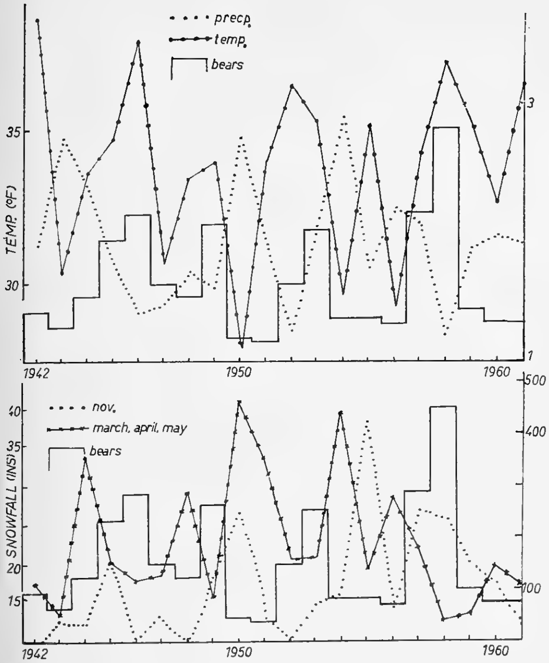

FIGURE 3. *Top.* The number of bears offered annually for bounty in the three Northwestern Ontario districts; the average monthly precipitation and the average daily temperature for March, April and May in Northwestern Intario.

Bottom. A repeat of the bear data; average monthly snowfall for March, April and May; the November snowfall in Northwestern Ontario.

around the den. Thirdly, we believe a rapid disappearance of the snow cover in early spring facilitates feeding by the hungry, adult bears.

Spring rainfall is considered to be relevant to this study in Northwestern Ontario. We believe that heavy rain hampers the feeding of the adults and perhaps causes some mortality among the new born cubs.

Temperature is perhaps most relevant in fall and spring. In the fall, snow cannot remain on the ground until the temperature permits it. In spring, warm temperatures are conducive to rapid drying of the land, which benefits both adults and cubs.

We, therefore, define 'favourable' spring weather as meaning warm (high) temperatures, low snowfall and low rainfall (low precipitation).

(3) *Bounty*

A bounty on bears was first established in Upper Canada in 1793 by an act entitled "An Act to encourage the destroying of wolves and bears in different parts of the province". This legislation was repealed in 1796 and the bounty was not paid again until 1942. In 1961 the bear bounty was dropped and black bears were protected under the Game and Fisheries Act of the Province of Ontario.

The use of bounty records as an indication of population size has often been questioned. However, since this is often the only record of population over long periods, investigators of population fluctuations frequently make use of it. There are a few reservations outlined by Keith (1963) that should be considered in each instance of use: fluctuating prices, unstable socio-economic conditions and the suspected practice of bounty hunters of preserving the breeding stock when populations are low. Each of these factors may have a significant effect on the number of bounties collected. We have carefully considered these reservations and believe that we can make the assumption that change in the number of bears presented for bounty is an indication of population change.

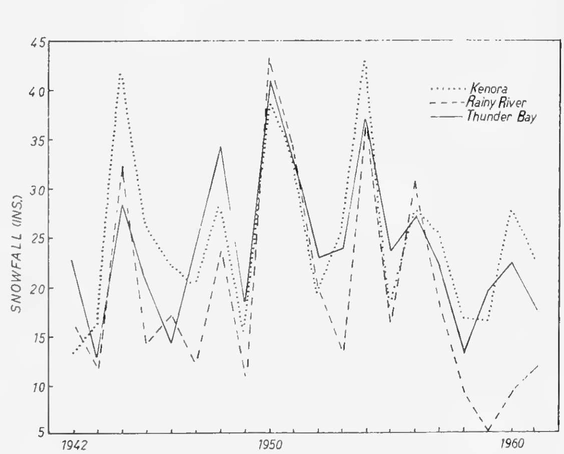

FIGURE 4. Average monthly snowfall for March, April and May in Kenora, Rainy River and Thunder Bay districts.

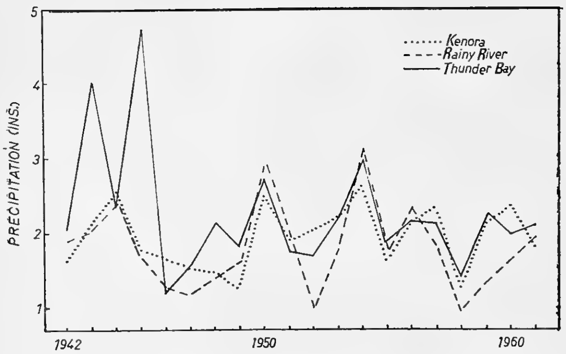

FIGURE 5. Average monthly precipitation for March, April and May in Kenora, Rainy River and Thunder Bay districts.

Discussion of Results

Reference to the figures show that the intervals between peaks were 3, 4, and 5 years in Northwestern Ontario (Fig. 3). In Kenora district the intervals were 3, 4, and 5 years. The population peak after the 5 year interval was very high in comparison with that of previous peaks. In Rainy River district, intervals were 3, 4, and 4 years. Thunder Bay district peaks were also 3, 4, and 4 years. The peaks in Thunder Bay district were of similar amplitude, the other districts varied considerably more (Figure 2).

The times required for the population to reach a low position from its peak were 2, 2, 3, and 2 years in Northwestern Ontario as a whole. Population lows were reached in Kenora district in 2, 2, 3, and 3 years; in Rainy River district in 1, 2, 2, and 1 years; and in Thunder Bay district in 2, 2, 2, and 3 years. Thus 58% of the lows were reached in 2 years, whereas 3 year drops to low occurred 25% of the time and 1 year drops occurred 17% of the time.

For Northwestern Ontario, peaks were attained from a population low in 3, 1, 2, and 2 years. The time required to attain peaks from lows in Kenora were 3, 1, 2, and 2 years; in Rainy River, 4, 2, 1, and 2 years; and in Thunder Bay, 2, 1, 1, and 1 years. Forty-five percent of the peaks were reached in 2 years, 38% in 1 year, 11% in 3 years, and 6% in 4 years.

The Thunder Bay population appears to exhibit a greater degree of stability and consistency than the populations of the other districts, peaks are reached rapidly and fall off to a low is relatively slow. Rainy River is least stable. Of possible significance here is that spring snowfall in Thunder Bay district fluctuates least and Rainy River district spring snowfall fluctuates most over the 1942-1961 period (Figure 4).

We have already defined favourable spring weather as high temperature, low snowfall, and low rainfall. Considering the nature of each of these three weather factors it is apparent that in years of peak black bear populations, spring temperatures were usually high compared to the years before and after the peak. In addition, snowfall and precipitation were low and medium to low respectively during the spring of a peak year. (Medium is used to indicate a position approximately midway between the high and the low).

In considering the nature of the weather factors in the year prior to a peak bear population, it appears that the temperatures were medium to high, the snowfall ranged from low to high, and precipitation from medium to high. Thus the three weather factors were less favourable to bears in the spring prior to a peak than in peak years.

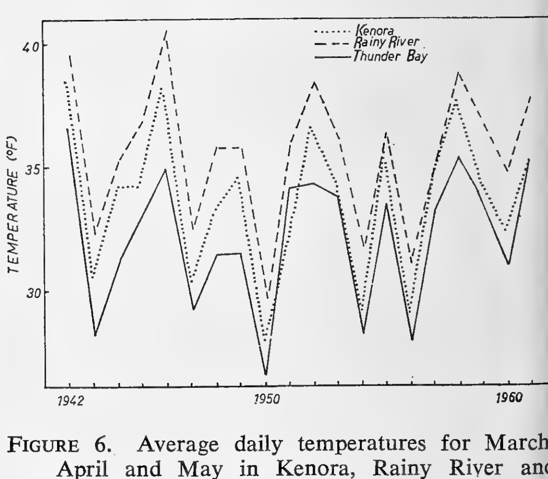

FIGURE 6. Average daily temperatures for March, April and May in Kenora, Rainy River and Thunder Bay districts.

In years of low population, the temperatures ranged from low to medium, snowfall from low to high, and precipitation from low to medium. Consequently, the weather factors during the spring in which a low population occurred were less favourable to the bears than during a peak year.

Considering the favourableness and unfavourableness of the three weather factors and relating them to the peak and low years, we find a definite concentration of favourables over unfavourables in peak years, and a less definite concentration of unfavourables over favourables in low years.

Further analysis of the weather records reveals that the variations in November snowfall in Northwestern Ontario from 1942-1961 may have a relationship to bear population levels. The years 1950 and 1955 had the greatest November snowfall recorded for the 20 year period. In 1950, the bear population was the lowest for the 20 year period of study, and the population in 1955 was very nearly as low. We believe that this indicates the possibility of an early heavy November snowfall forcing the bears into a premature denning situation as discussed earlier. Variations in October snowfall over the 20 year period do not appear to relate to the levels of population.

Variations in fall temperatures are probably only significant in the direct relationship of temperature to the production and permanence of snow.

When the winter snow cover is on the ground, the weather records indicate the factors of temperature and snowfall to be of little importance to bear populations in Northwestern Ontario.

It, therefore, appears that snowfall in November, and snowfall, rainfall and temperature during the spring are factors contributing to the population fluctuations of black bears in Northwestern Ontario.

There are two possible interpretations of this observation of favourable weather conditions producing high bear populations. The first is that we are measuring either a change in behavior of the bears during favourable weather (i.e. more movement, emergence from dens earlier when visibility is greater, feeding in open areas such as roads where there is early vegetation); or a change in hunting pressure when the weather is favourable.

A second interpretation is that black bear populations in Northwestern Ontario are cyclic. The concept of cyclic population fluctuations has been a subject of much dispute. One of the most widely used definitions is that proposed by Davis (1957):

> "In ecological usage, the term 'cycle' refers to a phenomenon that recurs at intervals. These intervals are variable in length, but it is implied that their variability is less than one would expect by chance, and that reasonably accurate predictions can be made."

Davis prepared this definition in response to Cole's (1951, 1954) statement that lists of random numbers provided 'cycles' that were as good as many of those produced in nature. Davis (1957) states that the problem lies in the use of the term random. According to him, 'random' does not mean 'uncaused', but means that there are so many causes of the fluctuation that no one cause dominates.

Many theories have been proposed concerning the causes of cyclic phenomena. Generally these are classified as extrinsic and intrinsic causative factors (Hutchinson and Deevey, 1949). Some of the extrinsic hypotheses include climatic factors of apparently random intervals (Palmgren, 1949), meteorological factors such as sunspot phenomena (Elton, 1924), combination of favourable weather conditions and emigration (Butler, 1953), cyclic fluctuations in rainfall resulting in cyclic recurrence of forest fires which initiate secondary succession favourable to many animals (Grange, 1949), ozone theory (Huntington, 1945), and predater-prey relationships (Pearson, 1966; Keith, 1963).

Among the intrinsic factors suggested as possible causes for cycles are: disease (MacLulich, 1937), stress (Christian, 1950), decreased viability (Chitty, 1957), and abortion (Clulow and Clarke, 1968).

The literature of cycles is very extensive but analyses of bear populations are few. For example, Keith's important 1963 work does not include such an analysis. In recent years several studies of the black bear have been conducted; for example, Erickson *et al* (1964) in Michigan, Erickson (1965) in Alaska, and Bray and Barnes (1967) in Colorado. These studies give no indication of cycles in black bear populations. Long-lived animals do not lend themselves to such a study.

The first interpretation could be important in managing the species. The second interpretation we consider more interesting and worthy of more investigation.

Conclusions

Warm temperatures and low precipitation in March, April, and May result in an increase in the numbers of black bears taken for bounty in Northwestern Ontario.

There are two possible interpretations for this:

(1) A favourable spring causes a change in bear behavior, i.e. more movement, early emergence from dens, and thus more susceptability to hunters.
or

(2) Black bear populations in Northwestern Ontario are cyclic.

Acknowledgements

We wish to express our gratitude to the Ontario Department of Lands and Forest for providing the bounty data and to the Meteorological Branch of the Department of Transport for permitting us to use their weather records. C. Jonkell made suggestions for improving the manuscript.

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Bird Communities in and around Cape Breton Wetlands

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Abstract. This paper discusses bird communities in and around water areas on Cape Breton Island, Nova Scotia, during late spring and summer. Three communities of standing water areas and one of flowing waters are distinguished and characterized, while two more (not studied) are mentioned. Most land birds detected belong to grassland or forest communities adjoining the wetlands; birds of these habitats are summarized but not discussed in detail.

Introduction

From 1960 to 1968, I spent about 400 days studying birds on Cape Breton Island, Nova Scotia. In the course of other work, I collected a large amount of information on bird distribution and density in some habitats. Earlier (Erskine, 1964b) I summarized additions to Godfrey's (1958) list of Cape Breton birds. In this paper I attempt to outline the bird communities found near the waters of Cape Breton Island during the late spring and summer.

Cape Breton Island (Figure 1) is over 4,000 square miles in area, but this paper deals only with the portion northwest of the Bras D'Or Lakes, about 100 miles long by up to 30 miles broad. It is largely an upland area, of which the northern half, the Cape Breton Highland, is a dissected plateau 1,300 to 1,500 feet above the sea. "Sunrise Valley", the vale of the Aspy Rivers, pierces the Highland on the northeast; and the upper gorges of the Margaree and Cheticamp Rivers cut deeply into it from the west. The lower intervales of the Margaree and Middle Rivers and of Lake Ainslie separate the main Highland from two smaller uplands, the Mabou Highland and the Creignish Hills, which reach 800 to 1,000 feet. Most of my work was concentrated in the lowlands — the river valleys and the narrow strips along the west coast.

Materials and Methods

I visited Cape Breton Island in the course of two largely unconnected studies. The first involved spring and summer surveys of ducks, to obtain indices to their population fluctuations (Erskine, 1964a). I visited 10 areas (Figure 1) regularly from 1960 to 1963, with two or three (only one in 1960) surveys between mid-May and early June, and two or (usually) three between late June and mid-August. A few of these areas were visited, but only sporadically, in 1965 to 1968. Characteristics of these, termed the waterfowl areas, are shown in Table 1.

The second was primarily a population study of mergansers, chiefly Common Mergansers *Mergus merganser* (Erskine, 1971a, 1971b). I spent some time on life history study in the early years, until the Margaree merganser population was greatly reduced by a shooting program. Data are summarized for 12 areas, visited at irregular intervals from mid-May through mid-August, in 1960 to 1963 and 1965 to 1968. I spent most of my time along the Margaree until shooting began there in August 1962. Thereafter I concentrated more on areas along other rivers. These areas, termed the merganser areas, are described in Table 2.

During the surveys, the presence of species other than ducks was usually noted, and frequently I kept a running tally of numbers seen and/or heard. A few ubiquitous species — Barn Swallow *Hirundo rustica*, Common Crow *Corvus brachyrhynchus*, Robin *Turdus migratorius*, Starling *Sturnus vulgaris*, House Sparrow *Passer domesticus*, Redwinged Blackbird *Agelaius phoeniceus*, Common Grackle *Quiscalus quiscula*, White-throated Sparrow *Zonotrichia albicollis*, and Song Sparrow *Melospiza melodia* — were omitted. Spotted Sandpiper *Actitis macularia*, American Goldfinch *Spinus tristis*, Savannah Sparrow *Passerculus sandwichensis*, and Slate-coloured Junco *Junco hyemalis* were omitted as ubiquitous on some surveys, and tallied on others. I have not tabulated the data for these species, but it is usually possible to infer their status.

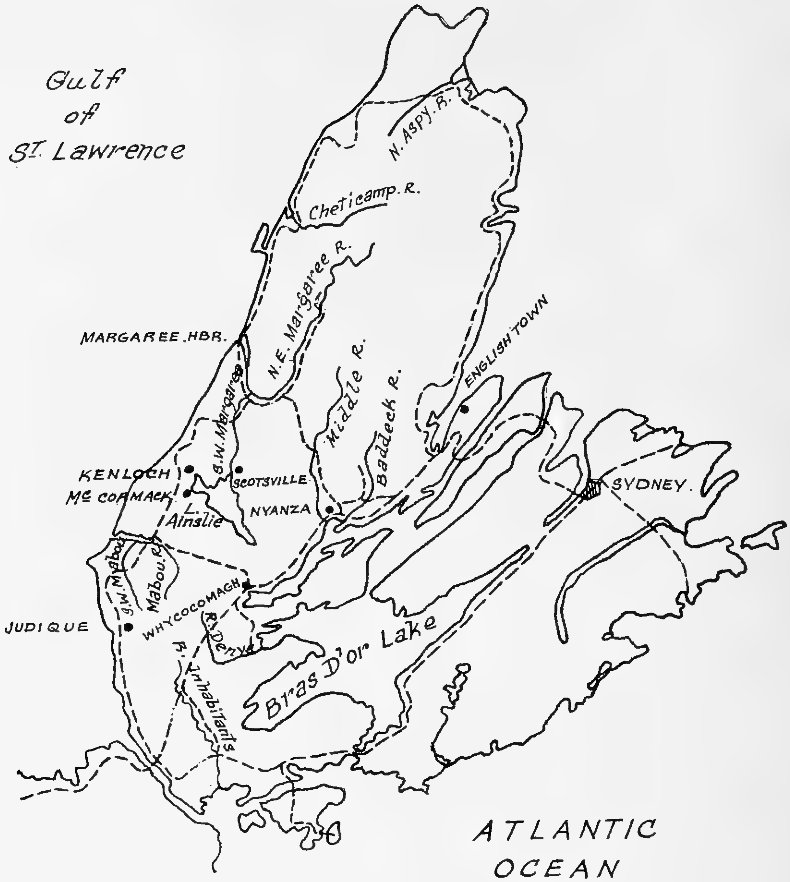

FIGURE 1. Locations of study areas, Cape Breton Island, Nova Scotia, 1960-68.

Results

In outlining the bird communities, I have examined the relative frequency of occurrence of species in the various areas, using Moreau's (1966) groupings.

(a) Water birds. Frequency data for species seen regularly, on a local or general scale, are summarized in Table 3. All areas were selected for study because mergansers and/or other ducks were present. Consequently, the absence, presence, or relative frequency of other water birds is more revealing than those of waterfowl, although there are differences even among the ducks.

(b) Raptors. Only four diurnal raptors were seen often enough to provide usable frequency data (Table 4). Pigeon Hawks *Falco columbarius* also were seen several times in summer at Big Intervale Margaree. Other hawks were noted chiefly in migration or in winter. A Great Horned Owl *Bubo virginianus* nested in the bottomland woods along the middle reaches of the N.E. Margaree River in 1962, and a Saw-whet Owl *Aegolius acadicus* with a large owlet was found in a steep hardwood forest at about 800 feet elevation north of Whycocomagh in 1966. One Barred Owl *Strix varia* along the Upper Middle River was the only other owl I noted.

(c) Other non-passerines. Four species provided useful frequency data (Table 5). A number of other species were noted sporadically

TABLE 1. — Areas visited regularly during waterfowl study, Cape Breton Island, N.S., 1960–63.

Area	General description
(a) *Brackish, non-tidal areas*	
Baddeck R. delta	Channels, lagoons, backwaters; medium-sized river mouth;
Middle R. delta	As above; river somewhat larger, with more rapid flow;
Whycocomagh	As above; only large brook discharging through area;
River Denys	As above; river smaller than at Baddeck R.
Judique ponds	4 barrier beach ponds - one open to sea, and two marshy creek mouths.
(b) *Brackish, tidal areas*	
Deltas of Mabou R. & S.W. Mabou R.	Channels and backwater lagoons; small rivers;
Margaree R. mouth	Tidal reach and estuary of large river; marshy areas largely fresh;
(c) *Freshwater areas*	
Scotsville	Marsh around lake outlet and along still-water stretch of large river;
Kenloch	Marsh around shallow bay off large lake;
McCormack	Marsh around shallow bays off large lake, with boggy creek discharging there;
River Inhabitants	Meandering, small river, with backwaters.

TABLE 2. — Areas visited frequently during merganser study, Cape Breton Island, N.S., 1960–68.

Area	General description
(a) *Upper reaches of rivers flowing from Cape Breton Highland*	
North Aspy R. (above Cape North)	Fairly small river; gradual flow; very few farms, on lower reaches
Cheticamp R. (above campsite)	Small river; rapid flow over boulders; no farming along area surveyed;
N.E. Margaree R. (above Margaree Valley)	Large river; rapid flow in uppermost reaches, becoming more gradual lower down; farms are infrequent;
Middle River (above top bridge)	Medium-sized river; rapid flow; farms infrequent;
(b) *Middle reaches of above rivers and others*	
N.E. Margaree R. (Margaree Centre to Margaree Forks)	Large river; gradual flow; most intervales farmed to some extent;
Middle River (top bridge to Middle R. bridge)	Medium-sized river; gradual flow; farms becoming frequent in lower half of area;
Baddeck R. (top bridges to head of tidal reach)	Fairly small river; gradual flow; few farms except in lowest reaches;
(c) *Middle reaches of rivers flowing from Creignish Hills*	
Mabou R. (E. Mabou fk. to Glendyer)	Small river; gradual flow except in gorges; only one or two farms in lower part;
S.W. Mabou R. (Hwy. 19 to head of tidal reach)	Small river; gradual flow; almost no farming;
R. Inhabitants (Kingsville to Morrison Sdg.)	Small, meandering river; slow flow; farming along upper two-thirds of area;
(d) *River draining large lake*	
S.W. Margaree R. (Scotsville to Margaree Forks)	Narrow river but with substantial and steady flow; some farming along lower reaches;
(e) *Outlets of small rivers and adjacent shingle spits*	
Englishtown area	Mouths of Indian and Barachois Brooks, and St. Ann's Spit.

FIGURE 2. The rapid, upper reaches of rivers harbour few water birds except Common Mergansers and Spotted Sandpipers. N.E. Margaree River above Portree.

along the rivers; but most sightings, of grouse for example, were away from the bottomlands and are not included in this analysis.

(d) Passerine birds. Data for these birds are summarized in Table 6. Relatively few of these species are directly associated with the waterside communities; most of these birds belong to the varied habitats that occur within earshot of the marshes and rivers.

Discussion

Since I spent most of my time near water, I have concentrated on the waterside communities. I will be discussing other communities only in so far as they adjoin the riparian ones.

The records in Table 3 show clearly the division between relatively rapid rivers and standing water areas. Common Merganser and Spotted Sandpiper were the only species found generally in all flowing water areas, whereas many water birds were seen regularly in the waterfowl areas. On the basis of the water birds (Table 3), we could recognize two sub-communities with flowing water — the more rapid, upper reaches with mergansers and sandpipers and few other birds; and the slower, downstream stretches along which many standing water species occur locally. The small, alder-grown brooks might be considered a third sub-community, in which mergansers are generally lacking and in which Woodcock *Philohela minor* (not included in Table 3) occur. However, I did not survey enough of this habitat to provide numerical data on its bird life.

The standing water areas were chosen for study because waterfowl were found there regularly. Black Ducks *Anas rubripes* were on nearly all areas, but the other species varied greatly in frequency of occurrence. Blue-winged Teal *Anas discors* were common on the brackish areas, and almost lacking on the fresh marshes. Ring-necked Ducks *Aythya collaris* were abundant on the non-tidal areas, including both fresh and brackish waters, but were absent on the tidal brackish areas in the west. Goldeneyes *Bucephala clangula* were common only on fresh marshes and those around the mouths of rivers, probably because they require sizeable trees — such as those in the bottomland forest — for nest sites. Common Mergansers occurred on all the waterfowl areas, but chiefly on those around the mouths of the larger rivers. They were much scarcer on the lake, and were not found breeding on the brackish ponds. Red-breasted Mergansers *Mergus serrator* were most frequent in the tidal, brackish-to-salt areas, and were most regularly found breeding there. Although some broods were hatched quite far up the courses of the Margaree and Middle Rivers, these birds apparently descended to the estuaries soon after hatching.

FIGURE 3. The fresh marshes provide breeding habitats for various ducks, Common Loons, American Bitterns, and a number of song birds. Marshy shore of Lake Ainslie at Kenloch.

TABLE 3. — Frequency of occurrence (as per cent of total visits) of water birds on Cape Breton study areas, 1960–68. Italized record include breeding evidence.

	Waterfowl areas											Merganser areas										
No. of Visits	(22)	(22)	(21)	(16)	(22)	(23)	(25)	(17)	(17)	(21)	(7)	(6)	(10)	(14)	(7)	(10)	(12)	(24)	(7)	(8)	(6)	(14)
Species	Baddeck R. delta	Middle R. delta	Whycocomagh	River Denys	Judique ponds	Mabou & S.W. Mabou deltas	Margaree R. mouth	Scotsville	Kenloch	McCormack	R. Inhabitants	S.W. Mabou R.	Mabou R.	S.W. Margaree R.	Baddeck R.	lr. Middle R.	lr. N.E. Margaree R.	up. N.E. Margaree R.	up. Middle R.	Cheticamp R.	North Aspy R.	Englishtown area
Common Loon		5	5			13		*29*	*41*	*48*												14
Pied-billed Grebe	5	5		12	*45*		8	*35*														
Dbl.-crest. Cormorant	73	45	19	69	5																	
Great Blue Heron	*68*	*91*	*71*	38	*95*	61	36	47	24	19	14	17		7	28			4			33	36
American Bittern	5		5		5		12	18	12	43	57		10				8					
Black Duck	*73*	*68*	*86*	*94*	*100*	*74*	*76*	*53*	*88*	*67*	*71*	33	*20*	*43*		10	8	8			17	
Green-winged Teal	27	*77*	*76*	25	18	26	12	6	*41*	24	*71*											
Blue-winged Teal	*86*	*68*	*52*	*63*	*45*	13	*64*	6		*14*	28			*14*								
Ring-necked Duck	*95*	*64*	*19*	*100*	*86*		16	*88*	*100*	*95*				7								
Common Goldeneye	*59*	*50*	19	*31*	5	13	4	*41*	*53*	*33*				7		*30*						
Common Merganser	*45*	*64*	*38*	*12*	9	*56*	*52*	*29*	*29*	*19*	*86*	*67*	*60*	*78*	*71*	*70*	*75*	*79*	*28*	*62*	*67*	43
Red-br. Merganser	5	9	10		18	*13*	*32*											25			17	*57*
Sora		5			5		4	24		9												
Common Snipe	55	45	67	*56*	23	26	*64*	*88*	29	62	100	17	30	14	57	30	17				17	
Spotted Sandpiper	36	*32*	48	50	27	35	*56*	29	24	14	100	*100*	100	*64*	71	*90*	*75*	*75*	*57*	87	67	*50*
Common Tern	14	55	67	50	59	35	16		6	14			10									*64*

TABLE 4. — Frequency of occurrence (as per cent of total visits) of diurnal raptors on Cape Breton study areas, 1960–68.

	Waterfowl areas											Merganser areas										
Species	Baddeck R. delta	Middle R. delta	Whycocomagh	River Denys	Judique ponds	Mabou & S.W. Mabou deltas	Margaree R. mouth	Scotsville	Kenloch	McCormack	R. Inhabitants	S.W. Mabou R.	Mabou R.	S.W. Margaree R.	Baddeck R.	lr. Middle R.	lr. N.E. Margaree R.	up. N.E. Margaree R.	up. Middle R.	Cheticamp R.	North Aspy R.	Englishtown area
Red-tailed Hawk	5			6	5						43	50	60		28			21	28		67	
Bald Eagle	*68*	*45*	52	94	50	48	24	12	35	14	43	67	30	71	57	10		8			17	21
Osprey	59	45	14	25			8	12	12	24	28			29			17					
Sparrow Hawk	9			6	9	9					43	17		21	43	10		8			17	7

TABLE 5. — Frequency of occurrence (as per cent of total visits) of other non-passerine birds on Cape Breton study areas, 1960–68.

	Waterfowl areas											Merganser areas										
Species	Baddeck R. delta	Middle R. delta	Whycocomagh	River Denys	Judique ponds	Mabou & S.W. Mabou deltas	Margaree R. mouth	Scotsville	Kenloch	McCormack	R. Inhabitants	S.W. Mabou R.	Mabou R.	S.W. Margaree R.	Baddeck R.	lr. Middle R.	lr. N.E. Margaree R.	up. N.E. Margaree R.	up. Middle R.	Cheticamp R.	North Aspy R.	Englishtown area
Chimney Swift	23	14	14	31	9	9	24	12	6	14	86	17	60	21	43	30	25	17	43	37	17	14
Belted Kingfisher	45	41	*81*	43	41	35	*32*	59	35	52	71	67	80	*86*	*86*	*80*	*67*	*96*	57	25	67	36
Flicker	45	18	14	*62*	32	*43*	36	29	*24*	19	100	67	70	*71*	86	40	*50*	*79*	71	*50*	50	
Downy Woodpecker	14			19	5	13	4				14	17	40	36	71	20	25	46	42	*87*	50	14

TABLE 6. — Frequency of occurrence (as per cent of total visits) of passerine birds on Cape Breton study areas, 1960–68.

Species	Waterfowl areas											Merganser areas										
	Baddeck R. delta	Middle R. delta	Whycocomagh	River Denys	Judique ponds	Mabou & S.W. Mabou deltas	Margaree R. mouth	Scotsville	Kenloch	McCormack	R. Inhabitants	S.W. Mabou R.	Mabou R.	S.W. Margaree R.	Baddeck R.	lr. Middle R.	lr. N.E. Margaree R.	up. N.E. Margaree R.	up. Middle R.	Cheticamp R.	North Aspy R.	Englishtown area
Eastern Kingbird		9	19		5	17	20	59		9	86	17	*60*	79	28		8	4				
Yel.-bel. Flycatcher										9	14	17	30		14	10	8	4	28	25	17	7
Traill's Flycatcher	9	14		19	18	17	8	12	6	19	14	50	20	7			25					
Least Flycatcher	27			25		5	20				86	100	60	29	14	30	50	54	57	50	50	
Eastern Wood Pewee	18	5		6	5	13	4	24		9	14	67	80	43	71	60	17	25	57	25	50	
Olive-s. Flycatcher	18	5		31	5		4	6	12	19	28	33	40		28	10	17	8	43	12	83	
Tree Swallow	14	18	14	19	36	13	8	18	6	5	43	17	10	7		30		17	14	25	33	14
Bank Swallow		5	38		18	9	24	18	29	19	*86*	33	20	14	42	*40*	*33*	8	14		33	
Blue Jay	32	14	14	37	5	30	20	29		24	57	33	60	57	57	60	8	46	14			14
Common Raven	14	5	19	19	23	30	20	18	6	9	28	33	40	50	57	30	17	42	14	25		21
Black-cap. Chickadee	45		5	43	18	26	24	18	6	14	43	33	60	36	43	50	67	58	28	50		7
Boreal Chickadee	23	5		62	18	22	24		18	19	43				86	10	17	42	14	12		21
Red-br. Nuthatch				6		4	12	6		5					28	10	17	4				14
Swainson's Thrush	14	5		25	23		16		6	19			30	14	14	20	25	54	71	87	50	14
Ruby-cr. Kinglet	36	18	18	44	32	26	20	29	29	33	86	33	30	7	14	40	25	33	28	50	50	14
Cedar Waxwing	9		9	6	5	13	4	6		24		17	30	21	71	30	8					
Solitary Vireo	27	5		25		4	4	6	12	9	43	17	10			40	33	58	57	75	50	7
Red-eyed Vireo	9			12	14	22	8	12	6	14	43	67	60	21	14	40	25	33	14	37	33	
Bl. & Wh. Warbler	18	5		37		4	4	29		19	43	17	30	50		30	50	67	43	37	83	
Parula Warbler	55			44	14	13	20	59	6	33	86	83	60	43	43	70	67	67	43		50	
Yellow Warbler	55	41	33	12	14	39	40	47	47	38	86	67	60	43	28	10	67	17		12	33	7
Magnolia Warbler	50	9	5	56	54	26	28	35	41	24	71	83	50	36	57	50	67	71	57	75	67	14
Myrtle Warbler	45	9	14	50	27	17	20	29	18	5	86	17	20	7	14	30	33	71	28	62	17	7
Bl. thr. Green Warb.	9			12	14	4					14	50	40	14		10	25	46	43	50	33	
Blackburnian Warb.	5						4					17	20			10	8	54	14	62	50	
Blackpoll Warbler	5	5	5	12			4	24		5	28					10	8	8	28	37		
Ovenbird	9		5					6		5		50	30	7	14		58	67	43	50	67	7
Nor. Waterthrush	5	9				9	36	35	18	33	28		20	7	28	30	83	75	57	50	100	
Mourning Warbler	9	5				4	8	12				67	30	14	71	50	50	46	57	50	67	7
Yellowthroat	64	18	14	44	23	13	20	59	24	43	57		50		14	10	8					7
Canada Warbler	5											17	30		14	30		4	14			
American Redstart	18			12	14	4	12	18		19	57	50	40	36	28	30	67	58	57	62	67	7
Bobolink	5	50	9	6	5	48	52	12	12		71	33	60	14	14	10	42				33	
Rusty Blackbird	9	9		31			4		12	5	28		20		43	50	8	17	28	50		
Evening Grosbeak	5		9			9		12			28	33	40	7	14	10		4			17	17
Purple Finch		5	19	25		13	12	6		5	43	17	40	14	28	20	33	42	57	62	50	21
Pine Siskin						4					14	17	20	7	14	10		8	43	25	33	7
Sharp-tailed Sparrow	9	36	33		27	30	20															
Lincoln's Sparrow	14			6			4										8	58	57		67	
Swamp Sparrow	64	32	38	37	27	22	12	47	82	62	43		30		28			8	14		33	7

Other water birds can be assigned to one or other of the above distribution patterns. Common Loons *Gavia immer,* American Bitterns *Botaurus lentiginosus,* and probably Soras *Porzana carolina* occurred chiefly on the fresh-water areas, whereas Double-crested Cormorants *Phalacrocorax auritus* and Common Terns *Sterna hirundo* were restricted to the brackish areas. The Double-crested Cormorant was also lacking from the tidal marshes of the west coast, perhaps because of nearby colonies of the larger Great Cormorant *P. carbo* which was sometimes seen on Mabou Harbour. Great Blue Herons *Ardea herodias* were seen more regularly on the brackish areas, particularly the non-tidal ones, than on fresh waters, and all breeding colonies found were near the former habitat. The Pied-billed Grebes *Podilymbus podiceps* were locally distributed, Scotville and Judique Ponds being the only areas where they occurred regularly. Common Snipe *Capella gallinago* were almost ubiquitous, probably because they range far outside of their preferred habitats in their "song flights". Spotted Sandpipers were on most areas, but chiefly those around river mouths and other gravelly shores.

The waterfowl areas fall into three categories: fresh marshes; brackish, non-tidal areas; and brackish, tidal areas. Distributions of the birds in Tables 4, 5, and 6 may now be compared

FIGURE 4. Brackish non-tidal areas are used by many ducks, Double-crested Cormorants, Great Blue Herons, Bald Eagles, and Ospreys, but few passerines. Delta of Middle River at Nyanza.

with these communities and that of the running water areas. Among the raptors (Table 4). only the Bald Eagle *Haliaetus leucocephalus* and Osprey *Pandion haliaetus* are associated with water. The eagle was seen near all water areas except the upper reaches of rivers flowing from the Highlands, but it was most frequent around the mouths and lower reaches of rivers. The Osprey was generally less common, particularly in the west coast areas (Judique, mabou, Margaree Harbour), but it reached peak frequencies in the same areas as the eagle. The other non-passerines (Table 5) include only one "water follower", the Belted Kingfisher *Megaceryle alcyon* which was nearly ubiquitous in the areas studied. Its highest frequencies were found along the lower reaches of rivers, where it nests commonly in the cut-banks.

Few of the passerines (Table 6) were clearly associated with water, but Traill's Flycatcher *Empidonax traillii*, Bank Swallow *Riparia riparia*, Yellow Warbler *Dendroica petechia*, Northern Waterthrush *Seiurus noveboracensis*, Yellowthroat *Geothlypis trichas*, Sharp-tailed Sparrow *Ammospiza caudacuta*, and Swamp Sparrow *Melospiza georgiana* were regularly found near water. The Redwinged Blackbird and Common Grackle, among passerine species not included in Table 6, also belong to the wetland bird communities. Among these, only the Sharp-tailed Sparrow was restricted to the brackish water areas. The Yellowthroat and Swamp Sparrow (probably also Traill's Flycatcher and Redwinged Blackbird) were much more frequent in all standing water areas, fresh as well as brackish, than along rivers. The Yellow Warbler and the waterthrush were the only species found along the upper courses of rivers, with the latter species reaching its greatest frequencies there. The Yellow Warbler was found nearly everywhere on the areas studied, as was the Common Grackle. The Bank Swallow, like the kingfisher, was most frequent along the lower reaches of rivers, where its colonies in eroding clay banks were common. Most other birds in Table 6 belong to upland bird communities, and were detected from the rivers and marshes abutting on suitable habitats. The upland birds are discussed briefly, for their habitats were not sampled systematically.

Tables 5 and 6 show that most of these birds were detected more frequently from the merganser areas (rivers) than from the waterfowl marshes. Relatively few small birds, except those belonging to such habitats, can be detected from far out on an extensive marsh, so to that extent this difference is real. On the other hand, the noise of rushing water often drowned out the calls and songs of distant birds along the rivers. In addition, on areas surveyed from a canoe (particularly S.W. Margaree River) my attention was frequently distracted from birds when I was negotiating rapids or shoals. However, failure to hear some birds near rivers was obviously less important than the absence of most birds from the marshes; even the larger and/or noisier birds, such as Flicker *Colaptes auratus*, Blue Jay *Cyanocitta cristata*, Common Raven *Corvus corax*, and Ruby-crowned Kinglet *Regulus calendula* were noted more frequently along rivers.

Most of these birds were associated with a particular habitat, and none was equally frequent everywhere. Sparrow Hawk *Falco sparverius*, Eastern Kingbird *Tyrannus tyrannus*, Bobolink *Dolichonyx oryzivorus,* American Goldfinch, and Savannah Sparrow were clearly associated with open areas, with or without water — the last two, although not tabulated, clearly belong in this category — and were seen most often along the lower intervales. Cedar Waxwing *Bombycilla cedrorum*, Mourning Warbler *Oporornis philadelphia*, and Song Sparrow were associated with edge situations, and the Lincoln's Sparrow *Melospiza lincolnii*

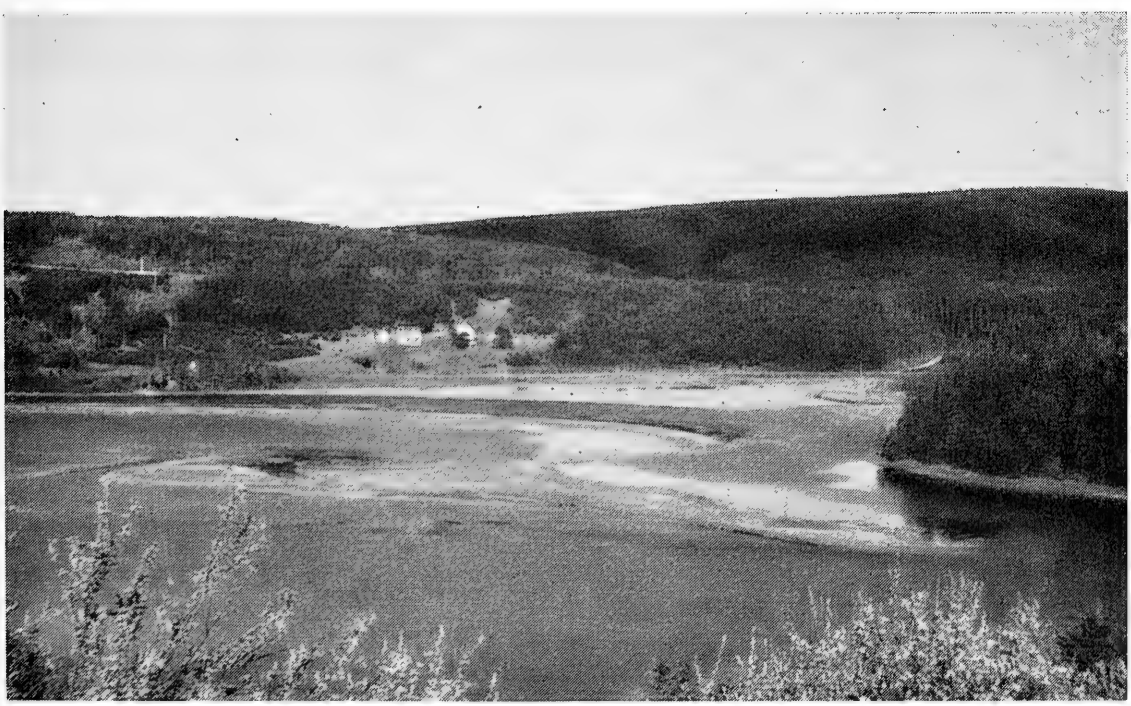

FIGURE 5. Brackish tidal areas are frequented by Black Ducks and mergansers, Bald Eagles and Spotted Sandpipers. Margaree River estuary below East Margaree.

TABLE 7. — Status of birds in wetland communities of western Cape Breton Island, 1960–68.

Species	Status in community				
	Brackish water areas		River estuaries	River courses	Fresh marshes
	Non-tidal	Tidal			
Common Loon					uncommon
Pied-billed Grebe	loc., unc.*				loc., unc.
Gt. Cormorant		uncommon			
D-c. Cormorant	common				
Gt. Blue Heron	common	common	uncommon		uncommon
Amer. Bittern					uncommon
Black Duck	common	common	uncommon	uncommon	common
Green-w. Teal	common				uncommon
Blue-w. Teal	common				uncommon
Ring-n. Duck	common				common
Common Goldeneye			uncommon	uncommon	common
Common Merganser	uncommon	common	common	common	uncommon
Red-br. Merganser	uncommon	common	common	uncommon	
Bald Eagle	uncommon	uncommon	uncommon	uncommon	uncommon
Osprey	uncommon				uncommon
Sora					uncommon
Common Snipe	common	uncommon		common	common
Spotted Sandpiper	uncommon	uncommon	common	common	uncommon
Common Tern	uncommon	common	uncommon		
Belted Kingfisher	uncommon	uncommon	common	common	uncommon
Tr. Flycatcher				uncommon	common
Bank Swallow			com., loc.*	com., loc.	
Yellow Warbler	uncommon	uncommon		common	common
N. Waterthrush				common	uncommon
Yellowthroat	uncommon	uncommon			common
Redw. Blackbird	common	uncommon		uncommon	common
Common Grackle	common	common	uncommon	common	common
Sharp-t. Sparrow	uncommon	common			
Swamp Sparrow	common				common

*Loc. – Local: com. – common: unc. – uncommon.

in this area was characteristic of old fields grown up with small white spruces. The remaining species, excluding Tree Swallow *Iridoprocne bicolor* and Red-breasted Nuthatch *Sitta canadensis* which were nowhere common, may be grouped according to the type(s) of forest in which they were most often detected:

Spruce — fir forest, along the upper courses of rivers — Red-tailed Hawk *Buteo jamaicensis*, Yellow-bellied Flycatcher *Empidonax flaviventris*, Swainson's Thrush *Hylocichla ustulata*, Solitary Vireo *Vireo solitarius*, Black-throated Green *Dendroica virens*, Blackburnian *D. fusca* and Blackpoll *D. striata* Warblers, Purple Finch *Carpodacus purpureus*, Pine Siskin *Spinus pinus*.

Hardwood forests, along the lower parts of rivers — Flicker, Least Flycatcher *Empidonax minimus*, Eastern Wood Pewee *Contopus virens*, Red-eyed Vireo *Vireo olivaceus*, Black-and-White Warbler *Mniotilta varia*, Canada Warbler *Wilsonia canadensis*.

Both conifer and mixed forests, upriver and down — Blue Jay, Black-capped Chickadee *Parus atricapillus*, Parula *Parula americana* and Magnolia Warblers *Dendroica magnolia*, Ovenbird *Seiurus aurocapillus*, American Redstart *Setophaga ruticilla*

Conifer forest, both upriver and down — Olive-sided Flycatcher *Nuttallornis borealis*, Common Raven, Boreal Chickadee *Parus hudsonicus*, Ruby-crowned Kinglet, Myrtle

Warbler *Dendroica coronata*, Rusty Blackbird *Euphagus carolinus*.

A few species were apparently very local in occurrence. Godfrey (1958) recorded both Black-billed Cuckoo *Coccyzus erythropthalmus* and Catbird *Dumetella carolinensis* on Cape Breton Island for the first time in 1954. I noted cuckoos on six occasions in 1961; once in 1960, 1962, 1966, 1967, and 1968; but not all in 1963 and 1965 despite similar time in the field. Those records included four near Margaree Forks (three in 1961), and three near Mabou; both of these areas included bottomland hardwood forest and edge. I found no Catbirds on Cape Breton in 1960 or 1961, but had seven records, including those probably breeding at Glendyer (Erskine, 1964b), in 1962. I also had three records near Margaree Forks in 1962. These records, as well as single birds at Glendyer in 1965, 1966, and 1967, were all in riverbank shrubbery. I noted Fox Sparrows *Passerella iliaca* only along the Aspy and to the north of it. Since 1965, they have become regular and are presumably breeding there (Erskine, 1968).

Evening Grosbeak *Hesperiphona vespertina* and Tennessee Warbler *Vermivora peregrina* are well known as "budworm indicator" species in New Brunswick, where they reach high densities in areas infested with spruce budworm. I noted the steady growth in numbers of both species near Mabou in 1966-68, and on that basis predicted that budworms might be found to be increasing there. Late in 1968 the Forest Insect Survey independently announced that this was occurring. Both birds were more numerous along rivers flowing from the Creignish Hills and along the Aspy than elsewhere.

Semipalmated Plovers *Charadrius semipalmatus* were previously known to breed on the spit opposite Englishtown (Godfrey, 1958), where I too found them regularly. I also noted this species in "display flight" at Little Judique Harbour and at Point Michaud Beach, possible breeding areas for this scarce species.

Horned Larks *Eremophila alpestris* occurred locally on the grasslands of the west coast of Cape Breton, but less commonly than in similar habitat in the western part of the Gulf of St. Lawrence. The Vesper Sparrow *Pooecetes gramineus*, which occupies similar habitats in New Brunswick, is lacking on Cape Breton Island.

Comparison of my surveys near water with those of the roadside Breeding Bird Surveys (cf. Robbins and Van Velzen, 1969) on Cape Breton Island indicates that certain species were consistently under-represented near the water. Most obvious among these were Yellow-bellied Sapsuckers *Sphyrapicus varius*, Brown Creeper *Certhia familiaris*, Winter Wren *Troglodytes troglodytes*, and Hermit Thrush *Hylocichla guttata*. My first coverage of the Mabou Breeding Bird Survey route in 1966 yielded more Sapsuckers and Wrens than I had noted in the five preceding years along the rivers.

The frequencies of Cardueline finches varied greatly from year to year. All species were low in 1960, and Purple Finches remained low in 1961 when Evening Grosbeaks and Pine Siskins were much increased. White-winged Crossbills *Loxia leucoptera* were more obvious in 1962 than before, and Evening and Pine Grosbeaks *Pinicola enucleator* and Siskins were numerous in late summer of 1963. 1967 was a peak year for both grosbeaks, and Evening Grosbeaks and Pine Siskins were common in 1968. Red Crossbills *Loxia curvirostra*, which had not been recorded on Cape Breton Island since 1905 (Godfrey, 1958) and were not detected at all from 1960 to 1967, were also common in July 1968.

In conclusion, we may recognize three bird communities of standing water areas, related to differences in salinity and to the presence or absence of tides. Flowing water areas have a more or less complex bird community, depending on the amount of marshy areas (standing water) along their courses. Since these are actually freshwater marshes, it is preferable to recognize only one bird community on the river itself. The status of birds in the wetland communities is summarized in Table 7. Brooks and bogs are other wetland communities, but they were not sampled and are not discussed in this paper.

Adjoining the wetland areas we can recognize grassland communities associated with the coasts and with the intervales, and at least three forest communities — hardwood forest, lowland conifer forest, and upland conifer forest. The intervale grasslands largely result from clearing by man, and all the forest habitats have been more or less disturbed by cutting and/or fire. Since my work was concerned mainly with the wetland areas, I have not attempted to outline the forest communities in detail.

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Notes on the Winter Ecology of the Mule and White-tailed Deer in the Cypress Hills, Alberta

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Abstract. White-tailed deer (*Odocoileus virginianus*) were observed to tolerate extreme cold without seeking forest cover, perhaps because of the presence of coyotes (*Canis latrans*). A small amount of snow in late fall caused whitetails to abandon a range which was occupied the previous year when there was no snow. A relationship is suggested between territoriality and the stability of the environment during the rut.

During an 18-month behavioral study of mule deer (*Odocoileus hemionus hemionus*) and white-tailed deer (*Odocoileus virginianus*) in the Cypress Hills Provincial Park, Alberta, I observed some of the deer's responses to various environmental conditions. The present account results mainly from incidental observations. However, the characteristics of the winters of 1968/69 and 1969/70 and some unexpected effects of cold and early snow on deer movements seem to warrant a short report.

Study Area and Methods

The Cypress Hills, a plateau in southern Alberta and Saskatchewan, are covered by a combination of forests (lodgepole pine *Pinus contorta*, white spruce *Picea glauca*, aspen poplar *Populus tremuloides*, balsam poplar *Populus balsamifera*) and grasslands (fescue prairie, *Festuca scabrella* association, and mixed-grass prairie, *Agropyron-Stipa* association). The fauna includes mule deer, white-tailed deer, elk (*Cervus canadensis*), moose (*Alces alces*), pronghorn (*Antilocapra americana*), coyote (*Canis latrans*), bobcat (*Lynx rufus*) and domestic cattle. A detailed description of the area is given in Breitung (1954) and Newsome and Dix (1968).

The study area included approximately 40 square miles in the northern part of the Alberta Provincial Park, ranging from about 3800 to 4700 feet above sea level. It consists, from south to north, of plateau with rough fescue (*Festuca scabrella*) and lodgepole pine, a valley running eastward, south-facing slopes with mixed-grass prairie, aspen and mixed forests, north slopes with mostly spruce and pine, and rolling mixed-grass prairie. Prominent shrubs include shrubby cinquefoil (*Potentilla fruticosa*), hawthorn (*Crataegus* spp.), chokecherry (*Prunus virginiana*), saskatoon (*Amelanchier alnifolia*), snowberry (*Symphoricarpos* spp.), rose (*Rosa* spp.) and willow (*Salix* spp.). Introduced grasses (*Bromus* spp., *Phleum* spp.) and some alfalfa (*Medicago sativa*) occur in the valley bottom.

Observations were made with 10×50 binoculars and a 15-60x telescope from viewpoints and along established routes on foot and by car, using a 12-volt spotlight at night. All observations were plotted on aerial photographs.

Effects of Cold

Late December and January of the winter of 1968/69 will be remembered for record lows and the long period of sub-zero temperatures. Mean daily temperatures for December, 1968, from two weather stations outside the Cypress Hills (Medicine Hat and Manyberries) were 10.3 and 6.5°F, a difference from normal of —9.6 and —11.6°F, and minima —46 and —42°F. Corresponding figures for January, 1969, were mean daily temperatures of —13.8 and —11.3°F, a difference from normal of —25.9 and —22.4°F, and minima of —44 and —41°F (Canada Department of Transport 1968, 1969). Inside the Park, I measured a

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record low of —48°F on January 23. Winds were generally light or absent.

I expected to see mule deer concentrate on the relatively warm upper half of south-facing slopes (Loveless 1967), and whitetails to seek the heat-conserving protection of coniferous cover, where temperatures are less extreme (Moen 1968a, Ozoga 1968). In general, mule deer stayed on the higher elevations, but lacked specific topographic preferences, probably because of the small scale of land features. However, they avoided extended tracts of forest and the plateau except for the edge. Mule deer spent the entire winter in the same area. Most of the whitetails left the shelter of the Hills in December and moved out into open prairie, where I saw them during most of January. They usually fed and bedded in groups on *Agropyron-Stipa* association with extensive rose patches and some willows and other shrubs. Although the northern edge of the forest was not more than half a mile away, they did not visit it regularly. Some cold nights were spent in the open, and the forest was usually not used for escape. The cover of light, uncrusted snow was 10 to 16 inches in both habitats, although it was more variable on the prairie due to drifting. In February, these whitetails left the vicinity of the Cypress Hills and moved into adjacent range and farm land, where they bedded in coulee thickets and fed on hay and other crops. They returned to the Hills in April, some time after the snow had gone.

Moen (1966, 1968b) has demonstrated the influence of body weight and food quality on the degree of cold stress deer can tolerate. Obviously the condition and diet of the observed deer during January was still good enough to compensate for the experienced heat loss. The energy balance may even have been more favorable on the open prairie than under forest cover, due to possibly better forage, somewhat easier snow conditions and little wind. Since winters in this part of Canada are critically long, it is to be expected that deer seek the best available energy budget even before they run out of their fat reserves. Otherwise they risk earlier depletion of storage fat and reduced chances for survival.

Nevertheless, the presence of coyotes may have been an important reason for the deer to stay away from forest cover. Coyotes roamed the area regularly, without paying much obvious attention to the deer. But wherever they howled or appeared the deer were alarmed, sometimes bunched together, and watched them intently. They did not run, however, until a coyote had approached within some 50 yards, and they soon stood again and watched. On the other hand, when I walked through the area, they took flight at 250 or 300 yards. I did not find a coyote kill that winter, but an apparently healthy whitetail doe killed in February, 1970, indicated how dangerous a combination of cover, slope and snow may be: two coyotes surprised the deer in the forest, chased it down a steep slope and caught it at the bottom when it turned sideways (evaluated from tracks). Obviously, such a technique can not be used in the prairie.

Although the white-tailed deer is generally considered a brush-type habitant, some exceptions are known. In the early days in Texas, deer were seen on treeless prairies (Teer 1965: 33). In Ecuador, most whitetails live on open grasslands, where they form herds and do not seek cover when disturbed (Spillett, *personal communication*). This is reminiscent of the situation in roe deer (*Capreolus capreolus*), where local populations in parts of Europe have adapted to completely open agricultural lands. Sparrowe and Springer (1970) observed South Dakota deer to evade hunters by taking to open fields. Similarly, the present observations indicate that white-tailed deer can dispense with their need for cover according to circumstances, even under conditions of severe cold.

Effects of Early Snow

In November, 1968, I counted 1383 deer (947 mule, 436 white-tailed) on 376 successful observation routes on the study area. In November, 1969, I saw only 624 deer (278 mule, 346 white-tailed) on 293 successful routes. Even more striking and more meaningful is the comparison of 13 sample areas of about 1/16 square mile each, in the center of the study area, which included mule deer, but not whitetail, late winter range. The figures are number of deer groups (including single animals) observed in October, November, December, 1968 — October, November, December, 1969 on these 13 plots: mule deer 52, 172, 46 — 35, 22, 17; white-tailed deer 19, 80, 11 — 0, 2, 0. Is this difference between the two years due to a population decline or caused by weather?

As total population size is difficult to estimate, trends will have to suffice. Mule deer have apparently declined: on 1193 successful observation routes during the last three months of 1968, I counted 412 groups, whereas 913 successful routes during the same period in 1969 gave only 149 groups ($X^2 = 52.3$, $P < 0.001$). The whitetail population seems to have remained unchanged: during the same three months, 145 and 127 groups were observed on 1067 and 836 routes in 1968 and 1969, respectively. These conclusions are supported by maximum counts on certain concentration areas in February, a month with similar weather in the two years, for instance: 1969 — 48, 1970 — 29 mule deer; 1969 — 24, 1970 — 13 mule deer; 1969 — 75, 1970 — at least 76 whitetails.

Late fall weather conditions in the two years were significantly different only with respect to snow; the cold spell of the first winter did not start before late December. The Canada Department of Energy, Mines and Resources measured snow depth on the ground at eight Cypress Hills locations at weekly intervals. Showing the number of measurements with at least 1 inch of snow and the number of measurements per month, the figures for October, November and December, 1968, are 0/32, 5/37, 29/31; for 1969, 28/38, 17/31, and 31/40. Snow depth averaged 0.0, 0.2, and 3.4 inches in October, November and December, 1968, 3.7, 1.0, and 1.6 inches in 1969.

Thus, it seems that the different deer distribution in 1969 was caused by snowfall in October. Whitetails in the eastern portion of the Park concentrated at the northern edge of the Hills within a week after the first October snowstorm and then disappeared. Presumably they entered the coulees and farmlands to the north and remained there for the rest of the winter. Incidentally, moderate hunting pressure during the first two weeks of November failed to bring the deer from 5 to 10 miles back into the Park, which was closed to hunters. Mule deer of the study area stayed inside the Park and were never seen away from the Hills all winter.

Authors agree that fall or early winter migrations of deer are often started by adverse weather (e.g. Severinghaus and Cheatum 1956: 155 and 158, for white-tailed deer; Richens 1967: 656, for mule deer; Cowan 1956: 572, for black-tailed deer *Odocoileus hemionus columbianus*; Formozov 1969: 50, for roe deer). However, it is mostly implied that the snow depth is critical, thus forcing the deer out of their summer or early fall range. For white-tailed deer, this critical snow depth is about 16 inches (Kelsall 1969) to 20 inches (Severinghaus 1947), for mule deer, about 18 inches (Gilbert, Wallmo and Gill 1970). In this latter study, the deer left their favorite range only after the accumulated snow exceeded 18 inches. In the present case, with a total October-November snowfall of less than 18 inches and much less snow on the ground, the amount of snow cannot be considered critical. The occurrence of high winds and temperatures above freezing during the period, that led repeatedly to spots of hard-packed and areas of crusted snow, was probably more important. Apart from impeding movement, a crust of snow can seriously restrict feeding on ground vegetation.

Since a crust was not too obvious most of the time, and south-facing slopes stayed essentially free of snow, there might have been another factor involved as well. Cowan (1956: 578) states that even comparatively light snowfall on Vancouver Island causes blacktails to form aggregations, and he points out that this "may well be a deep-seated trait of behavior designed to offer the advantage of numbers in establishing trails in deep snow." The same type of argument can perhaps be applied in the case of migrations triggered by snowfall below the critical amount. At any rate, a comparison of the two years indicates that weather conditions rather than a specific time have been responsible for the start of fall migration.

In a study of social behavior, it was of course discouraging to find the well-used rutting grounds of 1968 almost empty in 1969. However, this observation has led me to a speculation regarding a difference in social organization between roe deer and North American deer, *Odocoileus*. Bucks of the former species defend territories during the summer (Hennig 1962, Cumming 1966). This results in a tested social system at the onset of the rut, which takes place in August. The ultimate cause for that early date is possibly body size: the relatively small bucks would have a critically reduced chance to survive the winter after a rut in December. North American deer, at least bucks, appear to be basically non-territorial, and thus have a different social system during the rut. Roe deer summer habitat is more or less stable and permits prolonged maintenance of established territories. *Odocoileus* populations in regions with winter snow and differences in altitudes, however, may have to shift their ranges before or during the rut, a situation presumably unfavorable for the evolution of a territorial system. It is true that a majority of deer does not live in such a situation today; nevertheless, one could visualize a crucial step in the genus' evolution of social organization having occurred under such conditions. I suggest that an unstable environment during the rut could have contributed, certainly along with other factors, to the establishment of a non-territorial organization in North American deer.

Summary

During a behavioral study on a population of mule and white-tailed deer, differences between the winters 1968/69 and 1969/70 provided an opportunity for some observations on effects of cold and early snow.

During the exceptionally cold January, 1969, whitetails spent much time in the open prairie and did not normally resort to nearby forest cover. Although their metabolism was able to compensate for heat loss during that time, the apparent avoidance of cover needs explanation. It is suggested that coyotes may be less dangerous for deer in the open.

While October and November, 1968, were free of snow, there was a relatively thin snow cover during this period in 1969. The number of deer observed in the two months was smaller in 1969, especially for whitetails, although their population size apparently remained unchanged. Crusted snow and an "overshooting" behavioral adaptation may have caused an early movement to winter range, which for whitetails was outside the study area.

It is suggested that lack of territoriality in *Odocoileus* may be related to potential instability of the environment during the rutting season, as opposed to the situation in roe deer.

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Vegetation of Fort Reliance, Northwest Territories

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Abstract. Characteristics of vegetational communities and physical features in the region extending from Fort Reliance northward through Artillery and Ptarmigan Lakes and to Clinton-Colden and Aylmer Lakes are discussed, the former material (discussion of vegetational characteristics) being based on data obtained in the area by means of field sampling of communities. Sampling was most intensive (with the largest number of replications) in the following communities: forest communities dominated by black spruce and white spruce, and tundra communities described as low meadow, tussock muskeg, and rock field. Apparent ecological relationships of each community are discussed. Comparisons, particularly relating to climate-vegetational relationships, are made with similarly characterized communities in the Ennadai Lake area where the author made earlier studies (Larsen 1965). Climatic isopleths tend to converge in the Fort Reliance-Artillery-Aylmer Lakes area and it is possible that this climatic difference accounts at least in part for the apparent closer geographical juxtaposition of arctic and southern floral elements in the vegetational communities of the latter area.

Introduction

No part of the interior continental plains of Canada is more fascinating biologically than the region extending from the northeast arm of Great Slave Lake to Artillery Lake and from here northeast to the headwater lakes of the Back River. If ever a research station is projected for the northern Canadian plains, where ecology of forest and tundra can be intensively studied, my recommendations would be in support of its establishment at Ft. Reliance. Here are large tracts of boreal forest, a multitude of small lakes, and a protected inlet of the east arm of Great Slave Lake. A short distance north, at the south end of Artillery Lake, forest ends and tundra begins, the latter then extending northward for a great distance. North of Artillery lake, a chain of lakes swings to the west, permitting access to large areas of the land. The entire region is readily accessible by canoe, float aircraft in summer, and ski equipped aircraft in winter. Animal life is abundant and has been protected over large tracts of land since the Thelon Game Sanctuary was established (Clarke 1940).

The country was first seen by Hearne in 1770, during his exploration of the country west of Hudson's Bay (Hearne 1775) and in his description he states: "The land throughout that whole tract of country is scarcely anything but one solid mass of rocks and stones, and in most parts very hilly, particularly to the westward, among the woods. The surface, it is very true, is in most places covered with a thin sod of moss, intermixed with the roots of . . . insignificant shrubs and herbage; but under it there is in general a total want of soil, incapable of producing anything except what is peculiar to the climate."

Early exploration of Great Slave Lake and the Lockhart basin is summarized by Raup (1946). From his brief description the need is apparent for a full history of this region, including excerpted portions of journals beginning with Hearne's and continuing through the fascinating accounts of such adventurers as Richardson, Back, Dowling, Tyrrell, and Peter Pond. Clarke (op. cit.) conducted an official investigation of the Thelon Game Sanctuary; his detailed account of vegetation, people, and animal life was the result of extensive travels by canoe throughout the Artillery Lake, Hanbury River, and Thelon River areas. His description of the forest border at the south end of Artillery Lake is most vivid and accurate:

> "The timber-line is by far the most impressive faunal and floral boundary in Canada. East of Great Slave Lake it is a real line; the forest marches up to Timber Bay on Artillery Lake and halts. Because of the sudden change in altitude from Great Slave Lake to timber-line at Artillery Lake, one passes his last poplar, last jack pine, last tamarack, etc., one after another inside a few miles . . . The timber-line, is reached where the trees are unable to establish themselves under fairly exposed conditions. Beyond that line the spruce is most likely to be found in some sheltered spot where conditions unfavorable to the

dominant arctic vegetation and favorable to spruce prevail. Thus, on the loose sand of eskers in the Hanbury region, small, stunted clumps of spruce are frequently found, both black and white spruce, in tight little clumps of a few yards square and three or four feet high, or even higher at times. The best clump on the Thelon is in a place where springs emerge from sandstone and wash down to mineral soil."

Clarke found small clumps of spruce far beyond the forest proper, and concluded that this zone (where spruce persists as small, isolated clumps) was broader than the transition zone at the forest border. He found that tree sparrows followed the small clumps of spruce far into tundra, and that snow buntings apparently found the southern limit of their breeding range at the northern limit of the range of spruce as a species. Despite the broad extent of this zone, however, he concluded that "because of the few species involved it is perhaps not worthy of recognition as a valid life zone. There are, nonetheless, so many tiny clumps of spruce that were any climatic change to occur making it possible for trees to occupy exposed situations in that region the occupation would be rapid."

Regional Northern Limit of Spruce

It is of interest to establish the northern limits of the range of spruce in this region, primarily as a comparison to its range in the region north of Ennadai Lake (Larsen 1965). In the Ennadai Lake area, small isolated spruce clumps are found as far north as Yathkyed Lake where they have been observed by the author and where they were known to exist as early as in the days of Rasmussen (1927) who knew that Baker Lake Eskimos took trips to Yathkyed to obtain wood. The clump observed at Yathkyed, however, is extremely isolated and located near a small lake to the northwest (62°44″N; 98°38″W). Clarke reports that isolated tree clumps are reported south of the Maguse River and at Padley (Blanchet 1930), on the upper Kazan, and on the lower Dubawnt (Tyrrell 1896), on the south shore of Beverly Lake, the north end of Sifton Lake, on Hanbury Portage, and at Ptarmigan Lake. He points out that none had ever been mentioned from Aylmer or Clinton Colden Lake, but during the explorations of these areas I found small clumps of black spruce in the extreme end of the northeast arm of Clinton-Colden Lake and a few clumps were discovered during the course of rather extensive explorations at the west end of Aylmer Lake. The north arm of Aylmer Lake, however, is without spruce, and the Back River which has its origin just north of this arm is apparently the only major northern Canadian river that possesses no spruce whatsoever along the full extent of its course. The Thelon drainage is entirely beyond the continental forest border, but it possesses extensive groves of spruce along its shores at least south of the Beverly Lake area. Extensive groves exist at Beaverhill Lake, sufficient to construct cabins of considerable size and to provide firewood for a trapper for a period of many years (Gus D'Aoust, Ft. Reliance, pers. comm.)

It is apparent, however, that at some point to the northward the conditions even along major rivers become inimical to the survival of even the most dwarfed trees, and at these points the spruce finds the limit of its northward range. It appears that these limits correspond rather closely to the southern edge of the region where arctic air masses prevail almost continuously between spring and fall (Bryson 1966).

Physical Features

The east end of Great Slave Lake is extremely rugged along the shores, becoming less so as one moves progressively away from the lake. The region is described by Wright (1952) as follows:

"The granitic uplands bordering the lake basin present a monotonous succession of low rocky hills and ridges, with local relief rarely exceeding 250 feet. The upland south of the lake rises abruptly along an escarpment (McDonald fault) 700 to 800 feet above the lake, whereas north of the lake rocky slopes rise gradually to plateau level at one to four miles inland. Rivers entering the lake basin follow either poorly defined valleys or deep gorges, and are unnavigable for two to twelve miles inland. The monotonous aspect of the bordering uplands contrasts sharply with the rugged and picturesque topography within the lake basin. There, vertical cliffs of diabase and limestone in places rise several hundred feet from the water, or form cappings over steep slopes of softer rocks, particularly shale. . .

Although glacial boulders are abundantly distributed over most of the area, thick morainal deposits are essentially restricted to the northwest part of the area, particularly south of Artillery Lake. Boulder hills, 50 to 100 feet high and composed of unsorted, angular, granitic and gneissic boulders and coarse gravel, are conspicuously well displayed in this part of the map-area. . .

The country from Artillery Lake south to Snowdrift River is barren of trees except for a few, small, widely scattered stands of scrub trees one to six feet tall, and some stands of larger trees growing on local sand deposits. Elsewhere the region is sparsely timbered with spruce, birch, pine, and tamarack. Within the basin of the larger lakes, and on south facing slopes, trees are up to 18 inches in diameter, whereas on the more exposed upland areas they seldom exceed six inches."

The geological survey maps of the McLeod Bay area at the east end of Great Slave Lake reveal rather large areas of limestone, dolomite,

FIGURE 1. Rocky hill summit near the shoreline of the eastern arm of Great Slave Lake.

slate, and shale on the south shore; sandstone, quartzite, slate, and shale on Fairchild Point which is the site of Ft. Reliance; and vast tracts of land to the north given over to granitic and gneissic rocks with smaller areas of quartzite and greywacke.

Stands of well-developed white spruce are found on the soils derived from shale and slate on Fairchild Point; on the sandstone and quartzite soils at the mouth of the Lockhart River and on the west shore of Artillery Lake, and on the limestone and dolomite of Crystal Island on Artillery Lake.

Pike's Portage route between the east end of Great Slave Lake and the southern end of Artillery Lake links a number of long, narrow lakes lying along the McDonald Fault, north of which the parent material is principally gneissic and south of which it is largely quartzite or a gneissic, granitic complex. Along this portage, vegetation is principally black spruce once Great Slave Lake is some distance behind, grading perceptibly into tundra as one approaches Artillery Lake. From Artillery Lake to the southeast, tundra extends for many miles; treeline dips southward rather steeply from the south end of the lake.

The south end of Artillery Lake is surrounded by largely granitic hills with deposits of drift in the depressions, and as one travels north the deposits of glacial drift appear to become deeper and bedrock exposures less frequent. Halfway up the lake, the hills are rolling with gentle slopes, the surface material is gravel and sand intermixed with larger rocks of all shapes and sizes, indicating that here the accumulation of drift is deeper and nearly continuous over the surface of the earth. Eskers and gravel deposits of one kind and another are frequent. Essentially this same surficial geology is then found for a good distance north, including Ptarmigan, Clinton-Colden, and Aylmer Lakes, and the region around the Hanbury Portage, all of which were visited during the course of vegetational studies reported in the subsequent pages.

Water samples obtained from lakes in different types of geological material clearly demonstrate that limestone and dolomite contribute relatively large quantities of minerals to waters with which they are in contact. Of five small lakes sampled, four were surrounded by granitic rocks, the other was on Crystal Island where the substrate is principally dolomite. This latter sample (Sample 2, see below) contained a much higher content of minerals:

General water quality data for water samples from 5 small, barrengrounds ponds in the vicinity of Artillery and Clinton-Colden Lakes, N.T.W., collected by James A. Larsen in 1964[1].

	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
Spec. conductance, mmhos/cm^3[2]	Less than 40	100	Less than 40	Less than 40	Less than 40
Total alkilinity, ppm[3]	20	133	18	13	28
Sulfate ion, ppm	3	5	3	2	4
Chloride ion, ppm	2	2	2	2	2
Lab pH[4]	6.8	7.6	6.8	6.7	6.8

[1] All samples analyzed August 24, 1964 by H. W. Murdy, U.S. Fish and Wildlife Service.
[2] The Solu-Bridge used does not measure specific conductance below 40 mmhos/cm^3.
[3] No phenolpthalein alkalinity was present in any of the samples.
[4] Although lab measurements of pH often differ considerably from measurements taken at the time the sample is taken, these measurements do serve to emphasize the difference in general water quality between sample No. 2 and the other 4 samples.

Spruce Distribution on Artillery Lake

The controls governing white spruce distribution are quite apparent at the south end of Artillery Lake. Along the west shore, white spruce is found on glacial till which appears to be primarily of granitic origin, and on sand deposits adjacent to the shoreline, at points considerably farther northward than along the east shore or inland. Crystal Island white spruce attain large sizes in areas where stands are protected and where snow can accumulate to considerable depths in winter. Not a mile away, on the same material, but where the topography is flatter and unprotected, the spruce has been unable to become established.

Scattered white spruce are found along the shores of the lake and inland north of the forest border, and the northern part of the lake has white spruce occurring, but rarely, on the eskers.

Black spruce is found in large groves along the west shore and inland at the south end of the lake, becoming scattered or rare toward the north end. Small clumps of dwarfed black spruce are found nearly all of the way to the mouth of the Lockhart River along the east shore, although becoming markedly more scattered toward the north. Black spruce is also found in protected spots along the esker which crosses the Lockhart River between Artillery and Ptarmigan Lakes; it then occurs with decreasing frequency northward. Small clumps of dwarfed spruce are found in sites protected from prevailing winds where snow accumulates to considerable depth in winter.

There appears to be a relationship between type of substrate and white spruce abundance; the latter evidently finds conditions most favorable on alluvial or dolomitic materials. Black spruce, on the other hand, occurs over a wide range of substrate types as observed by the author during studies of the boreal forest (Larsen, in prep.). This is also in accord with observations by Hustich (pers. comm.) in northern Canada, indicating that white spruce distribution is more greatly influenced by soil conditions than is the distribution of black spruce. It is evident that black spruce occurs over a wider range of habitat conditions in northern regions than white spruce. Tyrrell's account corroborates these observations; his descriptions of forests in the late 1800's indicate that white spruce was fairly limited in habitat preference; it is not cutting, fire, or other recent disturbance that accounts for present-day proportions of white spruce in the northern forests.

White spruce on Crystal Island is an example. Water analysis shows a high base content of surface waters here, contrasting to the waters of the mainland. But basic soils are not the only requirement for white spruce on Crystal Island. Additionally, trees are at the base of a high cliff, facing southeast where they are protected from the strong winter winds and are completely covered by snow during the large part of the winter, according to Noel Drybone of Ft. Reliance, who was born on the island and lived there many years.

It is of interest that the northernmost clumps of dwarfed spruce are found in drainage lines of the same type as those similarly occupied by spruce in the Ennadai Lake area. Here are found the same accumulation of large rocks through which water must flow at least during snow-melt in early spring. *Betula glandulosa* and *Salix* species are also understory dominants. Many of the same forms suggesting introgression between white and black spruce are found in the Artillery Lake area as at Ennadai (Larsen 1965). It is also apparent that at Artillery Lake, clumps of spruce north of the forest border occupy the same special upland habitat as at Ennadai, the declivities between the rock fields, and on an ordination their understory vegetation will appear juxtaposed between rock fields and tussock muskeg communities.

A lichen woodland type is also found at places along the portage route between Great Slave and Artillery, with widely spaced spruce and an understory dominated by *Stereocaulon* and *Cladonia,* with denser aggregations of *Vaccinium vitis-idaea* and *Empetrum nigrum* beneath the trees. The substrate is primarily well-drained sand and gravel. The greater proportion of the black spruce stands across the portage, however, occupy those areas where till and weathering products have accumulated in the declivities between outcropping hills. The scattered dwarf spruce seldom exceed 20 feet in height or 12 inches basal area (bh). There are crustose lichens on the rocks and *Rhacomitrium* frequently surrounds the bases. An occasional white birch is present.

It seems probable that small spruce clumps would range northward in greater numbers if terrain of this exceptionally rugged type (providing small areas of favorable microclimate for spruce) also stretched for a distance northward. The south end of Artillery Lake, is however, characterized by rolling hills of till. It is

FIGURE 2a. A small grove of white spruce in a drainage line at the south end of Artillery Lake.

apparent that the trees survive in sheltered spots created by rocky bluffs and hills along the McDonald Fault. It is conceivable that timberline swings to the south from Artillery Lake eastward because here, too, till rather than outcropping bedrock is the dominant surficial geological formation.

The term "forest border" is a more meaningful bioclimatological reference than the "limit of trees", since this latter does not coincide as closely with the apparently limiting macroclimatic parameters as does the forest border.

It appears that the climatic transition across the Great Slave Lake-Artillery Lake forest-tundra transition zone is more abrupt than farther to the east (McFadden 1965). Along Pike's Portage, the zone of transition from forest to tundra is much compressed over the transition in, for example, the Ennadai Lake area, environmental gradients must be steeper, and southern boreal and tundra components of the vegetation range much closer to one another if they do not actually overlap (which many do). The nature of the substrata at least helps account in part for the increased importance of white spruce in this area as compared to the role of white spruce in the timberline forest in areas to the east. White spruce fails to occupy the till-dominated terrain beyond the south end of Artillery Lake because, northward, there is both an absence of nutrients contained in limestone rocks and because of unfavorable climatic conditions prevailing. Black spruce, however, would occupy the terrain if the climate permitted, since it is not as demanding in terms of nutrient requirements, but the climate northward is also inimical to black spruce survival over major portions of the landscape. Only in protected areas of favorable microclimate does spruce manage to survive to the north of the forest border on Artillery Lake. The most reasonable interpretation of the black spruce outliers north of Artillery Lake is that they are relict stands from a former time when the entire area was forested.

This view is supported by evidence that forest once extended farther north in the Ennadai Lake area (Larsen 1965; Bryson, Irving, and Larsen 1965). It is of interest that charcoal underlain by a fossil podzol has also been found by the author in a favorable site near the north end of Artillery Lake. The C^{14} date of this charcoal layer is 2140 $\pm$ 80 years BP (Bender *et al* 1967). In addition, W. C. Noble (pers. comm.) discovered a buried charred soil horizon at Winter Lake on the Snare River system (64°28′15″ N; 113°06′ W). Here the exposed soil horizon of black humus and charred spruce wood lay beneath 33 inches of aeolean sands capped by present stable vegeta-

FIGURE 2b. Outlet of the Lockhart River at the south end of Artillery Lake.

tion. The date obtained for the burned material was 2378 ± 140 BP.

Community Descriptions: Pike's Portage Area

Around Ft. Reliance hills of rugged aspect dominate the landscape but ample areas of glacial till exist to provide sites for vegetational growth which are comparable to those at Ennadai and Artillery Lakes. The vegetation on these deposits is that which was sampled in the studies reported in subsequent paragraphs. On the areas of outcropping rocks, plants are confined to rock fissures and small deposits of weathered material. On such areas, it is difficult to discern any aggregations of plants that might be considered a community and, hence, for the purpose of this study they have been ignored to a large extent. On hill summits where a larger deposit of gravel exists, however, plant cover is nearly continuous, and an association of largely decumbent, xeric species can often be found (Stand # 5-14 see Tables). An accompanying photograph shows a rocky summit, and the paucity of plant occupancy of such sites can be clearly seen (Fig. 1). The summits of the hills are often dotted with small peat bogs, and in these *Ledum decumbens* is abundant, along with an increased frequency of such other species as *Betula glandulosa, Vaccinium uliginosum*, and *V. vitis-idaea.*

Black spruce and white spruce communities dominate the landscape, however. The former are in lowland areas where they constitute the 'bog 'forests" of Raup (1946) who points out that "the development of a bog type of vegetation, or muskeg, in our region is dependent upon the presence of some sort of undrained depression in which a supply of moisture is available. The succession of vegetation set up in these depressions usually involves characteristic mosses and big shrubs, and culminates in a forest of black spruce, sometimes accompanied by larch. Almost invariably there is a shrub layer primarily of Labrador tea (*Ledum groenlandicum*) and a thick mat of mosses which are usually arranged in hummocks. In the wetter condition these mosses are *Sphagnum,* but in drier ones they are woodland species of *Hypnum*. Everywhere the forest is of small stature, the larger trees reaching heights of thirty to fifty feet."

White spruce forests, on the other hand, occupy some uplands, ancient beaches, stony shore ridges, and alluvial sand plains along the lakes and rivers. The ubiquitous nature of this association throughout the region is also noted by Raup: "Within the Athabasca-Great Slave Lake region an open, park-like forest of *Picea glauca,* often with the addition of *Betula papyrifera* var. *neoalaskana,* is widely distributed on ancient beach ridges and the lake shore terraces. Around the eastern end of Great Slave Lake it spreads to the surrounding uplands. Floristically it is rather uniform over the whole region, but locally it shows varying stages of mesophytism depending upon slope, exposure, and the character of the substratum."

In comparison with spruce communities elsewhere, those at Ft. Reliance possess a rich complement of species, as can be seen from the accompanying tables. This may in part be a consequence of the diversity of topography in the immediate vicinity of Ft. Reliance, permitting survival of a large number of species which represent, in the aggregate, a wide range of environmental preference. Thus, in general collections in the area, such species as *Dryas octopetala, Saxifraqa aizoon, S. nivalis, Rorippa islandica, Androsacaea septentrionalis,* and *Arnica alpina,* as well as others, are found rather commonly at times on suitable habitats. Occasionally adventive individuals are found in adjacent communities where otherwise they would constitute a somewhat puzzling rarity. This diversity at Ft. Reliance may also be the consequence, at least in part, of the diversity of substrate types, since these latter include various materials derived from dolomite and shale as well as granite and from the glacial drift found in a variety of sites throughout the region.

Another interesting aspect of the composition of the Ft. Reliance communities is the unusual intermixing of species customarily associated with the arctic environment, such as *Dryas integrifolia, Rhododendron lapponicum, Kobresia, Saussurea,* and others, in communities along with such typically southern boreal representatives as *Shepherdia, Linnaea, Arctostaphylos,* and *Petasites.* These species, whether they have arctic or southern boreal affinities, occur not at all or only rarely in the communities near the forest border at Ennadai Lake to the eastward. This apparently is the consequence of the more gradual climatic gradients in the Ennadai Lake region, with a broader zone between regions dominated by arctic air masses and air masses of southerly origin. Within this zone there is an apparent paucity of species which may be the consequence of a broad zone dominated by frontal conditions during the summer season (Larsen 1967). This zone is much abbreviated in the Great Slave Lake region, with steeper climatic gradients and hence a flora in which both arctic and southern boreal species are represented (in a sense overlapping) and with both arctic and southern boreal species found at or near the forest border. There is some evidence of a depauperate zone in the Lockhart Basin (Aylmer, Clinton Colden, and Ptarmigan Lakes), corresponding to, but not as floristically impoverished, as the depauperate zone in the region north of Ennadai Lake. In the Lockhart Basin, a number of arctic species are found in fairly high frequencies in the communities, but not in either numbers or relative frequencies are they found to equal those in communities farther to the northeast. Although studies have not been conducted at equal distance north of Aylmer or Artillery Lakes as they have north of Ennadai Lake to the eastward, it might be anticipated that a marked increase in arctic plants in both the floristic and frequency components of the communities will be found in the region around and to the south of Bathhurst Inlet, between Bathhurst and the upper Back River. If such is, indeed, the case, a floristic zonation will have been demonstrated such as exists to the northward of Ennadai Lake; a somewhat depauperate zone in a belt immediately north of timberline, with arctic species increasing in numbers and frequencies in plant communities as one travels northward of this zone.

In summary, the vegetation of the area shows a rapid and marked transition from boreal forest with strong southern boreal affinities around Ft. Reliance to tundra dominated landscape some twenty miles north at the south end of Artillery Lake. There are a number of characteristically arctic species in the communities at Ft. Reliance, and the indications are that here the arctic and boreal components of the communities overlap to a greater extent than in the area around Ennadai Lake to the eastward. This intermixing of arctic and boreal flora is at present not fully understood, but it appears that there is also a correspondingly more abrupt transition here between the dominant Pacific and southern air masses to the south and the arctic air masses to the north. If there is, indeed, a relationship between these two phenomena, and it appears to the author that, indeed, there must be, the inference is that for at least some of the arctic species, conditions permit an intrusion southward into the boreal forest, and at least for some of the southern boreal species, the conditions permit an intrusion northward into forest communities more characteristic of the northern transition zone. To the eastward, the ecotone between southern boreal and northern boreal and tundra is more gradual, so that such an overlap of arctic and southern boreal species is not found in the communities dominating the landscape. Indeed, if southern boreal or arctic species are found at all in the Ennadai northern transition ecotone communities, they are found only rarely and on special and unusual sites. The presence of this rather obvious zonation can be rather readily interpretated as a consequence of a corresponding zonation in climate, and in view of the general monotony of the terrain throughout this vast region, this is, indeed, the simplest and most generally satisfactory explanation. Farther north, Cody and Chillcott (1955) noted that break-up at Muskox Lake (slightly north of the north arm of Aylmer Lake) was two weeks behind that at Matthews Lake some 95 miles to the southwest, demonstrating a rather sharp climatic zonation in the region.

FIGURE 2c. Dwarfed spruce along a shoreline at the south end of Artillery Lake.

Vegetation of the Lockhart Basin

The Lockhart River joins the large lakes McKay, Aylmer, Clinton-Colden, and Artillery into a chain, providing the traditional route for both winter and summer travel through the country north of the east arm of Great Slave Lake. It was apparently first used as such, by other than native Indian hunters, when Capt. George Back and his party traveled along it to the headwaters of what is now known as the Back River in their journey northward to the Arctic Ocean in 1834 (Back 1936, King 1936).

Extensive botanical collecting in the region, however, was delayed for many years, although it is apparent that the country was visited frequently. An abundance of fascinating accounts of exploration and adventure are available. These include the journals of participants in Franklin Search Expeditions (Pullen 1852, Richardson 1851), explorers who canoed through the country (Anderson 1856), others who conducted various zoological, geological, and mapping surveys, and a number of individuals who were hunting for sport. These latter include the narrative of Wharburton Pike, a hunter after whom Pike's Portage was named, who published an account of his adventures in 1892.

Brief descriptions of these and a number of other early accounts are provided in the paper describing the vegetation of the Athabasca-Great Slave Lake Region published by

Raup (1946). More recently, Scotter (1966) describes the flora of the region around the east arm of Great Slave Lake as part of a study of conditions on the winter range of the barren ground caribou.

Descriptive notes accompany a Canadian Geological Survey map of the Aylmer Lake area (Geological Series Sheet 76c) indicate that lake elevations in the area range from about 1,100 to 1,500 feet above sea level and that local relief may be as much as 250 feet above the lakes but commonly reaches no more than 50 or so feet. The general characteristics of the surficial geology of the area are summarized:

"Glacial drift covers about 80 percent of the land area. It consists mostly of till, and commonly gives an indication of the bedrock . . . Drumlins and drumlinoid features are common . . . Well-scoured outcrops, eskers, and scattered sand and gravel deposits interspersed with numerous small rounded lakes mark the Pleistocene drainage routes."

This Aylmer Lake map includes land entirely within the barren grounds, while the map area to the south (Walmsley Lake Area, Geological Series Sheet 75N) includes portions of the forest border. Descriptive notes accompanying this sheet point out that the "percentage of rock outcrop varies with rock type and locality, and is much less in the barren ground part of the map area . . . Within the barren grounds less than 10 percent of the area underlain by sedimentary rocks, and only 25 percent of the parts underlain by volcanic rocks and granitic intrusions is exposed."

Richard King, surgeon and naturalist to Back's expedition, wrote rather florid accounts of the tundra regions of the Lockhart Basin, making note that:

> "The country . . . consisted of rounded hills, covered with lichens, mosses, and dwarf-birch; while here and there the scenery was relieved by rich meadows, from which an occasional rivulet was seen winding a serpentine course, marked by two distinct lines of willows clothing the banks. In preventing the growth of trees, nature has indeed deprived these parts of their softest beauties; and with justice procured them the epithet of barren. Nevertheless, their gigantic features, in many cases, amply repay the loss of the pleasant feelings arising from such beauties, by calling forth emotions of a far higher order."

King was not so overwhelmed by the majesty of the barren lands, however, that he failed to take note of other details. It is of interest that he observed decaying remnants of trees extending some distance into the tundra, concluding that forest once had occupied land farther north:

> "That the barren grounds were formerly less bare of wood than they are at present, we had proofs in the dead stumps that were met with beyond the living trees; fully confirming the account of the Indians, that large tracts of country now naked were once covered with thick forests. This decrease in wood in certain meridians has not been accounted for; although the same phenomenon exists in the more northern parts of the European continent; in Iceland, where wood was formerly abundant, scarcely any remains; and the same may be observed of the Orkney, Shetland, and Western Islands. The natives of North America cannot assign any cause for this change."

At the present time, clumps of dwarfed spruce are to be found at the eastern end of Clinton-Colden and the western end of Aylmer Lake, but is apparently absent, or at least insignificant, in the area between. A low-level reconnaissance flight to perhaps 100 miles north of Clinton-Colden revealed that in this area the landscape is uniformly barren with rolling rocky hills covered with a sparse vegetation much of it representative of rock field communities.

From the west end of Aylmer Lake, the forest border trends roughly northwesterly and Cody and Chillcott (1955) describe the distribution of spruce around Matthews Lake (64°05′ N; 111°15′ W), which lies just northwest of MacKay Lake, as follows:

> "Matthews Lake is at the northeastern limit of trees in this area.. No spruce trees were seen or reported from farther north. On

the west side of the Lake, black spruce is fairly common in sheltered valleys, and sometimes attains a height of 20 feet. However, most of the trees in rocky exposed areas are severely twisted and stunted, and have well-developed branches only on two feet of the trunk. Even in wet valleys, there is considerable dwarfing. Here the trees are well spaced, and numerous dead stumps, some of them much larger than the living trees, are scattered throughout the stands."

On the opposite or eastern side of the lake, Chillcott found spruce to be rarely more than two feet in height, growing in small clumps along the edges of lakes and ponds. These were apparently mature spruce, since scattered dead spruce of similar size were found within the clumps. In addition, heavy willow and birch thickets were found throughout the area, with an occasional alder, principally along drainage lines. Such thickets are as high as 10 feet on the west shore, but rarely attain more than six feet in height on the eastern shore.

Indians who have trapped the barrens during winter point out that for them it is essential to survival that they know the location of these small clumps of spruce. Only then can they dig into the snow and obtain firewood for tent stoves. When temperatures are far below zero the Indians traveling in these areas must obtain at least a few small pieces of wood which can be burned intermittently throughout the night. This appears to be a heroic measure, but actually the small one-man tents are quickly warmed by the highly resinous wood burned in the tiny stoves, and each fire warms both tent and sleeping robe sufficiently to permit a few hours of sleep before another fire is necessary. The spruce is rarely visible above the surface of the snow, however, and prior knowledge of the location of these small clumps must be acquired either from other trappers or during summer travel.

II
VEGETATIONAL COMMUNITIES

It was shown in a foregoing discussion concerned with the vegetation of the Ennadai Lake area that topography appears to work a decisive influence in determining the type of plant community which can be expected to occupy a given site within at least the low arctic zone and probably also within most of the high arctic region as well. It can be said that the tundra communities of the Lockhart Basin are no exception to this rule.

At Artillery Lake, as at Ennadai to the East, the dominant communities over the landscape are those occupying the low meadows, the summits and upper slopes of the rock fields, and the tussock muskeg communities on the lower slopes topographically intermediate between the meadows and the tops of the low, rolling hills. The gradation from one community to another is often gradual providing the slope is uniformly gentle and not marked by topographic discontinuities of one kind or another.

In addition, at the south end of Artillery Lake, as at Ennadai, the spruce forest reaches its northern limit. North of this border the spruce is increasingly confined to small groves in protected declivities between hills and in ravines where more often than not a small rivulet can be heard beneath the aggregation of larger rocks and boulders which make up the bed of these miniature valleys. As can be noted from the Tables, many of the species are shared by the Artillery and Ennadai Lakes areas. Moreover, many of these species appear in approximately the same proportions — with nearly the same frequency — in the communities of these two areas.

Rock Field Community

A characteristic rock field might be described as a thinly vegetated area on sloping upland or on relatively flat summit areas where the accumulation of surface organic material is shallow and where the percentage of exposed larger rocks is high. Lag gravel is abundant between the rocks, with most of the surface sand and smaller particulate material having been removed by wind and water erosion. In slight depressions permitting the accumulation of a thin *Sphagnum* cover, small areas of tussock muskeg often occur.

On many areas occupied by the rock field vegetational community, frost action is apparent. On such areas where disturbance has been most recent, the colonizing species are found to consist primarily of *Rhododendron, Diapensia, Carex glacialis, C. capillaris, Silene, Salix glauca,* and a few other species of more rare occurrence. The first two species named are found only rarely on the rock fields near the forest border, becoming relatively more common northward toward Aylmer Lake.

The areas where frost action has occurred are usually round in general configuration. They are flat and impart a slightly terraced appearance to the gentle slopes on which they are most often found. They are, in general, dark in coloration, the result of some organic accumulation which has mixed with the exposed inorganic material on the surface, this latter primarily composed of sand and small-sized gravel. The colonizing species in these areas are eventually joined by *Betula* and ericaceous species to form the relatively rich association represented by the examples provided in the accompanying Tables.

The rock fields are relatively uniform in general appearance over large areas, since the major proportion of the Artillery and Aylmer Lakes bedrock surface is covered by a layer of glacial till to considerable depth. The consequence is that the terrain is rolling and varied but without otherwise distinct features over large areas. Species tending to occupy the upper slopes of the rock fields, especially to the northward in the study area, are *Diapensia, Rhododendron, Saxifraga tricuspidata, Poa arctica,* and *Carex glacialis,* while the remainder of the more common species present are found with relatively uniform frequency throughout both the upper and lower rock field slopes.

Toward the north, the rock field communities tend to possess a larger complement of species usually associated with the flora of areas within or near the arctic, and among these are found *Arnica alpina, Dryas integrifolia, Potentilla nivea, Carex nardina, Rhododendron lapponicum, Salix reticulata,* and *Silene acaulis.*

It is of interest that the *Rhododendron* on these sites is of small stature and decumbent form, in considerable contrast to that found in the forest around Ft. Reliance, where it is surprisingly large, often growing to a foot or two in height and resembling other medium-sized shrubs in growth form and general aspect.

To the north of Aylmer and Clinton-Colden, in the area around the northern arms of each of these lakes, additional arctic species appear in the rock field communities, including *Astragalus alpinus* and *Diapensia lapponica.* Here there is also a high frequency on some sites of *Cornicularia divergens,* a lichen found commonly in arctic rock field communities such as those around Pelly and Curtis Lakes.

As in the Ennadai Lake area, there is a strong suggestion in the data from the Lockhart Basin that the communities in the area just north of the forest border and extending from here northward for many miles are floristically depauperate, although this is not as strikingly apparent in the Artillery and Aylmer Lakes area as it is north of Ennadai Lake (Larsen 1967). That this floral paucity is not as apparent here as at Ennadai can be seen from the scattering of such species as *Rhododendron lapponicum* and *Dryas integrifolia,* which here are found with low frequency throughout the area, while at Ennadai they do not appear, even as occasional rare individuals, for many miles northward.

It is to be expected, however, that north of Aylmer and Clinton-Colden Lakes, a rich arctic flora, similar to that found in the Dubawnt Lake area, will be encountered whenever field work is attempted, and that despite the more abrupt nature of the climatic zonation in the region north of Great Slave Lake, a depauperate zone does, indeed, exist here, corresponding in general to that described in the area between Ennadai and Dubawnt Lakes in the previous chapter.

Tussock Muskeg Communities

In topographic location, the tussock muskeg communities lie on the intermediate or lower slopes, usually just above the meadows and grading into the rock field communities above. In this respect, they are identical to the com-

FIGURE 2e. Dwarfed spruce along a shoreline of Ptarmigan Lake between Artillery and Clinton-Colden Lakes.

munities accorded this name in the Ennadai Lake area and elsewhere. The slopes of the areas are gentle, or may appear virtually flat, but this community is found only where drainage is sufficient to eliminate the possibility of standing water such as that found in the meadows at some period during the summer or at least in spring. Often a tussock muskeg community will be found around the periphery of a low meadow. Here the moss carpet, principally *Sphagnum,* which forms the virtually continuous substrate for the higher plants, is often particularly thick and well-developed. The tussocks of *Eriophorum* and *Carex,* however, give the community its distinctive appearance and are visible from considerable distances.

The tussock muskeg vegetation, in general, extends to the shorelines of the lakes or to the edge of the rare sandy beach. The shoreline species where tussock muskeg edges a lakeshore, particularly in the more northern parts of the study arear, include *Carex physocarpa, C. saxatilis, C. stans, Salix herbaceae, Salix* spp., *Potentilla palustris, Betula glandulosa,* and species of *Poa* and *Calamagrostis. Empetrum nigrum, Carex bigelowii,* and other species occur with lesser frequency. A late snow patch area on a southeast-facing slope at Thanakoie Narrows was covered with a mat of

Cassiope tetragona, Phyllodoce caerulea, Salix herbaceae, and an *Antennaria* species.

Permafrost at shallow depths is a constant feature of the tussock muskeg community. It was shown in the discussion of the Ennadai Lake area (Larsen 1965) that each community type possesses distinct permafrost characteristics in terms of the depth of the active layer, and the same holds true in the Artillery and Aylmer Lakes area. In addition, there is a marked seasonal lag in the rate of thaw between these two latter areas; the northern stations thaw to a given depth later, and possess shallower active layers, than southern portions of the study area.

Surface frost action is apparent on many of the areas occupied by the tussock muskeg community, and it appears from observation that frost action is more frequent and most destructive of the plant community on sites where the active layer is most shallow. This suggests the possibility that there exists a cycle in the tussock muskeg community, a cycle which might be said to be initiated by frost action which leaves the disturbed area free of plants and with a surface of bare peat available for recolonization. The areas of bare peat which result from frost activity are recolonized by the same aggregation of species that previously occupied it. Over a period of many years, these

FIGURE 2f. Spruce community on a hill summit along Pike's Portage route between the east arm of Great Slave Lake and Artillery lake.

plants and underlying mosses eventually create a thickened layer of detritus, which then apparently is again subject to frost disturbance. The mechanism is not at once apparent, but it appears that tussock muskeg ultimately reaches a stage where its destruction by frost action is again probable, after which is recolonized from adjacent and as yet undisturbed areas. The species which appear to be first in their invasion of the newly available surface are *Rhododendron* and the *Salix* species. The surface of the disturbed areas is dark in color, contrasting quite markedly with the surrounding undisturbed muskeg, and consists of almost pure peat in some instances or of sand and gravel intermixed with large proportions of peat.

It appears that such a cycle would prevent any significant progression from tussock muskeg to another community type, one dominated by black spruce for example, even in regions where black spruce might conceivably be capable of growth as in the forest border zone. In fact, on some tussock muskeg areas in the latter zone, extremely dwarfed and decumbent black spruce individuals can be found growing in the tussock muskeg community. But the cycle of destruction by frost action tends to prevent any succession beyond the tussock muskeg community type, and hence it might be said that the tussock muskeg is climax for these topographic sites, if the term has any validity in this instance.

From the long persistence of rock field communities on the upper slopes, and meadows on the lower, it must be assumed that these also are climax communities, although no cycle of destruction and recurrence similar to that on the tussock muskeg has been so far observed in these communities. Frost action is prevalent in each, but appears not to be induced by a thickening of the vegetational mat.

A temperature profile in tussock muskeg was obtained on August 3, 1964, in the area of the northeast arm of Clinton-Colden Lake and the following values were obtained: 3-inch depth—5°C; 4-in.—4°; 6-in.—3°; 12-in.—1°. Permafrost was encountered just below the last observation. It can be seen that temperatures at which rather marked inhibition of physiological processes can be expected are encountered a very shallow depths in the peat substrate of the tussock muskeg. This limitation, perhaps more than any other, appears responsible for the general exclusion from such areas of larger species, which would probably require more deeply penetrating root systems than the decumbent plants usually associated with this community.

The tussock muskeg communities become increasingly rare as one travels northward, with the local zones of transition from low meadow to rock field becoming more and more abrupt. It seems quite possible that tussock muskeg is a phenomenon of the low arctic regions, becoming increasingly infrequent as one approaches high arctic latitudes.

Low Meadow Communities

In the forested areas to the south of Artillery Lake the shallow depressions in the terrain are occupied by treed muskeg or the "bog forest" described by Raup (1946) in which the dominant plants are slow-growing black spruce which never attain large diameters or great height. These same topographic sites on the tundra to the northward, however, are occupied by low meadows, dominated by *Carex* and *Eriophorum* species with *Salix* and the *Ericads* as constant associates. Mosses are frequent but seldom form the continuous carpet such as that found beneath the spruce in the bog forests; mosses are more frequently associated with tussock muskeg than the low meadow.

The meadows are characterized by a shallow level of water during at least the spring season, when meltwater accumulates in the depressions, although by fall the meadows may have become noticeably dry. Plants which would have been considered shallow emergents in the spring have, by late summer, become fully exposed and the water level may have retreated to a depth of from a few to several inches beneath the surface of the vegetational mat.

FIGURE 3. View from the summit of a hill near Ft. Reliance at the east end of Great Slave Lake.

This latter is composed principally of the dead remains of *Eriophorum* and *Carex* which decompose slowly and accumulate to considerable depths, eventually filling in the more shallow portions of the depressions and raising the level of the surface to the point where a community more characteristic of tussock muskeg than of the low meadows becomes established. This, however, is apparently a process requiring long periods of time. In most of the larger areas occupied by meadow vegetation, the filling-in process has been carried to completion only around the edges of the meadow, accounting for the ring of tussock muskeg at the meadow periphery.

The relatively rapid retreat of the upper surface of the permafrost in these areas is demonstrated by measurements made on a meadow in the Aylmer Lake area which reveal an average depth of active layer on July 22, 1964, of 15 inches. This is compared with an average depth of 7 inches in one tussock muskeg and of 11 inches in another. One would assume that the permafrost retreats more rapidly in the meadows because of an absence of the insulating moss peat accumulations and the greater heat transport capabilities of the freely flowing meltwater accumulated over the loose sedge detritus which constitutes the vegetative mat.

The meadows possess a relatively short species list and many of these are more consistently associated with other communities in higher frequencies. It is to be noted that the *Carex* and *Eriophorum* species regularly inhabit the wetter sites of the meadows and such species as *Ledum decumbens* and *Empetrum nigrum,* as well as *Betula glandulosa,* are to be found on the mossy hummocks which are submergent only during the spring. Some of the meadows possess a growth of willows and dwarf birch around the periphery where they grade into tussock muskeg.

Esker Vegetation

The surface material of the esker is composed principally of a thin layer of lag gravel overlying a sand substratum. Wind and desiccation are two factors dominating the environment on these sites and the consequence is an extreme paucity of individual plants, although relatively high frequencies in the tabulations are attained because the individuals occur with sufficient density to appear at least once in most of the quadrats employed in sampling.

The high similarity in vegetation between the two eskers sampled is noteworthy, particularly in view of the fact that the two sampled sites were 75 miles apart. Equally high similarities often are not obtained when the same community is sampled twice by the method employed. Whether the high similarity is fortuitous or the result of a high uniformity in the composition of esker summit communities over a relatively large area is not apparent from the small and unreplicated sample.

Many areas of the eskers are totally devoid of vegetation, others are bare excepting for colonizing species of mosses, principally *Polytrichum,* and dwarf cushions of *Silene acaulis.* The esker slopes are more thickly vegetated, with *Betula, Empetrum,* and *Arctous* most frequent and *Saxifraga tricuspidata* and grass species not uncommonly represented. *Potentilla* and *Artemisia* are relatively more rare, as are the Ericaceous shrubs not already mentioned.

Conclusion

It is of considerable interest that the vegetation of the Lockhart Basin resembles very closely that of the Ennadai Lake area, with the exception that in the latter area a number of species are absent which constitute a significant component of the communities throughout the Lockhart Basin. Such species as *Dryas* and *Rhododendron* extend for a distance into the forested region in the Lockhart Basin, as far south as Ft. Reliance on special habitats, while they are not found commonly for a considerable distance to the northward of the forest border at Ennadai Lake.

The performance of these species is admittedly puzzling, and will not be solved by easy speculation. Since there appears to be no consistent relationship between the species and a given type of substrate, distribution must be related to accidents of migration or to other environmental factors such as climate. Since the climatic isopleths are broader to the eastward and tend to converge in this area, it is not impossible (and it is here proposed) that the closer juxtaposition of air masses representing the northern arctic and the more southern types may bear significantly on the problem.

At least some preliminary outlines of answers to these intriguing questions will, it is hoped, be obtained by other investigators as more detailed studies of the vegetation and environment of the region are carried on. There is much that remains to be done. Quantitative examinations of smaller segments of each area will provide fascinating material on the vegetational ecology of the forst tundra transition zone, particularly upon aspects of community composition and structure. These studies should include those most conspicuous elements of the landscape, the lichens and mosses. Regional macroclimatic studies, as well as studies dealing with the microenvironment, will be most productive; I have pointed out elsewhere (Larsen 1967) that a series of automatic weather recording stations spaced along a north-south trending transect even for a few months during summer would furnish much needed information on the climatic transition between forest and tundra. Data from a number of such transects, spaced between Hudson Bay and the western mountains, would help elucidate the ecological nature of what is surely one of the most impressive features of the North American continent — the northern forest border. There is much in the way of fundamental ecological understanding to be obtained here, as well as knowledge needed to preserve or, if necessary, manage these areas so as to insure their perpetuation as viable and useful — as well as scientifically irreplacable — portions of the North American landscape. The time is surely upon us when we must take all steps necessary to preserve those few remaining portions of the world's native vegetation which remain in a relatively undisturbed condition.

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Note on Sampling Procedure

The data presented in the appended Tables were obtained by procedures identical to those used in the studies of the vegetation of the Ennadai Lake area (Larsen 1965), and for a detailed account this reference may be consulted. In brief, the data on the ground vegetation was obtained by frequency tabulation (in each sampled stand) of species occurring in

20 one-square-meter quadrats equally spaced (usually 20 paces) along a transect which followed a compass line through the sampled community. Trees and saplings were sampled by means of the point quarter method. Trees were defined as possessing a basal area equal to or greater than 12 square inches at breast height, and saplings as possessing a diameter of one inch at breast height or greater (up to tree size). Seedlings were smaller than the minimum for saplings and were recorded as components of the ground vegetation.

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Appendices

APPENDIX 1. — Data on characteristics of the arborescent stratum in stands of black spruce in the Ft. Reliance area.

Stand	Species	Average Basal Area of Trees	Relative Frequency		Average Distance Between Trees and Saplings	
			Trees	Saplings	Trees	Saplings
5–1	Black spruce	14 in.	100%	98%	12.6 ft.	8.7 ft.
	Larix			2		
(Permafrost at 12.5 inches; June 25).						
5–5	Black spruce			100**		14.8
(Permafrost at 20.8 inches; June 29).						
5–6	Black spruce	20.9	100	100	19.3	7.4
5–11	Black spruce	19.3	69	92	16.1	8.5
	White spruce	41.7	19			
	Larix	35	12	5		
	White birch			3		

**None of tree size; all less than 12 inches ba bh.

APPENDIX 2. — Data on characteristics of the arborescent stratum in stands of white spruce in the Ft. Reliance area.

Stand	Species	Average Basal Area of Trees	Relative Frequency		Average Distance Between Trees and Saplings	
			Trees	Saplings	Trees	Saplings
5–2	White spruce	43 in.	92%	85%	16.5 ft.	12.3 ft.
	White birch	14.6	8	15		
5–3	White spruce	18.6	100	100	13.9	10.4
5–7	White spruce	46	85	83	14	13
	White birch	14.5	15	15		
	Betula occidentalis			2		
5–8	White spruce	26	89	59	25.2	12.9
	Black spruce	24	11	39		
	White birch			2		
5–9	White spruce	23	50	22	14.7	8.3
	Black spruce	15	50	60		
	Larix			18		
5–10	White spruce	19.2	100	66	26.8	27.9
	White birch			33		
5–12	White spruce	23.8	81	87	13.4	16
	Black spruce	18.2	19	11		
	White birch			2		
5–13	White spruce	53	100	88	21.3	21.8
5–20	White spruce (Artillery Lake)	46.6	100	100	19	23.4

APPENDIX 3. — Percent frequency of species in the understory of black spruce stands in the Fort Reliance area.

Stand	5–1	5–4	5–5	5–6	5–9	5–11
Species						
Alnus crispa Ait.		5				5
Andromeda polifolia L.	45	10	45		55	5
Arctostaphylos rubra (Rehd. & Wils.) Fern.	65	80	45	25	40	35
Betula glandulosa Michx.	10	5			35	
Betula papyrifera var. *neoalaskana* (Sarg.) Raup	5					
Calamagrostis canadensis var. *Langsdorfii* (Link) Inman					5	
Carex aquatilis Wahlenb. var. *aquatilis*		10			15	
C. concinna R. Br.	20					
C. scirpoidea Michx.	15	10	55			
Carex sp./spp.	60	15	55	30	60	45
C. vaginata Tausch		40	10		45	25
Dryas integrifolia Vahl		5				5
Empetrum nigrum L. var. *hermaphroditum* (Lge.) Sor.	80	20	30	75	5	60
Equisetum arvense L. (E. Calderi Boivin)	25	70	15	10		10
Equisetum scirpoides Michx.	40	35	15	60	50	55
Equisetum sylvaticum L.					5	10
Eriophorum angustifolium Honck.	5					
Eriophorum vaginatum L.	15				10	
Geocaulon lividum (Richards.) Fern.	25	50	10	15		65
Grass sp./spp.	15		20	25	10	45
Habenaria obtusata (Pursh) Richards.		35		5		
Larix laricina (Du Roi) Koch (seedlings)	5	25	15		10	
Ledum decumbens (Ait.) Lodd.	30		5			5
L. groenlandicum Oed.	95	30	75	55	60	95
Myrica Gale L.		15				
Orchis rotundifolia Banks	15					
Pedicularis labradorica Wirsing	20	20		5	15	
Petasites palmatus (Ait.) Gray				15	10	
Picea mariana (Mill.) B.S.P. (seedlings)	35	15	20	10	25	30
Pinguicula villosa L.		10	5			
Pyrola grandiflora Radius s. lat.	5					5
Pyrola secunda L. var. *obtusata* (Turcz.) Hult.					5	
Pyrola sp.		5				
Ranunculus lapponicus L.						5
Rhododendron lapponicum (L.) Wahlenberg.	10	65	15		15	
Rosa acicularis Lindl. s. lat.	5					
Rubus acaulis Michx.			5	25	20	
R. Chamaemorus L.	20				25	15
Salix arbusculoides Anders.		10				
Salix arctophila Cock. ex Heller			10		15	
S. glauca L.	5	5	5	45		35
S. myrtillifolia Anders.	55	60	30	35	65	10
S. reticulata L.	5	5				
Scirpus caespitosus L.			25			
Shepherdia canadensis (L.) Nutt.		5	5			
Tofieldia pusilla (Michx.) Pers.	25	40	10	5		5
Vaccinium uliginosum L. s. lat.	65	15	80	100	45	55
V. Vitis-idaea L. var. *minus* Lodd.	90	45	75	100	45	95
Lichens	100	50	100	100	unk.	100
Mosses	100	100	100	100	unk.	100

APPENDIX 4. — Percent frequency of species in the understory of white spruce stands in the Fort Reliance area.

Stand	5–2	5–3	5–7	5–8	5–10	5–12	5–13
Species							
Alnus crispa Ait.			5	5			
Andromeda polifolia L.				85	5		
Anemone multifida Poir. s. lat.							35
Arctostaphylos Uva-ursi (L.) Spreng. s. lat.	75	65				25	5
Arctostaphylos rubra (Rehd. & Wils.) Fern.	35	45	15	95	5	15	
Arenaria uliginosa Schleich.	5						
Betula glandolusa Michx.						10	5
Betula occidentalis Hook.					35		
Betula papyrifera var. *neolaskana* (Sarg.) Raup (seedl.)		10	5			5	
Calypso bulbosa (L.) Oakes	5						
Carex capitata L.					5	25	
C. concinna R. Br.	30					15	
C. scirpoidea Michx.	5			10			
Carex sp./spp.	55	40	20	20	35	35	25
Dryas integrifolia Vahl.		15	15	35		90	
Dryopteris fragrans (L.) Schott s. lat.					10		
Empetrum nigrum L. var. *hermaphroditum* (Lge.) Sor.	65	15	25	15	40		45
Epilobium angustifolium L. s. lat.		5	15	15			30
Equisetum scirpoides Michx.				5			
Geocaulon lividum (Richards.) Fern.	55	40	65	5		20	60
Grass sp./spp.	30	35	20				40
Habenaria obtusata (Pursh) Richards.				10			
Juniperus communis L. s. lat.	25	55	10			40	5
Kobresia simpliciuscula (Wahlenb.) Mack.						30	
Ledum decumbens (Ait.) Lodd.				15			
L. groenlandicum Oed.	5	25	20	55		5	
Linnaea borealis L.	5	30				5	
Orchis rotundifolia Banks		5		5			
Pedicularis labradorica Wirsing	10	5	15		5		
Picea glauca (Moench) Voss s. lat. (seedlings)	15	20	35	5	10	10	15
P. mariana (Mill.) B.S.P. (seedlings)		5		5		5	
Pinguicula villosa L.					5		
Potentilla nivea L.					5		
Pyrola asarifolia Michx.				15			
P. grandiflora Radius s. lat.						35	
P. virens Schweigg.	5						
Pyrola sp.			5	15			
Rhododendron lapponicum (L.) Wahlenberg.				65			
Rosa acicularis Lindl. s. lat.	45	30	15	25	5		
Salix arbusculoides Anders.				5			
S. Bebbiana Sarg.							5
S. glauca L.		15		40			
S. myrtillifolia Anders.						5	
Salix sp.							30
Saussurea angustifolia DC.	5						
Saxifraga Aizoon Jacq. var. *neogaea* Butters	5						
S. tricuspidata Rottb.	5	15	5	10	10		25
Shepherdia canadensis (L.) Nutt.	30	25	25			30	
Symphorycarpos albus (L.) Blake				5			
Tofieldia pusilla (Michx.) Pers.				45			
Vaccinium uliginosum L. s. lat.	5	5		60	50	15	
V. Vitis-idaea L. var. *minus* Lodd.	90	50	95	45	30	35	90
Lichens	100	40	95	100	100	100	100
Mosses	100	40	95	100	100	100	100

APPENDIX 5. — Percent frequency of species in the rock field community on a hill summit in the Fort Reliance area.

Stand	5–14
Species	
Alnus crispa Ait.	5
Betula glandulosa Michx.	10
Betula occidentalis Hook.	15
Calamagrostis sp.	5
Carex sp.	5
Cerastium Beeringianum Cham. & Schlecht.	15
Dryopteris fragrans (L.) Schott. s. lat.	25
Empetrun nigrum L. var. *hermaphroditum* (Lge.) Sor.	60
Festuca sp.	5
Hierochloe alpina (Swartz) R. & S.	5
Juniperus communis L. s. lat.	5
Picea glauca (Moench) Voss s. lat. (seedlings)	10
Saxifraga tricuspidata Rottb.	30
Solidago multiradiata Ait. s. lat.	5
Stellaria longipes Goldie	10
Vaccinium uliginosum L. s. lat.	25
V. Vitis-idaea L. var. *minus* Lodd.	60

Additional species noted: *Carex capitata* L., *Salix glauca* L., *S. planifolia* Pursh, *Potentilla nivea* L., *Arctostaphylos alpina* (L.) Spreng.

APPENDIX 8. — Percent frequency of species in the understory of a tamarack community in the Artillery Lake area.

Stand	7–33
Species	
Arctostaphylos alpina (L.) Spreng.	5
Betula glandulosa Michx.	70
Carex Bigelowii Terr.	60
Carex physocarpa Presl	55
Carex rotundata Wahlenb.	20
Carex scirpoidea Michx.	95
Carex sp./spp.	100
Carex aquatilis var. *stans* (Drej.) Boott.	10
Carex vaginata Tausch	5
Empetrum nigrum L. var. *hermaphroditum* (Lge.) Sor.	25
Eriophorum angustifolium Honck.	5
Grass sp.	25
Larix laricina (Du Roi) Koch (seedlings)	10
Larix laricina (Du Roi) Kock (saplings)	5
Ledum groenlandicum Oed.	30
Myrica Gale L.	65
Rubus acaulis Michx.	75
Rubus Chamaemorus L.	80
Salix arctica Pall. s. lat.	25
Salix planifolia Pursh	65
Vaccinium uliginosum L. s. lat.	90
Lichens	100
Mosses	100

Additional species noted: *Salix arctophila* Cock. ex Heller, *Carex saxatilis* L. var. *rhomalea* Fern., *C. paupercula* Michx.

APPENDIX 6. — Percent frequency of species in the understory of black spruce communities in the Artillery Lake area.

Stand	Pikes Portage 7–20	Pikes Portage 7–21	Pikes Portage 7–22	Pikes Portage 7–24	Pikes Portage 7–25	Artillery Lake 7–31	Artillery Lake 7–44	Artillery Lake 8–68
Species								
Alnus crispa Ait.	5	5	20	10	15			5
Andromeda Polifolia L.				5	5			
Arctostaphylos alpina (L.) Spreng.			5	25	60			10
Arctostaphylos Uva-ursi (L.) Spreng. S. lat.			15					
Betula glandulosa Michx.	50	85	55	20	50	85	40	35
Betula occidentalis Hook.					5			
Carex Bigelowii Torr.				20				
Carex scirpoidea Michx.					20			
Carex sp./spp.		10	20	80	80	90	100	5
C. vaginata Tausch		5		25	10		10	
Empetrum nigrum L. var. *hermaphroditum* (Lge.) Sor.	95	75	70	80	15	100	95	40
Equisetum sylvaticum L.	40	15			10	25	90	
Geocaulon lividum (Richards.) Fern.	5							5
Grass sp./spp.	40							75
Juniperus communis L. s. lat.			5					
Larix laricina (Du Roi) Koch (seedlings)	5							
Ledum decumbens (Ait.) Lodd.	35	65	35	35	15	80	15	30
Ledum groenlandicum Oed.	95	40	35	65	100	65	100	85
Loiseleuria procumbens (L.) Desv.	5	5	15	10			5	10
Oxycoccus microcarpus Turcz.						25		
Pedicularis sp.	20							
Picea mariana (Mill.) B.S.P. (seedlings)	30	10	15	40	25	60		75
Potentilla palustris (L.) Scop.						5		
Pyrola secunda L. var. *obtusata* (Turcz.) Hult.							10	
Pyrola sp.	10				5			
Rubus Chamaemorus L.	30	15		35	5	100	100	
Salix glauca L.	25			15	15			10
Salix planifolia Pursh	10	10				30		
Salix Scouleriana Barratt							10	
Salix sp.				45	45			
Tofieldia pusilla (Michx.) Pers.					10			
Vaccinium uliginosum L. s. lat.	85	55	60	100	90	40	60	90
Vaccinium Vitis-idaea L. var. *minus* Lodd.	100	90	95	100	100	95	100	100
Lichens	95	95	95	100	100	40	30	100
Mosses	100	65	95	100	100	100	100	100

Additional species noted: *Carex canescens* L., *C. glacialis* Mack., *C. paupercula* Michx., *Dryas integrifolia* Vahl., *Hedysarum alpinum* L., *Salix myrtillifolia* Anders., *S. reticulata* L., *S. Richardsonii* Hook.

APPENDIX 7. — Percent frequency of species in the understory of white spruce communities in the Artillery Lake area.

Stand	Artillery Lake 5–20	Pike's Portage 7–19	Pike's Portage 7–32	Crystal Island 7–35
Species				
Alnus crispa Ait.	15			
Arctostaphylos Uva-ursi (L.) Spreng. s. lat.	10			
Arctostaphylos alpina (L.) Spreng.	70			90
Andromeda Polifolia L.				80
Arnica alpina L. Olin	10			
Betula glandulosa Michx.	85	25	100	10
Betula occidentalis Hook.		5		
Carex Bigelowii Torr.			25	
Carex capillaris L.				10
Carex rotundata Wahlenb.				60
Carex scirpoidea Michx.	10			
Carex sp./spp.	55		60	100
Carex vaginata Tausch	20			
Dryas integrifolia Vahl.				65
Empetrum nigrum L. var. hermaphroditum (Lge.) Sor.	80	50	80	20
Epilobium angustifolium L. s. lat.			5	
Equisetum scirpoides Michx.				70
Geocaulon lividum (Richards.) Fern.		10		
Grass sp./spp.	35	10	45	
Hedysarum Mackenzii Richards.				55
Juniperus communis L. s. lat.	5			
Kalmia polifolia Wang.			30	
Kobresia simpliciuscula (Wahlenb.) Mack.				15
Ledum decumbens (Ait.) Lodd.	30		40	
Ledum groenlandicum Oed.	35		65	75
Loiseleuria procumbens (L.) Desv.	20		15	
Lycopodium annotinum L. s. lat.			15	
Oxycoccus microcarpus Turcz.				5
Oxytropis sp.	10			
Pedicularis labradorica Wirsing	5	10		
Picea glauca (Moench) Voss s. lat. (seedlings)	10		5	10
Picea mariana (Mill.) B.S.P. (seedlings)		10		
Pyrola secunda L. var. obtusata (Turcz.) Hult.	10			
Rhododendron lapponicum (L.) Wahlenberg.				60
Rubus Chamaemorus L.				55
Salix Bebbiana Sarg.		5		
Salix glauca L.	10			15
Salix myrtillifolia Anders.	5			10
Salix reticulata L.	5			55
Salix Richardsonii Hook.				15
Salix planifolia Pursh.			5	
Shepherdia canadensis (L.) Nutt.	15			
Tofieldia pusilla (Michx.) Pers.	5			75
Vaccinium uliginosum L. s. lat.	95	20	100	55
Vaccinium Vitis-idaea L. var. *minus* Lodd.	85	100	90	60
Lichens	100	100	100	90
Mosses	95	95	100	100

Additional species noted: *Astragalus alpinus* L., *Carex aquatilis* Wahlenb., *C. aquatilis* var. *stans* (Drej.) Boott., *C. canescens* L., *C. glacialis* Mack., *C. membranacea* Hook., *C. paupercula* Michx., *Triglochin maritima* L.

APPENDIX 9. — Percent frequency of species in rock field communities in the Artillery Lake area.

Stand	5–15	5–16	5–17	5–19	5–21	7–23	7–26	7–28	7–29	7–36	7–43
Species											
Arctostaphylos alpina (L.) Spreng.	95	85	15	70	95	45	20	60		85	55
Arnica alpina L. Olin		5	10	5							
Betula glandulosa Michx.	25	60		95	80	95	85	100	100	35	80
Betula occidentalis Hook.						5					5
Calamagrostis canadensis var. *Langsdorfii* (Link) Inman			5	10							
Carex Bigelowii Torr.				25	5	15		35			5
Carex glacialis Mack.						60		25		25	30
Carex nardina Fries				5						55	
Carex sp./spp.	50		75	100	45	70	35	60	55	70	40
Carex supina Wahlenb. spp. *spaniocarpa* (Steud.) Hulten			10								
Carex sp. (1)									20		
Carex physocarpa Presl					35				25		
Carex sp. (2)				20							
Draba sp.			10								
Dryas integrifolia Vahl.	30		20	45							
Empetrum nigrum L. var. *hermaphroditum* (Lge.) Sor.	55	55	15	85	90	100	75	100	95	15	100
Epilobium angustifolium L. s. lat.		45	90								
Equisetum scirpoides Michx.	15	10									
Festuca brachyphylla Schultes			85								10
Geocaulon lividum (Richards.) Fern.		5									
Grass sp./spp.	40	65	35	45							
Hierochloe alpina (Swartz) R. & S.	10		15							40	
Ledum decumbens (Ait.) Lodd.	75	50		70	95	85	95	80	75	25	55
Loiseleuria procumbens (L.) Desv.				60	80	100	65	80	45		30
Oxytropis sp.	35	15	45								
Pedicularis labradorica Wirsing	20	10		10	5	5	20				
Picea glauca (Moench) Voss S. lat. (seedlings)				10							
Potentilla nivea L.		5	80							5	
Pyrola grandiflora Radius s. lat.	20	25	10								
Rhododendron lapponicum (L.) Wahlenberg.	45	25		70						30	
Salix arbusculoides Anders.					10	5		5			
Salix glauca L.	35	65	10			20	25	20			25
Salix myrtillifolia Anders.				5							
Salix planifolia Pursh					20						
Salix reticulata L.	45			35							
Salix sp.	35			15							
Saxifraga tricuspidata Rottb.	5	20								40	
Silene acaulis L. var. *exscapa* (All.) DC.					10					55	
Stellaria longipes Goldie	10	5	25								
Tofieldia pusilla (Michx.) Pers.	5			30							
Vaccinium uliginosum L. s. Lat.	75	85	20	55	90	45	20	75	100	60	90
Vaccinium vitis-idaea L. var. *minus* Lodd.	100	90	45	95	95	100	100	100	100	75	80
Vicia sp.	5	5	5								

Additional species noted: *Carex capillaris* L., *C. scirpoidea* Michx., *C. brunnescens* (Pers.) Poir., *C. membranacea* Hook., *C. physocarpa* Presl, *C. vaginata* Tausch, *Hedysarum alpinum L.*, *Oxytropis* sp., *Astragalus alpinus* L., *Salix arctophila* Cock. ex Heller., *Luzula confusa* Lindb.

APPENDIX 10. — Percent frequency of species in tussock muskeg communities in the Artillery Lake area.

Stand	Artillery 5–18	Artillery 5–22	Artillery 5–30	Pike's Portage 7–27
Species				
Arctostaphylos alpina (L.) Spreng.	25			
Andromeda Polifolia L.	80	60	100	75
Betula glandulosa Michx.	55	50	90	25
Carex aquatilis var. *stans* (Drej.) Boott.				5
Carex Bigelowii Torr.				10
Carex capillaris L.		5		
Carex capitata L.				10
Carex paupercula Michx.				10
Carex rariflora (Wahlenb.) Sm.			65	
Carex rotundata Wahlenb.	25		5	
Carex sp./spp.	95	35	100	60
Carex vaginata Tausch			5	
Dryas integrifolia Vahl.	5			
Eleocharis sp.	10			
Empetrum nigrum L. var. *hermaphroditum* (Lge.) Sor.	20	5	45	90
Eriophorum angustifolium L. s. lat.			5	
Eriophorum vaginatum ssp. *spissum* (Fern.) Hulten	45	40	100	
Grass sp./spp.	5			
Ledum decumbens (Ait.) Lodd.	95	100	90	100
Loiseleuria procumbens (L.) Desv.				10
Luzula Wahlenburgii Rupr.	10			
Oxycoccus microcarpus Turcz			15	10
Pedicularis labradorica Wirsing	25	15		10
Pinguicula villosa L.	5			
Rhododendron lapponicum (L.) Wahlenberg.	20			
Rubus Chamaemorus L.	45	90	90	95
Salix arbutifolia Pall.			100	
Salix arctophila Cock. ex Heller	20			
Salix planifolia Pursh	5	10		
Salix reticulata L.	5			
Scirpus caespitosus L.		10		5
Tofieldia pusila (Michx.) Pers.	15			
Vaccinium uliginosum L. s. lat.	50		100	50
Vaccinium Vitis-idaea L. var. *minus* Lodd.	90	100	95	95
Lichens	85	100	100	95
Mosses	85	100	100	100

Additional species noted: *Anemone parviflora* Michx., *Carex chordorrhiza* Ehrh., *C. ?saxatilis* L., *C. tenuiflora* Wahlenb., *Castelleja pallida* (L.) Spreng., *Salix glauca* L., *S. pedicellaris* Pursh var. *hypoglauca* Fern.

APPENDIX 11. Percent frequency of species in rock field communities in the area of the upper Lockhart River basin around Aylmer and Clinton-Colden Lakes.

Stand	Ptarmigan	Clinton Colden	Clinton Colden	Aylmer	Aylmer	Aylmer	Aylmer	Aylmer	Aylmer	Aylmer	Aylmer	Thanakoie Narrows	Thanakoie Narrows	Ptarmigan
	7–37	7–38	7–41	8–50	8–51	8–54	8–56	8–57	8–58	8–59	8–62	8–63	8–64	8–66
Species														
Antennaria sp.		10												
Arctostaphylos alpina (L.) Spreng.	90	90	80	95	85	95	85	90	75	95	5	25	75	85
Astragalus alpinus L.		10												30
Betula glandulosa Michx.	50	25	60	90	90	20	40	70	60	30	100	90	90	55
Calamagrostis purpurescens R. Br.						5		15						
Carex Bigelowii Torr.			10							5	40	50	10	10
Carex capillaris L.	5			10	5						5	10		
Carex glacialis Mack.	5			15	10	10		5		20		10	10	
Carex nardina Fries.		40	40											
Carex sp./spp.		70	45	25	10	15					90	60	25	20
Diapensia lapponica L.						35		15		25	5	20	15	
Dryas integrifolia Vahl.		35												
Empetrum nigrum L. var. *hermaphroditum* (Lge.) Sor.	80	50	60	95	90	25	60	65	60	45	75	75	60	55
Grass sp./spp.	15			25	65	80	70	65	75	50	55	15	75	50
Hierochloe alpina (Swarts) R. & S.	5	15	35	10	35	25	40	25			30		20	5
Ledum decumbens (Ait.) Lodd.	75	70	100	100	95	40	95	90	100	70	100	100	95	100
Loiseleuria procumbens (L.) Desv.		10	15	75		10	5	35	10		65	30	15	10
Luzula confusa Lindb.				10	5	5	5				15			
Luzula parviflora (Ehrh.) Desv.					5									
Pedicularis sp.											25			
Poa arctica R. Br.		45				50		5						
Rhododendron lapponicum (L.) Wahlenberg.	10	5		40	10	75		20	10	50	20	15	15	
Rubus Chamaemorus L.							25	5	10		5			
Salix arbusculoides Anders.	10			40										
Salix glauca L.			10	10	20	80					80	10	25	5
Salix herbacea L.											5	5		
Salix pedicularis Pursh var. *hypoglauca* Fern.					20									
Salix planifolia Pursh											35	60	15	
Salix sp.								60	10	75				
Saxifraga tricuspidata Rottb.						40		5						
Silene acaulis L. var. *exscapa* (All.) DC.											5	10		
Tofieldia pusilla (Michx.) Pers.				10							10	10		
Vaccinium uliginosum L. s. lat.	70	60	45	95	50	95	65	90	75	85	95	85	95	90
Vaccinium Vitis-idaea L. var. *minus* Lodd.	95	85	100	100	95	55	90	100	100	75	100	95	90	100
Lichens	95	100	100		100	95	100	100	100	100		100	100	100
Mosses	90	80	100		95	85	80	85	90	100		75	100	70

Additional species noted: *Carex rotundata* Wahlenb., *Kalmia polifolia* Wang., *Salix arbutifolia* Pall., *S. herbacea* L.

APPENDIX 12. — Percent frequency of species in tussock muskeg communities in the area of the upper Lockhart River basin around Aylmer and Clinton-Colden Lakes.

Stand	Clinton Colden 7–42	Aylmer Lake 8–49	Aylmer II 8–55	Thanakoie Narrows 8–63
Species				
Andromeda Polifolia L.	25		30	
Arctostaphylos alpina (L.) Spreng.	65	35	40	85
Betula glandulosa Michx.	35	100	70	35
Calamagrostis canadensis var. *Langsdorfii* (Link) Inman			5	25
Carex Bigelowii Torr.	15	20		
Carex rotundata Wahlenb.			5	
Carex scirpoidea Michx.			5	
Carex sp./spp.	80	30	90	
Carex aquatilis var. *stans* (Drej.) Boott.			5	
Empetrum nigrum L. var. *hermaphroditum* (Lge.) Sor.	20	85	75	15
Eriophorum vaginatum ssp. *spissum* (Fern.) Hulten	5		60	
Grass sp./spp.	70	80		95
Ledum decumbens (Ait.) Lodd.	100	100	100	100
Loiseleuria procumbens (L.) Desv.		60	5	10
Luzula confusa Lindb.		10		40
Luzula parviflora (Ehrh.) Desv.	10			
Lycopodium Selago L.			5	
Oxycoccus microcarpus Turcz			40	
Rubus Chamaemorus L.	75	20	100	40
Salix arbutifolia Pall.			5	
Salix glauca L.				5
Salix petiolaris Sm.		40		5
Tofieldia pusilla (Michx.) Pers.		5		
Vaccinium uliginosum L. s. lat.	65	75	95	70
Vaccinium Vitis-idaea L. var. *minus* Lodd.	100	100	80	100
Lichens	100	100	80	100
Mosses	100	100	100	100

Additional species noted: *Salix arbusculoides* Anders., *Potentilla palustris* (L.) Scop.

APPENDIX 13. — Percent frequency of species in the understory community of a dwarfed spruce clump at the end of the northeast arm of Clinton-Colden lake in the upper Lockhart basin.

(64° 08′ N, 107° 27′ W).

Stand	7–39
Species	
Betula glandulosa Michx.	90
Empetrum nigrum L. var. *hermaphroditum* (Lge.) Sor.	100
Grass sp./spp.	30
Ledum decumbens (Ait.) Lodd.	100
Ledum groenlandicum Oed.	60
Oxycoccus microcarpus Turcz	10
Rubus chamaemorus L.	10
Salix glauca L.	30
Vaccinium uliginosum L. s. lat.	90
Vaccinium Vitis-idaea L. var. *minus* Lodd.	100
Lichens	60
Mosses	90

Additional species noted: *Carex chordorrhiza* Ehrh., *C. rotundata* Wahlenb., *C. aquatilis* var. *stans* (Drej.) Boott., *Equisetum sylvaticum* L., *Lycopodium annotinum* L. s. lat.

NOTE: This was the last clump of dwarfed spruce seen as we traveled northward in this area. Black spruce has a 30% frequency in the transect, all dwarfed, none exceeding five feet in height.

Notes

A Nesting Raft for Ducks

Abstract. A simple nesting raft for Mallards and Black Ducks is described. Structural details are discussed, plus the results of five years of field testing.

There are thousands of small lakes and beaver ponds in northern Ontario but these water areas produce surprisingly few ducks. This situation appears to be due, in part at least, to a scarcity of predator-free nesting sites. The few ducks which do nest successfully in this area usually choose offshore islands in the larger lakes, in order to escape from mammalian predators (Young 1968). For the wildlife manager, the obvious solution to this problem is to provide safe, artificial nesting sites. Elsewhere in North America, artificial nesting devices have been used extensively to increase wetland utilization by ducks. Most of the earlier types were modifications of European designs, such as the pitcher-shaped wicker baskets from the Netherlands and the woven reed wigwams from Denmark (Burger and Webster 1964). One of the more successful North American models is a type of open-ended cylinder which is either attached to trees in flooded swamplands or mounted on poles (Boyer 1958). There are no recorded instances of any of these devices having been used successfully in the forested regions of Ontario. The Sudbury Game and Fish Protective Association erected a large number of nesting cylinders around a small lake near Sudbury in 1963 and 1964 but none was used. The birds appeared to avoid all unnatural-looking structures. In order to overcome this aversion, a more rustic, brush-covered raft was tried. This design proved to be readily acceptable to both Mallards (*Anas platyrhynchos*) and Black Ducks (*Anas rubripes*).

Figures 1 and 2 illustrate the main structural details of the nesting raft. It is made of 6 foot long cedar logs held together with 'two by fours'. The nest box, which is placed near the centre of the raft, is 18 inches square and 6 inches deep. It is filled with leaf litter and screened with brush. The whole raft is then covered over with cedar boughs to protect the nest from crows and owls and is anchored several hundred feet from shore by means of a large rock and a length of ¼ inch polypropylene rope. Mink, which are the most serious predators of duck nests in this area, will not swim out to the rafts if they are placed well out in the lake. The spacing of the rafts is not critical. Since these birds do not generally nest within their defended territories, there is no pro-

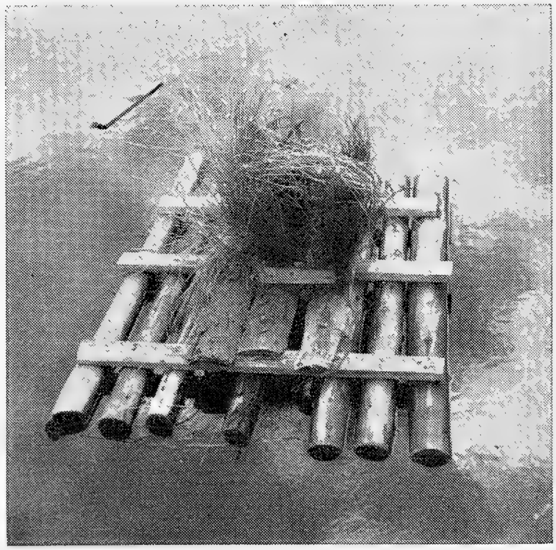

FIGURE 1. Duck nesting raft showing the construction of the platform and the nest box.

FIGURE 2. The completed raft, camouflaged with cedar boughs.

TABLE 1. The use of duck nesting rafts, by species, at Laurentian Lake, Sudbury, Ontario, 1965 – 1969

Year	Number of rafts set out	Number of rafts used	Number of clutches laid				
			Mallard	Black	Unknown species	Hybrid	Total
1965	6	3	2	2			4
1966	12	6	3	3			6
1967	18	14	6	7	2		15
1968	20	18	12	8	3		23
1969	20	20	8	9	6	3	26

blem with individual spacing; indeed, two or three nest boxes may be placed side by side on the same raft without risk of conflict between occupants. The usual inclination is to anchor the rafts in small sheltered bays or narrow creek mouths but this simply increases the chances of predation. It was found that the nesting birds are remarkably tolerant of wind and wave action, provided of course that the nest boxes do not actually become flooded. One should emphasize the importance of getting the rafts out on the lake as soon as possible after spring break-up. At this latitude, the lakes are usually ice-free by the first week of May and the ducks take possession of the rafts as soon as they are made available. In the majority of cases the first egg is laid within three to four days of the rafts being set out; in several instances the first egg was laid on the same day. As for cost, the only real expense is labour. All of the building materials are available locally at little or no cost. One man working full time can put together 6 to 8 of these rafts per day once the materials have been gathered on the site.

In 1965, six rafts were tested. They were put in place on the third of May and within three days, three of the rafts were occupied. The attractiveness of at least one of the rafts was demonstrated by the fact that three different ducks used it during the same season. First a Black Duck laid a full clutch of 12 eggs in the nest box, then a Mallard added another 11 eggs and finally a second Mallard arrived and shared in the incubation of the huge clutch after having added a few eggs of its own. In 1966, twelve rafts were set out and six were used, three by Mallards and three by Black Ducks. In 1967, fourteen of the eighteen available rafts were occupied. Again in 1967, one of the rafts was used by two different birds, in this case one after the other and both brought off broods successfully. Table 1 summarizes the nesting data up to the present time. The records indicate that there were often more clutches laid than there were rafts available. This can be explained by the fact that some of the rafts had more than one nest box and that individual boxes were sometimes occupied by a succession of nesting birds.

The nesting rafts appear to be equally acceptable to Black Ducks and Mallards; their usage by the two species reflects the species composition of the local population. This overlap in nesting requirements may be partly responsible for the high incidence of hybridization between Mallards and Black Ducks in this area.

Conclusions and Recommendations

The nesting raft described in this paper has been used successfully for five years on lakes and ponds in the Sudbury district in northern Ontario. It is suitable for both Black Ducks and Mallards. It is inexpensive and simple to construct and provided that it is properly constructed and anchored well out from shore, is effectively predator-proof. Exceptional situations may arise in which individual predators may "learn" to associate the rafts with the prescence of duck eggs. In such cases a limited amount of selective predator control may be warranted. A management program involving rafts of this type is particularly well suited to intensively managed areas such as those that are frequently administered by local conservation groups and fish and game clubs.

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Bay-breasted Warbler in Newfoundland

On 11 July 1969, a specimen of Bay-breasted Warbler (*Dendroica castanea*) was collected by the second author in a mixwood forest at Doyles, Codroy Valley, Newfoundland. The bird was a male in bright breeding plumage, and, when collected, was accompanied by a female. Its skull was fully ossified and its testes measured approximately 3.5×2.0 mm. The furculum depression was completely filled with fat with small deposits on abdomen. The specimen is now preserved in the ornithological collection of the Department of Biological Sciences of the University of Montreal (No. 01824).

Henry Reeks in 1869 called the Bay-breasted Warbler tolerably common in Newfoundland, arriving in June, and Cooke (1904) reported it breeding. However, the present specimen appears to be the first one of this warbler to be collected in Newfoundland. There are several convincing sight records: two seen at Grand Lake on 8 June 1911 by Arnold (1912), and single males observed by Harold Harwood (Tuck, 1968) at South Branch on 12 June 1958 and Barrachois Pond on 6 July 1964. Mrs. H. J. Reid observed it at Ramea on 15 June 1962, 8 June 1964, and 27 May 1966 (Tuck, 1968). A National Museum of Canada party, composed of Henri Ouellet and the first author, saw a single male at Doyles, on 22 June 1959. The AOU Check-list of North American Birds (1957) does not list the Bay-breasted Warbler as occurring in Newfoundland.

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Spring Bird Phenology at Karrak Lake, Northwest Territories

Abstract. Arrival dates and status of 39 bird species during the summers of 1966, 1967, and 1968 are recorded from Karrak Lake, Northwest Territories, the location of the largest known nesting colony of Ross' Geese and a rarely visited area of the Canadian Arctic.

Karrak Lake (67°15′N, 100°15′W) is the location of the largest known nesting colony of the comparatively scarce Ross' Goose (*Chen rossii*) (Ryder 1969). While conducting a study of this species during the summers of 1966, 1967, and 1968, I had an opportunity to record arrival dates and general occurrence of a number of bird species. Field work at Karrak Lake extended from 27 May to 10 July 1966, 29 May to 18 July 1967, and 1 June to 17 July 1968. All observations were made during daily routines of the main study within a radius of about 2 miles from our camp at Karrak Lake. I believe the observations give an accurate indication of the species one would observe without systematically searching for nests. Bird names used here were taken from the American Ornithologists' Union Check-list (1957) except *Chen caerulescens* which I use to refer to both the Lesser Snow Goose and the Blue Goose (see Godfrey 1966).

Karrak Lake is in the Simpson River Rock Plain portion of the Central Arctic Lowland (Bird 1963). The area is characterized by expanses of meadows and marshes relieved by numerous drumlins, eskers and shallow lakes.

TABLE 1. — Birds observed at Karrak Lake, N.W.T., 1966, 1967 and 1968

Species	Occurence[1]	Dates and numbers[2] first seen		
		1966	1967	1968
Yellow-billed Loon (*Gavis adamsii*)	r	3 July (1)	—	—
Arctic Loon (*Gavia arctica*)	o	3 June (3)	16 June (1)	—
Red-throated Loon (*Gavia stellata*)	o	13 June (2)	17 June (2)	15 June (1)
Whistling Swan (*Olor columbianus*)	o	27 May (4)	—	3 June (2)
Canada Goose (*Branta canadensis*)	o	27 May (4)	30 May (2)	1 June (1)
White-fronted Goose (*Anser albifrons*)	o	27 May (6)	30 May (7)	1 June (14)
Lesser Snow Goose (*Chen caerulescens*)[3]	a	28 May (2)	6 June (2)	2 June (14)
Blue Goose (*Chen caerulescens*)[3]	a	28 May (4)	9 June (2)	3 June (4)
Ross' Goose (*Chen rossii*)[3]	a	30 May (14)	10 June (3)	4 June (4)
Pintail (*Anas acuta*)	o	9 June (2)	11 June (4)	9 June (2)
Oldsquaw (*Clangula hyemalis*)[3]	c	5 June (2)	16 June (4)	7 June (7)
King Eider (*Somateria spectabilis*)[3]	o	9 June (5)	16 June (2)	12 June (7)
Rough-legged Hawk (*Buteo lagopus*)[3]	o	12 June (2)	19 June (1)	5 June (1)
Peregrine Falcon (*Falco peregrinus*)	r	—	—	11 June (1)
Rock Ptarmigan (*Lagopus mutus*)[3]	o	28 May (2)	29 May (2)	1 June (2)
Sandhill Crane (*Grus canadensis*)	c	27 May (10)	29 May (4)	1 June (2)
American Golden Plover (*Pluvialis dominica*)	o	29 May (1)	11 June (2)	3 June (4)
Black-bellied Plover (*Squatarola squatarola*)	o	—	10 June (2)	2 June (4)
Ruddy Turnstone (*Arenaria interpres*)	m	8 June (3)	12 June (3)	6 June (4)
Knot (*Calidris canutus*)	m	—	15 June (3)	14 June (2)
Pectoral Sandpiper (*Erolia melanotos*)	o	6 June (1)	21 June (1)	6 June (2)
Baird's Sandpiper (*Erolia bairdii*)[3]	o	1 June (5)	10 June (1)	—
Dunlin (*Erolia alpina*)[3]	o	11 June (1)	11 June (15)	3 June (5)
Semipalmated Sandpiper (*Ereunetes pusillus*)[3]	c	5 June (6)	10 June (1)	4 June (1)
Red Phalarope (*Phalaropus fulicarius*)[3]	o	11 June (1)	20 June (8)	14 June (2)
Northern Phalarope (*Lobipes lobatus*)	r	8 June (1)	—	—
Pomarine Jaeger (*Stercorarius pomarinus*)	m	5 June (7)	10 June (1)	5 June (7)
Parasitic Jaeger (*Stercorarius parasiticus*)[3]	c	11 June (1)	12 June (2)	4 June (5)
Long-tailed Jaeger (*Stercorarius longicaudus*)	c	7 June (2)	11 June (5)	5 June (1)
Glaucous Gull (*Larus hyperboreus*)[3]	c	30 May (1)	28 May (1)	1 June (3)
Herring Gull (*Larus argentatus*)[3]	c	27 May (8)	6 June (2)	4 June (1)
Sabine's Gull (*Xema sabini*)	m	7 June (1)	13 June (3)	11 June (9)
Arctic Tern (*Sterna paradisaea*)[3]	c	11 June (1)	12 June (8)	13 June (2)
Snowy Owl (*Nyctea scandiaca*)	r	—	—	3 June (1)
Horned Lark (*Eremophila alpestris*)[3]	c	29 May (3)	11 June (1)	4 June (2)
Common Raven (*Corvus corax*)	r	30 May (1)	—	9 June (1)
Water pipit (*Anthus spinoletta*)[3]	o	29 May (2)	9 June (1)	7 June (2)
Lapland Longspur (*Calcarius lapponicus*)[3]	c	29 May (1)	2 June (4)	3 June (7)
Snow Bunting (*Plectrophenax nivalis*)[3]	c	27 May (15)	30 May (5)	1 June (10)

[1]a = abundant, c = common, o = occasional, r = rare, m = migrates through study area. See text for definitions of these terms.
[2]Number of individuals seen on first day observed.
[3]Nests observed.

Five criteria were used to define the occurrence of each observed species at Karrak Lake for the three seasons: *abundant,* more than 100 individuals seen per day; *common,* more than one but less than 100 individuals seen per day; *occasional,* 100 or less individiuals seen per month; *rare,* one or two individuals observed during any one season; *migratory,* species which move through the study area to their nesting grounds. I have assumed that all the species which are classified as abundant, common or occasional were nesting in or near the study area. In all such cases, Godfrey (1966) includes Karrak Lake within the breeding range.

Weather conditions at Karrak Lake in late May and early June were marked by prevailing north winds of 20 to 25 miles per hour. These were usually accompanied by light rain or snow. The average daily temperatures for June 1966, 1967, and 1968 were 41°F, 37°F and 40°F respectively. By the end of the first week in June 1966 and 1968 the average weekly temperatures were above freezing. In 1967, mean weekly temperatures remained below 32°F until the third week of June. Precipitation in 1966 was recorded on 10 of 29 days from 30 May to 30 June, including snow on 30 and 31 May. In 1967 there was precipitation on 19 days between 2 to 29 June with snow on 8 days. In 1968 snow fell on 6 days and rain on 5 days during a 27-day period between 3 and 30 June. Sixty-seven per cent of wind recorded daily was from the north in 1966, 69 per cent in 1967, and 63 per cent in 1968.

Table 1 presents the dates and numbers at first sightings and occurrence throughout the study of the bird species observed. I recorded 39 species of which 19 were seen nesting and 11 assumed nesting. The Ruddy Turnstone (*Arenaria interpres*), Knot (*Calidris canutus*), Pomarine Jaeger (*Stercorarius pomarinus*), and Sabine's Gull (*Xema sabini*) migrate through the study area to their nesting grounds. I did not see the Gyrfalcon (*Falco rusticolus*), Willow Ptarmigan (*Lagopus lagopus*), White-rumped Sandpiper (*Erolia fuscicollis*), Stilt Sandpiper (*Micropalama himantopus*), Hoary Redpoll (*Acanthis hornemanii*), Common Redpoll (*Acanthis flammea*), or Savannah Sparrow (*Passerculus sandwichensis*) which Godfrey (1966) records as breeding birds in the area.

As Sealy (1967) points out, phenology is concerned with plant and animal life in relation to seasonal changes and that, by themselves, phenological data are of limited scientific value. Their significance becomes apparent upon analyses of many years of observations especially if distributional and population changes can eventually be related to current environmental conditions. In that phenological lists from the Arctic are few, this being the first from the Karrak Lake area, the purpose of this report is to contribute knowledge of the birds in a rarely visited area of the Canadian Arctic and to enable comparisons with current and future species in adjacent areas (see Aleksiuk 1964; Gavin 1947; Hanson, Queneau and Scott 1956; and Sealy 1966 for the Perry River region; McEwan 1957 for the Bathurst Inlet area; and Macpherson and Manning 1959 for the Adelaide Peninsula).

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Changing Composition of Duck Nests in Relation to Lake Levels

While investigating a Great Blue Heron colony on a 16-acre island in Dowling Lake, Alberta, for a brief period on June 15, 1967, I accidentally found three nests of Gadwalls and one of a Mallard and a Pintail. A thorough investigation of the nesting composition of ducks in April, May, and June, 1968, revealed a total of four Mallard and nine Pintail nests. In 1970, the island was searched for nests by two observers for a one hour period each on June 4 and 9. The search resulted in 37 nests consisting of 9, 9, 13, 4 and 2 nests of the Pintail, Mallard, Gadwall, American Widgeon and Redhead respectively. As the 1970 search was not exhaustive, many nests may have escaped our attention. One of the Pintail nests was counted as two nests because two hens were observed flying from that nest. The rectangularly shaped nest contained two sets of six eggs, each set distinctly differently coloured from the other, indicating that two hens were nesting side by side.

From measurements it appeared that Dowling Lake averaged approximately two feet deep in 1967 and 1970, but went almost completely dry in May 1968. The difference in species composition and number of nests in 1968 and 1970 may be related to the varying lake levels between those years. Pintails and Mallards are early nesters compared to Gadwalls and American Widgeon. The latter two species usually initiate their first clutches in Alberta during the last half of May (Keith, 1961; Vermeer, 1968). As Dowling Lake had dried up by the second half of May, 1968, Gadwalls and American Widgeon may have been discouraged from nesting there that year. The observation that Gadwalls also nested on the island in 1967 when the lake was filled with water lends additional support to this hypothesis.

Acknowledgments

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Freshwater Ostracoda (Crustacea) from Lake Nipigon, Ontario

Abstract. Twelve species of Ostracoda were identified from collections made in Lake Nipigon. This adds eight new records of Ostracoda for this lake. Morphological variation hitherto unrecorded was found in two species. Some species considered as shallow water forms from previous work were recorded from deep water. The distribution of species in the lake appears to be influenced by the temperature of the water.

Introduction

Lake Nipigon is the largest inland water body of Ontario with an area of 1769 square miles (Wilson, 1910). It is an oligotrophic lake of low productivity (Rawson, 1955) with a mean depth of 180 feet. Studies were made on the chemical and physical limnology of Lake Nipigon by Clemens (1923), on the plankton by Bigelow (1923), on the molluscs by Adamstone (1923), on the benthic fauna by Adamstone and Harkness (1923), and fish by Dymond (1923) and Clemens *et al.* (1923).

There are few published records of Ostracoda from Lake Nipigon. Adamstone and Harkness

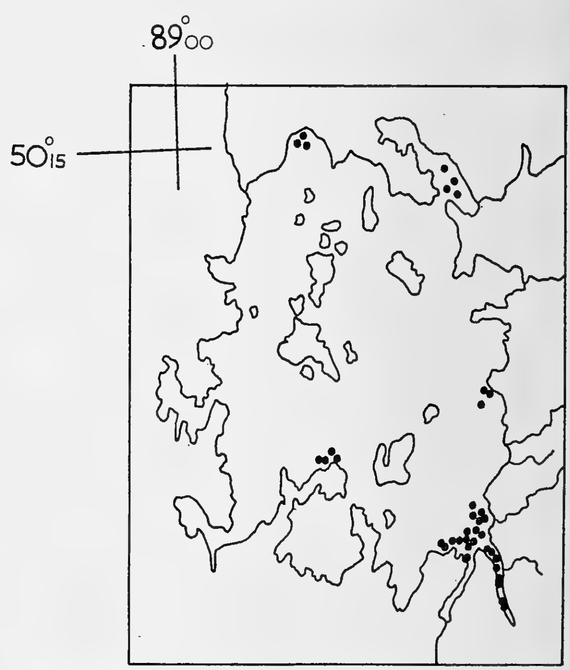

FIGURE 1. Map of the collecting sites in Lake Nipigon.

TABLE 1. — Data available on Ostracod collections from Lake Nipigon.

Species	Numbers	Depth	Substrate	Date
Cyclocypris laevis	2 ♀	6′	mud	July
C. serena	2 ♀	6–9′	mud	July-August
Candona candida	4 ♀ 1 ♂ 1 instar	6–159′	mud, clay and gravel	June-August
Cytherissa lacustris	28 adults 5 instars	6–327′	mud and sand	June-August
Candona ohioensis	3 ♀ 10 ♂ 1 instar	<9′	mud and sand	July-August
Candona cf. C. scupulosa	1 instar	9′	mud	August
C. elliptica	3 ♂	54–312′	mud and sand	June-July
C. eriensis	2 ♂	84–90′	clay	June
Candona cf. C. acutula	1 ♂	108′	sand and clay	August
Limnocythere friabilis	1 ♀	237′	mud	June
Candona crogmaniana	1 ♀	276–285′	mud	—
Ilyocypris bradyi	right valve ♀	279′	mud	—

(1923) and Clemens *et al.* (1923, 1924) mention the occurrence of ostracods in the stomach of fish. Bigelow (1923) records the occurence of *Cypria* sp., *Spirocypris tuberculata, Limnocythere reticulata* and *Ilyodromus pectinatus.* Adamstone (1924) records the occurrence of *Candona* sp. and *Limnocythere* sp. from the lake bottom. The present paper is a more complete report on Ostracoda collected from Lake Nipigon.

Materials and Methods

Material for this study was collected by F. B. Adamstone during 1921-23 as part of the Ontario Fisheries Research Laboratory and University of Toronto Limnological investigation of Lake Nipigon. Thirty-eight samples containing ostracods were taken from the lake bottom at depths which varied from 1.5 to 312 feet (figure 1). The type of substrate for each sample was noted by Adamstone.

The ostracods were recovered from the samples by washing through a set of filters and preserved in methyl alcohol. For identification, the two valves of the carapace were carefully separated from the rest of the animal and mounted on micropalaeontological slides with tragacanth glue. The soft-parts of the animal were then dissected in a drop of ACS mounting fluid (Edward Gurr Ltd., London, England) on an ordinary glass slide. In this way a permanent record of both soft and hard parts of the ostracod were made.

Systematics

The following twelve species were identified:

Candona candida (Muller, 1776)
Candona crogmaniana Turner, 1894
Candona elliptica Furtos, 1933
Candona eriensis Furtos, 1933
Candona ohioensis Furtos, 1933
Candona cf. *C. acutula* Delorme, 1967
Candona cf. *C. scupulosa* Furtos, 1933
Cyclocypris laevis (Muller, 1766)
Cyclocypris serena (Koch, 1838)
Cytherissa lacustris (Sars, 1863)
Ilyocypris bradyi (Sars, 1890)
Limnocythere friabilis Benson and MacDonald, 1963

In addition we have found a few specimens referable to the genus *Candona* but they were too poorly preserved to be accurately identified.

Candona cf. *C. acutula*

Delorme (1968) reports a distinct postero-dorsal hinge flange in *C. acutula*, but in the present specimen the hinge flange was not distinct. Furthermore we were unable to find a description of the 'soft-parts' of this species in the literature. The species resembles *C. subtriangulata* Benson and MacDonald in many features of the carapace.

Candona cf. *C. scupulosa*

One instar only was collected from Lake Nipigon. The anterodorsal sinuation in the dorsal margin of the carapace was not as pronounced in our specimen as drawn by Furtos (1933) but the soft-parts fitted the description given by Furtos (1933).

Ecology

Some remarks can be made on the ecology of the species collected in Lake Nipigon on the basis of data available (Table 1). The material on which the present study was based was collected from different types of substrates: mud (28 samples), sand (6 samples), clay (3 samples), and gravel (1 sample). No clear relationship was found between the species and the substrate type. Elofson

(1941) however has shown a relationship between the substrate and the structure of the carapace in different species of marine ostracods. The species collected from shallow water were *Cyclocypris laevis, C. serena, Candona* cf. *C. scupulosa,* and *Candona ohioensis.* All these are warm water species. On the other hand species collected at depths over 50 meters were *Limnocythere friabilis, Candona crogmaniana* and *C. elliptica.* These are probably limited to lower temperatures since Clemens (1923) found that the water below 50 meters did not rise above 5°C in Lake Nipigon.

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Argia Vivida Hagen (Odonata: Coenagrionidae) in Hot Pools at Banff

Abstract. The larvae of the damselfly *Argia vivida* Hagen have been found in thermal pools at 26°C in Banff. The genus *Argia* is mainly Neotropical in distribution and has been recorded from hot springs in the United States. *Argia vivida,* however, is previously recorded only from cold spring-fed streams. *A. vivida* appears to be a 'summer species' at Banff and it is suspected that photoperiod is important in the seasonal regulation of its life history.

Argia vivida Hagen has been collected in the adult stage from Banff, Alberta and from Field and Glacier, B. C., these being the only sites recorded for Canada (Walker 1953). Walker (1927) found the species at two localities on Sulphur Mountain at Banff, both in the vicinity of hot springs, and he subsequently wrote: "We believed that the nymphs would probably be found in the warm springs issuing from the baths, but had no proof of this supposition." (Walker 1953, p. 152). This note substantiates Walker's prediction and discusses some ecological questions that are raised by the discovery.

The location of the hot pools in the Bow Valley below the outflow from the Cave and Basin Hotsprings has been recorded by McAllister (1969), who described the presence of five introduced species of tropical fish. The temperature of the water that issues below the Baths is 30°C, but during the 100m flow to the pools in the valley it cools to about 26°C. Air and water temperatures have been monitored at the pools since February 1970, and the water temperature has fluctuated between 26° and 27° C in spite of air temperature variations from minima around −20°C in February to maxima of 32°C in June.

The commonest invertebrates in the pools are several species of gastropods and there are also gammarid Crustacea, chironomid larvae, stratiomyid larvae, and tubificid worms. The vegetation is lush, consisting largely of a submerged species of *Potamogeton* and a species of water cress, along with some exotic species (D. Dyck, personal communication). The nymphs of *A. vivida* are found amongst the vegetation in the pools, in the streams connecting the pools, and amongst mosses and vascular plants in wet areas at the edges of the pools and streams.

Other odonates collected in the pools are *Ischnura cervula* Selys, which Walker (1953, p. 267) records from the Third Vermilion Lake at Banff and notes "is clearly associated with hot springs", and *Libellula quadrimaculata* Linn. Several species of Odonata, many unfortunately undetermined, have previously been reported from thermal waters (see the work of Brues 1924, 1928, 1932), although Tuxen (1944) lists no species of Odonata from Icelandic hot springs.

I first found teneral adults of *A. vivida* and their exuviae on 28th April 1970 (although I had not visited the site for a whole month prior to this). Walker collected adults at Banff from 12th June to 3rd August. I have not collected intensively enough to determine whether *vivida* has a marked peak of emergence, but it would appear to be a 'summer species' as defined by Corbet (1962). As temperature in the pools is high and constant throughout the year, it might be suspected that photoperiod is involved in regulating rates of growth and seasonal emergence of adults, as was found by Jenner (1958, in Corbet 1962) for several species of Odonata. However, consideration of the role of environmental factors is complicated by the fact that some larvae, at least, spend some time in semi-terrestrial situations at the edges of the pools where temperatures are much lower.

Existing records show that *A. vivida* is not dependent on thermal water. In British Columbia adults have been taken at Field where there are no hot springs. The possibility exists, however, that the species may have been breeding in drainage ditches from the railway roundhouse (Whitehouse 1941). On the other hand, Kennedy (1915) collected *vivida* nymphs from a cold, spring-fed creek and Williamson (1932) found adults around "clear, cold water" high on spring-fed streams. Williamson states that, "So dependent is *Argia* vivida on springs that its presence anywhere may be taken as positive proof of adjacent spring water."

Argia is mainly a neotropical genus, the greater number of species being found in South and Central America (Walker 1953). Paulson's (1969) check-list of the Odonata of Middle and North America lists 63 species of *Argia,* of which 54 are found in Central America, 19 in the United States, and 7 in Canada [*A. violacea* (Hagen), which resembles *vivida* but is purple rather than blue and which has an eastern distribution is, however, omitted from Paulson's List]. The genus has been recorded previously from hot springs in the United States. Needham and Cockerell (1903) reported an unidentified species of *Argia* in warm waters running off from hot springs in New Mexico, and Brues (1932) found *Argia* nymphs in hot pools in 10 locations in California, Idaho, and Nevada at temperatures between 31° and 41°C.

It is perhaps significant that *Argia vivida,* in the northern part of its range at least, is recorded only from waters which maintain a reasonably constant temperature throughout the year. The occurrence of the species in hot pools at Banff may be related more to the constancy of temperature and the fact that the water does not freeze in winter than to the high temperature *per se* or the peculiar chemical composition. Mechanisms for seasonal regulation may well be similar in hot springs and in cold springs, and it would be interesting to compare the development of *vivida* in the Banff hot pools with development in cold springs such as those in Oregon where Kennedy found the species to be so common. Work is currently in progress on the seasonal regulation of development in this species.

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A Canadian Specimen of Risso's Dolphin

Abstract. Measurements and skeletal material were obtained from a Risso's dolphin which drifted ashore in British Columbia. This is apparently the second recorded stranding and first complete specimen of this species in Canada.

In terms of pelagic sightings, Risso's dolphin, *Grampus griseus* (G. Cuvier) (Schevill, 1954), is one of the more cosmopolitan of cetacean species (Slijper, 1962; Schevill, 1954; Daugherty, 1966; Pike and MacAskie, 1969). However, specimens of this species are very rare from North American shores. Orr (1966) reports that a male specimen obtained in 1963 from San Mateo County, California, was apparently the first continental record since the late nineteenth century. Guiget and Pike (1965) record a specimen from protected waters near Stuart Island, British Columbia, (approximately 50°20′ N, 125°00′ W). Unfortunately, all but the flukes and a portion of the caudal peduncle of this specimen were lost. Stroud (1968) gives the only other published account of a North American specimen, a male found on a beach in northern Washington. My note here records a second British Columbia occurrence and, apparently, the first complete Canadian specimen.

The animal, also a male, washed ashore on the east side of Vargas Island, Clayoquot Sound, Vancouver Island, British Columbia (49°10′ N, 125°58′ W) on 17 April 1970. The following measurements, all given in centimeters, were taken as suggested by the American Society of Mammalogists, Committee on Marine Mammals (1961), and the reader is referred to this source for explanation of specific measurements:

Grampus griseus (G. Cuvier), 17 April 1970

Testes (length × width): left—18.0 × 2.5; right—18.8 × 2.1
Number of teeth: right upper—0; left upper—0
right lower—4; left lower—4
Diameter, largest tooth—0.73
Length, total—266
Length, tip of upper jaw to center of eye—34
Length of gape—24
Center of eye to angle of gape—8.1
Center of eye to center of blowhole—28 (around curve)
Length, tip of upper jaw to blowhole along midline—35
Length, tip of upper jaw to anterior insertion of flipper—52
Length, tip of upper jaw to tip of dorsal fin—158
Length, tip of upper jaw to midpoint of umbilicus—146
Length, tip of upper jaw to midpoint of genital aperture—161
Length, tip of upper jaw to center of anus—173
Projection of lower jaw beyond upper—none
Thickness of blubber, mid-dorsal at anterior insertion of dorsal fin—3.7
Thickness of blubber, mid-lateral at midlength—1.9
Thickness of blubber, mid-ventral at midlength—2.4

Girth, on a transverse plane intersecting axilla—117
Girth, maximum—129 (at anterior insertion of dorsal fin)
Girth, on a transverse plane intersecting the anus—78
Dimensions of eye (left): height—2.1; length—3.6
Length, anal opening—2.6
Dimensions of blowhole: width—2.6; length—4.0
Length, flipper (anterior insertion to tip)—51
Length, flipper (axilla to tip)—39
Width, flipper (maximum)—14
Height, dorsal fin (fin tip to base)—30
Length, dorsal fin base—33
Width, flukes (tip to tip)—58
Distance from nearest point on anterior border of flukes to notch—17
Depth of notch between flukes—2.5

I was unable to determine cause of death. Dissection revealed no sign of mechanical injury and no gross pathological condition. The stomach was empty except for a half-liter wad of eelgrass (*Zostera marina*) and an unidentified, flaccid, *Ulva*-like alga. This occurrence of plant material in a cetacean stomach is not unique. Orr (1951) reports that a male Pacific blackfish (*Globicephala scammonii*) which was shot near shore along the Alaska Peninsula in 1937 had about 30 pounds of a "large tubular seaweed" in its stomach. He says, "Since these animals do not ordinarily consume vegetation, it was thought that this had been swallowed incidentally, perhaps while it was thrashing about in an attempt to escape after coming too close to shore." In view of the fact that domestic canids (also basically carnivorous) may frequently be seen eating grass when ailing, it seems plausible that cetaceans may seek "herbal remedies" in similar fashion.

Color photographs of this specimen are on file at the Department of Zoology's Vertebrate Museum, University of British Columbia (photographic file number 51). The skull, axial skeleton, and bones from one pectoral appendage are also housed at the Vertebrate Museum, collection number 9464.

Thanks are due Dr. Ian McTaggart Cowan and Mr. R. Wayne Campbell, University of British Columbia, for critically reading the manuscript.

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Listera australis in Nova Scotia

According to Mousley (1940) the first report of the orchid *Listera australis* Lindl. (Southern Twayblade) in Canada was by Fletcher who found it 15 miles east of Ottawa in 1893. Mousley himself found the second Canadian station 20 miles north of Montreal in 1940. Correll (1950) listed these two localities and commented: "The occurrence of this typically southern plant in several isolated stations in Canada is most interesting. It is the only species of the genus extending from Florida to Canada, and is possibly the rarest orchid to be found in the eastern half of the Dominion." Greenwood (1962) reported the species at five separate sites within 20 miles of Quebec city, and recently Doyon and Cayouette (1969) reported another site in the same vicinity.

On 16 June 1969 the present writer discovered eight plants of *Listera australis* in a bog in Inverness county, Nova Scotia. The plants were in full flower, and one of them was sent to the National Herbarium at Ottawa (CAN 323,497).

The bog is located at latitude 46°7′ N and longitude 61°14′ W, about 8 miles south of Inverness on Cape Breton Island. The plants were in scattered locations from 2 to 200 feet apart, in open *Sphagnum* but never more than 2 feet from small Spruce or Tamarack. The cover included *Smilacina trifolia* in good bloom, *Vaccinium oxycoccos, Drosera rotundifolia* and *Ledum groenlandicum*. About 100 feet past the last *Listera* the character of the bog changed, becoming wetter and grassier with some *Calla palustris* in flower. About 300 feet in another direction from the first *Listera* were two plants of *Cypripedium acaule* in full bloom.

It appears that the elusive *Listera australis* is to be looked for, in Nova Scotia as in other parts of eastern Canada, among various small plants in open locations of *Sphagnum* bogs. Spots that are sheltered but not much shaded by larger heaths and conifers should be given special attention.

This seems to be the first recognition of the Southern Twayblade in Nova Scotia. Neither Donly (1963) nor Roland and Smith (1966) reported its presence there, and recent enquiries to the two herbaria at Ottawa (CAN and DAO) revealed no records or collections from that province. The species has been found in northern Maine (Correll 1950) and is now to be expected in New Brunswick and Prince Edward Island, and possibly in Newfoundland.

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Cyperus fuscus L. New to Canada[1]

Among plant material sent in for identification to the Plant Research Institute, from T. R. Davidson, Canada Department of Agriculture, Vineland, Ontario, was a new record for Canada of a European species of sedge, *Cyperus fuscus* L. The collection was made on Sept. 20, 1970, at the edge of a pond, St. Johns Conservation Area, Pelham Township, Welland County, Ontario, *Wm. L. Putnam* No. 5.

Cyperus fuscus is a sedge native to central and southern Europe and Madeira; it is a rather distinctive annual having few rays, and spikelets 3-6 mm long. The scales are broadly ovate, obtuse, keeled, with reddish brown sides; the achenes are strongly trigonous and pale in color. The plant derives its name from the color of the scales. Fernald (1950) gave the range as, "Mass. to w. N.Y. and Va." Gleason (1952) indicated that it is rarely introduced at scattered stations in the eastern states. Boivin (1967) who has enumerated the Canadian species of vascular plants, does not list this species. The specimen has been deposited in the herbarium of the Plant Research Institute (DAO).

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Received November 16, 1970
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[1]Contribution No. 802 from the Plant Research Institute, C.E.F., Ottawa, Canada

Notes on Summer Birds along the North Shore of the Gulf of St. Lawrence

Abstract. Observations on the birds of the North Shore of the Gulf of St. Lawrence were made from 3 July to 20 July 1970. Data which supplement previous knowledge are presented on eight of the 57 species recorded.

The bird life along the North Shore of the Gulf of St. Lawrence (reviewed by Godfrey, 1966; and Todd, 1963) is relatively well known.

We spent the period from 3 July to 20 July 1970 at Netagamu River (Harrington Harbour) studying Red-throated Loons (*Gavia stellata*). During this time we recorded all birds seen (57 species) and present the following list of those which supplement the data in Todd and in Godfrey.

RING NECKED DUCK, *Aythya collaris*

On 4 July one male Ring-necked Duck was found loafing in a pond 2 km inland from the coast along the Netagamu River. The nearest breeding record is from Baie Johan Beetz about 250 km to the west (Cooch, 1955).

SPARROW HAWK, *Falco sparverius*

The Sparrow Hawk has not been recorded along the North Shore east of the Moisie River near Seven Islands (Godfrey, 1966). On 4 July one Sparrow Hawk was seen in the treeless area 2 km inland from the coast along the Netagamu River. It was being chased by a Pigeon Hawk (*Falco columbarius*) which hit the Sparrow Hawk in mid-air. As the Sparrow Hawk flew off to the west the Pigeon Hawk flew back east and landed in a scrub spruce about 0.5 km away. The Pigeon Hawk may have been on territory as they breed in the area (Todd, 1963).

LEAST SANDPIPER, *Erolia minutilla*

The Least Sandpiper breeds along the coast of Labrador through the Strait of Belle Isle west to Blanc Sablon (Gabrielson, 1952). It also breeds on Anticosti Island (Godfrey, 1966). We found Least Sandpipers on the Boat Islands (part of the St. Mary's Archipelago) on 13 July. One bird hovered on rapidly beating wings, calling loudly; it then gave several 'broken-wing' distraction displays. It evidently had a nest or young in the area. Three other Least Sandpipers were seen on the islands.

EASTERN KINGBIRD, *Tyrannus tyrannus*

The Eastern Kingbird has been reported eight times in the first half of June along the North Shore between Sept Iles and Wolf Bay (Todd, 1963). The only July record is by H. Lewis on the 14 July 1940 at Mutton Bay (Todd, 1963). We recorded a single individual on the St. Mary's Islands on 6 July.

OLIVE-SIDED FLYCATCHER, *Nuttallornis borealis*

There are few summer records of the Olive-sided Flycatcher along the North Shore and none east of Kegaska (Todd, 1963). We recorded one at Netagamu River on 10 July. This is about 150 km east of Kegaska. The bird sang loudly all day but was not seen or heard before or after.

TREE SWALLOW, *Iridoprocne bicolor*

Todd (1963) considered the Tree Swallow rare or absent as a breeder along the North Shore east of Natashquan. He suggested a lack of suitable nest trees may be the reason for this. In recent years residents of Netagamu River and Harrington Harbour have erected bird houses. Tree Swallows are now common breeders in these communities with 5-10 pairs in each place. Even on the barren rocks of the Cape Whittle light house Tree Swallows were nesting in a nest box. It is not known if they also use natural structures in this region.

BLACK-AND-WHITE WARBLER, *Mniotilta varia*

One Black-and-white Warbler was seen at the mouth of the Netagamu River on 4 July. There are only 3 June records along the North Shore east to St. Augustine (Todd, 1963). This species has not been recorded breeding east of Mingan (Godfrey, 1966).

BROWN-HEADED COWBIRD, *Molothrus ater*

The Brown-headed Cowbird breeds southwards from Havre St. Pierre which is 300 km west of Netagamu River (Godfrey, 1966). The only records along the North Shore east of Havre St. Pierre are August records of single birds at Harrington Harbour and Bradore Bay (Lewis, 1934, 1938). Cowbirds are now common at Netagamu River. They were seen daily about the settlement with at least 3 females and 2 males being present. According to local residents cowbirds first appeared about 5 years ago and are now the most common birds in the spring. Our daily records would indicate probable breeding by this species.

Acknowledgements

This work was supported indirectly by a grant from the National Research Council to Dr. C. D. MacInnes.

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News and Comment

Scientists See "Slightly Brighter" Future for Great Marine Turtles

Sea turtles, which are among the most endangered — and most valuable — of marine resources, now have a slightly brighter chance of survival and recovery as a result of co-operative links established between a small group of scientists and commercial users and suppliers of turtle products.

Informal agreements emerged from a meeting of the Marine Turtle Specialist Group, a unit of the Survival Service Commission, one of six Commissions of the International Union for Conservation of Nature and Natural Resources. The World Wildlife Fund provided major financial assistance for the three-day meeting held March 8 to 10, 1971, in Morges, Switzerland.

The trade in turtle products, in addition to meat and eggs, includes (calipee the cartilaginous material taken from among the bones of the belly shell) for soup, hides for turtle leather, shells for "tortoise-shell", oil for cosmetics, and even stuffed yearling turtles for souvenirs. Sea turtles and their eggs have always been an important local source of protein in the tropical areas where they nest, but this non-commercial use is not considered a threat to the various species.

The world's first turtle farm, Mariculture Ltd. of Grand Cayman Island in the British West Indies, agreed to obtain for its hatching programme only turtle eggs that otherwise would be subject to natural destruction. The scientists will exchange experience with Mariculture on captive breeding experiments. Mariculture is pioneering commercial farming of sea turtles, a process which, it is hoped, eventually will reduce the pressure on dwindling natural sources.

Assurances were received by the Group from a leading representative of the turtle soup industry of continuing co-operation in refusing to buy illegally or inadvisably taken.

This was the second biennial meeting of the turtle scientists who came from distant parts of the world to plan continuing conservation, management and research programmes on the big marine reptiles, all seven species of which are listed in IUCN's authoritative Red Data Book of endangered species.

Sea turtles have been used by man for centuries, but only recently have they been studied extensively. There are still great gaps in knowledge about them. The IUCN Group is trying to close these gaps, and considerable progress already has been made.

Research priorties for the next two years include:

1. mapping of group-nesting sites, particularly undocumented areas of Australia, Africa, Indonesia and South America,
2. research into captive culture techniques,
3. population ecology and energy flow studies,
4. taxonomic-zoogeographic studies.

The IUCN Group agreed to serve as a special consultative body to governments of countries where turtles occur, offering counsel on all aspects of turtle conservation.

Considerable praise was voiced for the U.S. Endangered Species Act of 1969 as constructive legislation which will help save these endangered reptiles. Three species of sea turtles are listed under the legislation, and these species and their products cannot be imported into the United States. They are Kemp's Ridley, Hawksbill and Leatherback turtles.

The Group condemned the trade in stuffed young turtles, sold as souvenirs to tourists throughout tropical areas. This trade is considered a major threat to the Hawksbill turtle. However, uncontrolled taking of turtle eggs is considered the greatest overall threat since it affects all species. The leather trade principally affects the Olive Ridley species and has virtually wiped out the highly-endangered Kemp's Ridley, which is found only in the Gulf of Mexico.

Turtle vandals were bitterly condemned: one case was cited where 18 leatherback turtles were killed in one night on a nesting beach and the entire carcasses left to rot.

The meetings were chaired by Dr. Gerardo Budowski, Director General of IUCN and Dr. Colin Holloway, IUCN ecologist, and organized by Miss Moira Warland, IUCN staff executive officer for the Survival Service Commission.

Members of the Turtle Group present were:—

Dr. Gustavo Casas Andreu
Mexico

Professor L. D. Brongersma
Netherlands

Dr. H. Robert Bustard
Australia

Professor Archie Carr (Group Chairman)
U.S.A.
Mrs. Mary-Margaret Goodwin
Puerto Rico
Professor John R. Hendrickson
U.S.A.
Dr. Harold F. Hirth
U.S.A.
Mr. George R. Hughes
South Africa
Dr. Peter C. H. Pritchard
U.S.A.
Dr. Dietrich Sahrhage
F.A.O.
Mr. G. S. de Silva
Sabah, Malaysia

Mr. John Lusty of London represented the turtle soup industry, while Mr. Mark Fisher took part for Mariculture Ltd.

Text of Joint U.S.-Canada Reference to the International Joint Commission

(Dated April 7, 1971)

The Governments of the United States and Canada, pursuant to Article IX of the Boundary Waters Treaty of 1909, have agreed to request the International Joint Commission to investigate the environmental consequences in Canada resulting from the elevation of Ross Lake in the State of Washington from 1,602.5 feet above mean sea level to 1,725 feet above mean sea level, and to make such recommendations as it may deem appropriate for the protection and enhancement of the environment and the ecology in the area of Canada affected by the elevation of the lake.

The Commission is requested:

(a) to investigate the environmental and ecological consequences in Canada of the raising of the Ross Lake to an elevation of 1,725 feet above mean sea level, taking into account relevant information about environmental and ecological consequences elsewhere on the Skagit River, and measures being taken or planned to protect and enhance the environment in these areas;

(b) in the light of its findings, to report on the nature, scope and impact of these consequences;

(c) to make recommendations, for the protection and enhancement of the environment and the ecology of the Skagit River Valley not inconsistent with the Commission's Order of Approval dated January 27, 1942, the Agreement required thereby between the City of Seattle and the Province of British Columbia dated January 10, 1967, and the purposes for which such Order of Approval was granted.

The Commission is requested to submit its conclusions and recommendations to the Governments of the United States and Canada no later than six months from the date of this letter of reference.

In the conduct of its investigation and otherwise in the performance of its duties under this reference, the Commission may utilize the services of specialists in th eenvironmental field and other specially qualified personnel of the technical agencies of Canada and the United States, and will, so far as possible, make use of information and technical data heretofore acquired or which may become available in either country during the course of the investigation.

Editor's Note: The text of this joint U.S.-Canada Reference to the IJC is reprinted here to enable interested readers to bring their knowledge or opinions to the attention of the Commission. Address all presentations to:

The International Joint Commission,
Burnside Building,
151 Slater St.,
Ottawa, Canada.

Reviews

Atlas of Alberta

By Government of Alberta and the University of Alberta, Edmonton. University of Alberta Press in association with University of Toronto Press. List of Maps + 158 pp + Index. Color. 1969. $20. (Residents of Alberta); $30 for others.

As the official centennial project of the Government and University of Alberta, this gargantuan masterpiece of provincially financed book binding (13¾ × 17½ inches) presents a uniquely inclusive tally of Alberta's social, economic and natural resource development to date. Good reproduction and liberal use of space and color on a backing of sturdy semi-matte bond lend ease and pleasure of usage to the volume, making it a technical milestone among the general run of Canadian publications with their retina-destroying glare and inconsistent graphic presentations.

Perhaps unfortunately, the atlas has also reached a milestone in another direction, that of efficiency. If a large corporation needs an investment feasibility study of Alberta, this is it. Information sources and references are almost completely omitted and explanatory notes are at an absolute minimum, often lacking when term definitions etc. are essential for adequate usage of the illustration. "Acknowledgements" includes some of the best known and distinguished Alberta researchers (e.g. R. G. H. Cormack, W. Fuller, W. R. Salt, R. W. Longley) but any references to their contributions have been omitted. The validity of much of the data presented is thus left open to question, exclusive of statistical information based on 1961 census figures.

The atlas is basically well organized with 18 primary divisions (Relief and Geology, Climate, Water, Vegetation, Soil, Wildlife, History, Population, Land Use, Agriculture, Forestry, Fishing and Trapping, Minerals, Power, Manufacturing, Service, Settlement Patterns, Administration) presented in a kind of chrono-developmental sequence beginning with the natural and terminating with the artificial.

The coverage and range of topics included under each heading is generally good. Emphasis appears to have been on social and economic development data but the previous lack of easily accessible sources of such information may be accountable. Natural history topics are treated rather briefly however the birds, mammals, fish and general ecology of the province are well covered in four separate publications. This volume is definitely not intended as a natural history publication.

The natural history content does include distribution maps (1/9th page size) for a small selection of native trees (9 maps, 16 species), plants (9 m., 12 sp.), birds (12 m., 27 sp.), mammals (15 m., 16 sp.), and fish (9 m., 11 sp.). In addition, maps are included of migration routes, waterfowl staging areas and ecosystems. The mammal distributions are indicated by spot shading superimposed on colored background maps of the principal ecological zones. Unfortunately the same procedure was not followed for the bird and fish distributions. Also, small inserts showing general North American ranges are included with plant and tree maps but lacking for the vertebrate groups.

Bird ranges are indicated by a combination of spot and color shading and fish distributions by color separation of occupied drainages. Range similarities would indicate that bird and mammal data have originated from "The Birds of Alberta" (W. Ray Salt and A. L. Wilk, 1966) and "The Mammals of Alberta" (J. Dewey Soper, 1964) but I have no idea of the information source used to prepare the fish maps. Despite their attractive presentation, the lack of references and the presence of numerous errors in distribution and status (native or introduced) in various drainages makes these of little use except as general references for sportsmen. Fortunately, this gap is now filled by the excellent range maps in the recently published "Fishes of Alberta" (M. J. Paetz and J. S. Nelson, 1970).

The choice of species included has been directed primarily at the popular hunting and fishing interests however here, as elsewhere in the atlas, the inconsistency of subject choice and emphasis is disturbing. The section on fish includes only game species, that on mammals game species plus wolf, bobcat, lynx and mountain lion and I gave up completely on the bird presentation (four subspecies of *Junco,* three species each of *Dendroica* and *Parus,* one accipiter (*Buteo swainsoni*) included incidentally in a predator-prey illustration and various other interesting combinations). Whatever value the vertebrate maps may have had is almost completely negated by the lack of explanatory notes and references.

On the positive side, the atlas ends with an excellent combination index-gazetteer. Names are preceded by the page reference and followed consecutively by a descriptive term, 1968 population if applicable, position both by latitude and longitude and by township and range, plus a grid reference. And, wonder of wonders, the index is accompanied by a clear, concise and complete explanatory note with a couple of definitions thrown in for good measure.

"Atlas of Alberta" is a superbly presented general scorebook of Alberta's economic development and natural resources to publication date, a fitting addition to the cluster of evergreen and gold U. of A. yearbooks in the offices of provincial cabinet ministers. For conservationists, by combining the excellent population, mineral and agricultural resource maps with those on vegetation and topography an index is available for predicting possible endangered areas worthy of preservation. For the serious researcher its use is limited to that of a general reference in fields other than his own and for the layman, its too expensive.

T. A. WILLOCK

Milk River,
Alberta

Handbook of Rocky Mountain Plants

By Ruth Ashton Nelson. Illustrated by Dorothy V. Leake. Dale Stuart King, 2002 N. Tucson Blvd., Tucson, Arizona 85716. 331 pp. 514 illus. 1969. $4.95 paperback, $6.95 clothbound (US).

Mrs. Nelson is the wife of the late Aven Nelson, botanist and curator of the Rocky Mountain Herbarium, University of Wyoming. Together they collected plants in the Rocky Mountains for many years. She has utilized her experience and knowledge of plants of this region to produce a book with a minimum of technical detail, which is designed for the layman.

In this book Mrs. Nelson describes and keys out over 875 of the more easily recognized plants found above 5000 ft. altitude in the Rocky Mountains from northern Arizona and New Mexico to the Canadian border. The text is easily read and contains much information on habitats, habit, distribution and general knowledge. The emphasis is on the common name rather than the scientific, and indeed in some cases the latin name given is not the correct one but perhaps as she points out, a more widely known name.

Introductory sections deal with climate, the land and how it was formed, plant succession, vegetation zones and the characteristics of plants. The latter part is well illustrated. Throughout the text are 362 line drawings of various species. These are on the whole quite well executed, and greatly enhance the volume. Seventy-four pictures on twelve plates in the middle of the book have been reproduced with remarkably good colour. There are a few spelling errors, but these do not detract from the value of the book. Plate 5a does not appear to be *Draba aurea,* which is a taller plant, but is readily recognizable as a species of *Draba.*

It is interesting to note that the binding was done at the Arizona Training Centre for the Handicapped, Tucson, Arizona — a professional job.

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Frogs of Colombia

By Doris M. Cochran and Coleman J. Goin. 1970. Smithsonian Institution, United States National Museum, Bull. 288, 655 pp., 68 plates, 54 figures, 1 map. Available from Superintendent of Documents, United States Government Printing Office, Washington, D.C., 20402. $4.00 (US).

South America probably has a richer and more diversified frog fauna than any other continent. Both South American and foreign herpetologists have contributed to our knowledge of this immense fauna. When we consider that Canada has about 25 species of frogs, while Colombia has over 200, and Brazil in the vicinity of 500 species and subspecies, it is very apparent just how difficult the task is to cover a country such as Colombia or Brazil.

The late Dr. Doris M. Cochran and Dr. Coleman J. Goin have completed a tremendous task with their monograph of the frogs of Colombia. (Unfortunately Dr. Cochran did not live to see the work published). The paragraph (p. 6) sums up very clearly the modesty of both authors: "Thus, we have visualized our task not as one of preparing the final word on the frogs of Colombia but rather as bringing together what is now known and making such knowledge available in a single volume. If this report makes the study of Colombian frogs easier in the future than it has been in the past, then this labor of love is not without value and no further apology is necessary."

During the course of Cochran and Goin's work, which began in the late 50's, they worked in co-operation with Brother Nicéforo María, Director, Museo del Instituto de La Salle, Bogotá, Colombia, who has for many years been very active in Colombian herpetology.

Cochran and Goin treat 212 species and subspecies giving descriptions and keys. All species, with the exception of two, are illustrated by black and white plates or line drawings. There is also a very useful gazeteer and reference list.

No doubt there will be criticism of Cochran and Goin's work. However, it will be up to the critics to produce something better, and their task although a big one, will be made much easier by the contribution of Cochran and Goin. It is very likely that "Frogs of Colombia" will remain the basis for further study of the frogs of Colombia and adjacent areas for some time to come.

At the extremely modest price anyone interested in the frogs of Colombia should have a copy.

STANLEY W. GORHAM

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World Wildlife: The Last Stand

By Philip Kingsland Crowe. 308 p., illus. with photos and maps. Charles Scribner and Sons, New York. $17.95. Available in Canada from W. B. Saunders & Co., Toronto.

This is a very readable but shallow book covering three trips taken by the author as a member of the Board of Trustees of the World Wildlife Fund. The expressed purpose of the trips and book was to discuss and report on conservation matters with leaders of government and senior officials in various countries.

Beginning in 1966, the three trips took the author firstly to the Indian subcontinent and assorted Himalayan countries; secondly to Central America from Panama north to Mexico, and finally, to developing countries of Southwest Africa south of the equator.

As a general rule, Crowe found in each country visited, good or improved conservation laws and good intentions but little money and even less enforcement. The increasing number of parks, sanctuaries, preserves and reservations that have been proclaimed is gratifyingly large but unfortunately most are of the paper variety, unsurveyed and unprotected. Finally, the book contains interesting vignettes of social and cultural implications of wildlife preservation.

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Animals of the North

By William O. Pruitt Jr. Harper and Row, New York, illus. by Wm. D. Berry, 173 pp. 1966. $5.95 U.S.

When this book was published I watched for it on frequent prowls through book stores, and found a copy with the usual greedy Canadian markup over the American price. Inflation had yet to prepare me for a slender volume of uncertain content costing over seven dollars. A year ago I found this title indexed in an Ottawa library, but the book itself had wandered off unrecorded. Fate, in these ways, prevented my reading Pruitt's book for four years. Recently I read it in two memorable sittings. It is years since I have relaxed with a book so satisfying, so crammed with new ecological understanding, yet so easily assimilated. Here is a thoroughly boreal, hence thoroughly Canadian, popular account of ecology that gives vivid insight into the lives of animals of the taiga. It specializes in mammals, giving much space to the environmental factors that are a northern specialty, cold and snow.

Pruitt is a good scientist and a skilful communicator of his knowledge to the non-scientist. This is a rare and needed combination of talents. At a time when our biosphere is falling apart there is need, in democratic countries at least, for informed citizens who understand the living world and how it functions. Most Canadians today, including most in positions of power, are biological illiterates unaware of the facts of life. In the business of caring intelligently for the landscapes necessary to our survival we are often prevented from appropriate management by tradition and politics rather than the need for more knowledge. It is common for science to know more than managers are allowed to use. For some decades now the ivory towers have been crumbling, but science is still a long way from being able to communicate with the public easily, entertainingly, and on the public's level. Pruitt's book is the best example of clear communication of science that I have encountered in several years.

In writing animal stories there are pitfalls that most laymen seem unable to avoid. Our human language is human oriented, so it is difficult to write animal stories without the animals and their behaviour becoming humanized. Pruitt avoids this trap as a scientist should, but he does it easily so the result is a writing style acceptable to layman and scientist alike. He does use technical jargon, but he seems to have chosen his scientific excesses well, while a small glossary erases most word problems if the reader thinks to consult it.

This book is illustrated by William Berry. I know of this artist only that he wrote and illustrated the small book "Deneki" (Macmillan, 1965) about an Alaskan moose. It is perhaps a children's book (good children's books are never obviously for children alone) but for any age it is as fresh and true as a real day in an Alaskan forest. The wash drawings in "Animals of the North" prove again that Berry's hand reflects with accuracy what a good naturalist has seen, and seen well.

Needless to say, I recommend this book highly. It is an ecological statement about Canadian conditions that should be widely read, whether casually for fun or as required reading by students of ecology.

YORKE EDWARDS

Canadian Wildlife Service,
Ottawa.

Mollusks

Paul Bartsch. (Reprint of Part III, "Mollusks", from Shelled Invertebrates of the Past and Present, by R. S. Bassler, C. E. Resser, W. L. Schmitt, and P. Bartsch, 1934, Smithsonian Institution, Washington.) Dover Publications, Inc., New York, paperback, 111 p. 62 illust., 6 col. pls. $2.00.

This little book is full of delightful and incredible facts about molluscs or, to the uninformed, about "shells". The five chapters contain lively discussions and anecdotes concerning pelecypods, scaphopods, gastropods, chitons, and cephalopods and present much fascinating information on biology and ecology which cannot be found elsewhere. The coloured plates are also attractive and the figures are very well executed.

Animal biology doesn't change so, even though the book was written nearly forty years ago, the reader will be educated as well as entertained. Taxonomic names and classifications do change, however, so many of the names used and parts of the systematic arrangement are now out-of-date. For example the author recognizes only four living Classes of molluscs but modern workers recognize seven.

Paul Bartsch was one of North America's foremost malacologists throughout the first half of this century. The book clearly reflects his broad knowledge and his love for molluscs. It is heartily recommended for anyone who is interested in the world around him.

A. H. CLARKE

National Museums of Canada
Ottawa, Canada

Native Trees of Canada

By R. C. Hosie. Queen's Printer, Ottawa. illus, 380 pp. $5.00 in paper, $8.00 in cloth.

Trees of Canada and the Northern United States

By F. H. Montgomery. Ryerson, Toronto. illus., 144 pp. 1970. $4.95.

To date the best book on Canadian trees has been "Native Trees of Canada", a publication of the Federal Government that since 1917 has gone through many editions. It was a pleasant book, but it never did give the serious student of trees reliable help with identification. Suddenly, in 1969, all this changed when the so-called seventh edition appeared. It is a new book with a new author, but for unknown reasons it is camouflaged under an old title of limited reputation. Canada now has a tree book for all occasions that is well organized, well illustrated, filled with fact, and efficient at involving people with the details of trees. An outstanding feature is lean, direct keys, perhaps the sort expected of an author who has devoted much of his life to introducing trees to students of forestry.

But Prof. Hosie's book is really the Canadian tree book for all occasions but one. His is a book for indoors on the table or shelf, so it left a need for a small book to help name the trees when outside with the trees. Prof. Montgomery's book fills this need.

It is a thin, well bound little volume easily carried in a jacket pocket. The text is essentially a long, easily followed key with some ecological and geographical information worked in. Good line drawings by Mrs. David Ratz illustrate all species.

The only valid test of such a book is how well it works with trees to give their names. It is essentially a summer key, born and announced here in winter, but knowing the author's previous works we are confident of high quality. It gives real satisfaction to hold at last the trees of Canada in so slim a volume. It will be much used. At the same time, this milestone is not the only brief approach possible to the subject. We can see further needs, including a winter key; and a more austere key with less information and just enough content to do the naming job; and a key more vegetative in approach, paying even less attention to seasonal things like fruit. There may in future be even slimmer books on Canadian trees, but they will be severely specialized for the naming process only.

This book is not so narrow in approach that it has lost its value as an indoor source of facts. But it is mainly an outdoor identifier. If you are a tree watcher, carry it in your pocket anywhere in Canada.

YORKE EDWARDS

Canadian Wildlife Service,
Ottawa.

Exploring Manning Park

By R. Cyca and A. Harcombe. Photographs by G. and B. Epting. 1970. Gundy's and Bernie's Guide Books, 3782 West Second Ave., Vancouver 8, B.C. 96 pp. $2.95.

I approached this book telling myself to be kind, because I know Manning Park pretty well. After all, I thought, I crossed the miles of Three Brothers Mountain a dozen times when I was exhausted at the place where these people begin the hike from their cars; and just possibly I stood triumphant on the highest knife-edge of Frosty Mountain before these authors could walk; and I stumbled by accident onto Poland Lake when Joe Hilton was the only other man I could find who had seen it. I soon found from their book that the authors have seen more of the park than I have; and they know some natural history too, which makes my admiration of the book complete.

This is the best guide to a wild Canadian park that I have seen. The description is crisp and adequate; the guiding is clear and accurate; the abundant photographs are outstanding. The very design of the book is clean, attractive communication. As a naturalist I would have put in more natural history; but perhaps as a hiker I would want it as small as it is and would tell the naturalist to carry his own field guides if he wants to specialize.

The people that put this book together are young and tough, energetic and enthusiastic. I sense from their writing their wild delight at meeting the challenges of wild terrain. And this, after all, is what large wild parks are all about. They are for the youths of all ages fired by a zest for life and a need to be tested. What better test of the man than to walk away from his technology, and as a mere man to enter an untamed world to make it a joyful experience. Parks are for the young of spirit. Appropriately, this guide is by youth. May it fall abundantly into the hands of the old men of all ages who can see no priceless values in large, wild parks.

YORKE EDWARDS

Canadian Wildlife Service,
Ottawa 4, Ontario.

OTHER NEW TITLES

Academic Gamesmanship: How to Make a Ph.D. Pay. Pierre Van den Berghe. Abelard-Schuman, New York. 1970. 116 p. $4.95.

***Air Pollution Experiments for Junior and Senior High School Science Classes.** Air Pollution Control Association, Pittsburgh, Pa. 1969. 64 p. $1.00.

***Analysis of Temperate Forest Ecosystems.** David E. Reichle (ed.) Springer-Verlag, New York. 1970. 304 p. $14.50. Ecological Studies Series No. 1. Biological, physical and chemical analyses of the parts and processes of ecosystems.

*Assigned for review

*__Data Processing in Biology and Geology.__ J. L. Cutbill (ed.) Academic Press, New York. 1971. 346 p. $15.00. Proceedings of a symposium held at the University of Cambridge, 1969.

*__Biology and the Social Crisis: A Social Biology for Everyman.__ J. K. Brierly. Heineman Educational Books Ltd., London. 1967. 260 p. $7.00 cloth, $3.00 paper. Available in Canada from Bellhaven House, Scarborough.

*__Biological Aspects of Thermal Pollution.__ P. A. Krenkel and F. L. Parker. Vanderbuilt University Press, Nashville, Tenn. 1969. 407 p. $7.95.

The Biosphere. Editors of Scientific American, San Francisco. 1970. 134 p. $6.50 cloth, $3.25 paper.

Bird Navigation. G. V. T. Mathews. Cambridge University Press, New York. 1970. $2.45 paper, $7.00 cloth.

*__Birds of the Early Explorers in the Northern Pacific.__ Theed Pearse. Gray's Publishing Co. Ltd., Sidney, B.C. 1968. 275 p. $7.50.

The Case for Extinction. M. Stultifer. Dial Press, New York. 1970. 88 p. $4.95. An answer to Conservationists.

Communities and Ecosystems. R. H. Whittaker. Macmillan Co., New York. 1970. 162 p. $3.95.

Concorde: The Case Against Supersonic Transport. R. Wiggs. Pan Books, New York. 1970. 177 p.

The Ecology of Running Waters. H. B. N. Hynes. University of Toronto Press, Toronto. 1970. 556 p. $25.00.

*__Ecology of the Subarctic Regions.__ Proceedings of the Helsinki Symposium. UNIPUB Inc., New York. 1970. 365 p. $19.00.

*__The Ecosystem Concept in Natural Resource Management.__ G. Van Dyne (ed.) Academic Press Inc., New York. 1969. 383 p. $16.50.

The Environment of Crowded Men. Paul A. Colinvaux (ed.) MSS Educational Publishing Co., New York. 1970. 113 p. $3.75.

The Environment, The Establishment, and The Law. H. Henkin, M. Merta, and J. Staple. Houghton Mifflin Co., Boston. 1971. 224 p. A record of the 1968 hearings held before the Wisconsin Department of Natural Resources to determine if DDT is an environmental pollutant.

Environ/Mental. P. Shepard and D. McKinley. Houghton Mifflin Co., Boston. 1971. 250 p. A book of current readings to illustrate the scope of current environmental disorder and emphasize the interrelationships of human and ecological stress and of their solutions.

Evaluating the Safety of Food Chemicals. U.S. National Research Council Food Protection Committee and Subcommittee on Toxicology. 55 p. $2.50.

*__Forest Gene Resources: Their Conservation and Utilization with Special Reference to the Canadian Spruces.__ L. Roche. Canadian Forestry Service, Forest Research Laboratory, Quebec Region, Quebec Information Report Q-X-16. 27 p.

Freshwater Fishes of Northwestern Canada and Alaska. J. D. McPhail and C. C. Lindsey. Fisheries Research Board of Canada Bulletin No. 173. 1970. 381 p.

A Glossary of Mycology. W. H. Snell and E. A. Dick. Harvard University Press. 1971. 181 p. $6.50. Defines nearly 7,000 terms; with diagrammatic line drawings.

The Growing Tree. B. F. Wilson. University of Massachusetts Press. 1970. 152 p. $6.50. For people who care about trees; the basic processes of growth and regulation and the interaction of various parts in their competition for photosynthetic products.

Fairweather Duck. V. Dethier. Walker and Co., New York. 1970. 178 p. $4.95.

Field Guide to the Native Trees of Manitoba. T. Oswald and F. H. Nokes. Forest Research Laboratory, 25 Dafoe Road, Winnipeg 19. 68 p. Free.

Flowering Vines of the World. E. A. Menninger (ed.) Hearthside Press Inc., New York. 1970.

The Grasses of Central Australia. M. Lazarides. Australian National University Press, Canberra. 1970. 282 p. $10.00.

*__Growth and Development of Trees.__ Vol. 1. Seed Germination and Shoot Growth. T. T. Kozlowski. Academic Press, New York. 1971. 443 p. $23.00.

The Hidden Forest. S. F. Olson and L. Blacklock. Viking Press, New York. 1969. 127 p. $14.95.

In Quest of Quiet: Meeting the Menace of Noise Pollution. H. Still. Stackpole Books. 1970. 221 p. $6.95. A call to citizen action; discusses the various sounds of contemporary civilization, the cost of high speed travel, the nature of sound and its effects on man.

Introduction to Fungi. J. Webster. Cambridge University Press, New York. 1970. 424 p. $10.50. An up-to-date account of the biology of fungi as living organisms.

*__Introduction to Herpetology__. 2nd edition. C. J. Goin and O.B. Goin. W. H. Freeman and Co., San Francisco. 1971. 353 p. $8.00.

A Key to the Microtinae of the Pacific Northwest. C. Maser and R. M. Storm. Oregon State University Bookstore Inc., Corvallis, Oregon. 1970. 162 p. $4.95.

The Life and Organization of Birds. W. B. Yapp. American Elsevier Co., New York. $5.95 paper, $11.75 cloth. Birds from the earliest development of the phylum; consideration of their flight, physiology, behaviour, classification, and distribution.

The Life of Reptiles. A Bellairs. The Universe Natural History Series, Universe Books, New York. 1970. 590 p. $25.00 for the two volume set.

*__Man and His Environment.__ Don R. Arthur. American Elsevier Co., New York. 1969. 218 p. $8.50.

Man and the Environment: An introduction to Human Ecology and Evolution. A. S. Boughey. Macmillan Co., New York. 1971. 480 p. $6.95 paper, $9.95 cloth.

Man and the Natural World. C. J. Goin and O. B. Goin. Macmillan Co., New York. 1970. 643 p. $9.95.

Management of Lakes and Ponds. G. W. Bennett. Van Nostrand Reinhold, New York. 2nd ed. 376 p. $15.95.

Memories. J. Huxley. Allen and Unwin, London. 1970. 296 p.

***Meteorological Aspects of Air Pollution.** World Meteorological Organization Technical Note No. 106. UNIPUB Inc., New York. 1970. 69 p. $4.50. The full text of three papers presented at the 1969 WMO meeting.

Molecular Approaches to Ecology. M. Florkin and E. Schoffeniels. Academic Press, New York. 1969. 203 p. $10.00. Includes many examples of ecological responses that are known to have a chemical basis.

***A Natural History of Man.** J. K. Brierly. Heinemann Educational Books Ltd., London. 1970. 184 p. $7.00. Available in Canada from Bellhaven House, Scarborough.

***Natural Regulation of Animal Populations.** I. A. McLaren. Atherton Press, New York. 1971. 195 p. $2.95 paper, $6.95 cloth. Available from Aldine Publishing Co., Chicago, Ill.

The New York Aquarium Book of the Water World: A Guide to Representative Fishes, Aquatic Invertebrates, Reptiles, Birds, and Mammals. W. Bridges. New York Zoological Society/American Heritage Press, New York.

***The Nature of Life: Earth, Plants, Animals, Man, and Their Effect.** Lorus Milne and Margery Milne. Chanticleer Press Edition, Crown Publishers Inc., New York. 1970. 316 p., 208 illus. $21.95. Available in Canada from General Publishers Co., Don Mills.

Nuclear Power and the Public. H. Foreman (ed.) University of Minnesota, Minneapolis; Oxford University, London. 1971. 273 p. A series of papers from a conference at U. of Minn. in 1969. Motivation was public concern about a proposed nuclear power plant to be built 40 miles upstream from Minneapolis.

***Oil on Ice: Alaskan Wilderness at the Crossroads.** T. Brown. Sierra Club Battlebook. 1971. 160 p. $1.95. Available in Canada from Clarke, Irwin & Co., Toronto.

Papers on Evolution. P. R. Ehrlich, R. W. Holm, and P. H. Raven. Little, Brown, and Co., Boston. 1969. 564 p. $6.50.

Parasitic Insects. R. R. Askew. American Elsevier Co., New York. 1971. $11.50.

Persistent Pesticides in the Environment. C. A. Edwards. Chemical Rubber Co. Press, Cleveland. 1970. $10.50.

Physiology, Environment and Man. D. H. K. Lee and D. Minard. Academic Press, New York. 1970. 248 p. $11.00.

The Physiology of Flowering Plants. H. E. Street and H. Opik. American Elsevier Co., New York. 1970. $5.95 paper, $11.75 cloth. Treats plants as whole organisms rather than as separate and specialized parts.

Plants, Chemicals and Growth. F. C. Steward. Academic Press, New York. 1971. 200 p. $3.95 paper, $6.95 cloth.

Polar Research — A Survey. Committee on Polar Research. National Academy of Sciences, Washington, D.C. 1970. 204 p. $15.00.

The Politics of Ecology. J. Ridgeway. Dutton, New York. 1970. 224 p. $5.95 paper, $7.25 cloth. Available in Canada from Clarke-Irwin & Co., Toronto.

Pollution and the Death of Man: The Christian View of Ecology. F. A. Schaeffer. Tyndale House Publishers, Wheaton, Ill. 1970. 125 p. $2.15.

Population and Food Supply: Essays on Human Needs and Agicultural Prospects. Sir J. Hutchinson (ed.) Cambridge University Press, London. 1969. 144 p.

Proceedings of the Third International Peat Congress. C. Lafleur and J. Butler (eds.) Department of Energy, Mines and Resources and the National Research Council of Canada. 1968. 405 p.

***Renewing Nature's Wealth.** R. S. Lambert and P. Pross. Copp Clark Publishing Co., Toronto. $9.50. History of the Ontario Department of Lands and Forests.

***Rocky Mountain Trees.** R. J. Preston Jr. Dover Publications Inc., New York. 1969. 305 p. Available in Canada from General Publishing Co., Don Mills, $3.25.

***Science and the Crisis in Society.** Frank H. George. John Wiley and Sons, Toronto. 1970. 180 p. $5.50.

***Science, Man and Society.** R. B. Fischer. W. B. Saunders Co., Toronto. 1971. 124 p. $3.20.

Seaweeds of Cape Cod and the Islands. J. M. Kingsbury. Chatham Press Inc., Chatham, Mass. 1969. 212 p. $12.50.

The Secret Life of the Forest. R. M. Ketchum. American Heritage Press, New York. 1970. 112 p. $7.95.

Songs of the Humpback Whale. Whale Campaign, New York Zoological Society and Capital Records. 1970. $10.00. Beautiful music from the deep!

***Twenty-one Popular Economic Fallacies.** E. J. Mishan. Allan Lane, The Penguin Press. 1969. 245 p. $7.75. Available in Canada from Longmans, Toronto.

***Urban Forestry In Canada.** E. Jorgensen. The Shade Tree Research Laboratory, Faculty of Forestry, University of Toronto. 16 p. Free.

Urban Water Supply Alternatives. I. MacIver. University of Chicago Research Paper No. 126. 1970. A study of the perception and choices in the Grand River Basin, Ontario.

Weather and Life. An Introduction to Biometeorology. W. P. Lowry. Academic Press, New York. 1969. 305 p. $5.95. About the exchange of energy within and between the physical and biological environments.

When the Tide Goes Far Out. Lorus Milne and Margery Milne. Atheneum, New York. 1970. 88 p. $4.25. Illustrated by Kenneth Gosner.

***The Winter of the Fisher.** C. Langford. Macmillan Co. of Canada Ltd., Toronto. 222 p. $6.95.

Information Governing Content of The Canadian Field-Naturalist

Feature Articles

Beginning with the 1970 issues, the Canadian Field-Naturalist will be open for the consideration of major feature articles whose purpose is to make authoritative reviews of outstanding natural history and/or environment issues of our time. If possible, feature articles should be illustrated. Publication costs are open for negotiation between the author, editor and the business manager of the club.

Articles

The Canadian Field-Naturalist is a medium for publication of research papers in all fields of natural history. Reviews, compilations, symposia, controversial or theoretical papers, historical researches, etc. can also be published. Environmentally related papers are given priority in publication sequence.

News and Comment

Informed naturalists, biologists and others are invited to present documented narratives and commentaries upon current scientific and political events that affect natural history and environment values. This section deals with activities, policies, and legislation relating to land and resource use, national and provincial parks, pollution, natural science education, conservation, natural area and species preservation activites and so on. Contributions should be as short as possible and to the point.

Notes.

Short notes on natural history and environment written by naturalists and scientists are welcome. Extensions of range, interesting behavior, pollination observations, reproductive phenomena, oil and pesticide pollution statistics and many other kinds of natural history observations may be offered. However, it is hoped 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 environment values are welcome. These should be brief, clear, pertinent and of interest to a wide audience.

Reviews

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

Special Notices and other items

The Canadian Field-Naturalist has a flexible publication policy. Hence an item not falling under any of our traditional sections can be given a special place provided that it is judged suitable.

(See Instructions to Contributors inside back cover)

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Their Excellencies the Governor General and Mrs. Roland Michener.

The objectives of the Club are 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 co-operate with organizations engaged in preserving, maintaining or restoring quality environments for living things.

The Canadian Field-Naturalist

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Back Numbers

Prices of back numbers of this journal and its predecessors, (TRANSACTIONS OF THE OTTAWA FIELD-NATURALISTS' CLUB, 1879-1886, and the OTTAWA NATURALIST, 1889-1919), are obtainable from the Business Manager.

Cover Photograph: A small herd of caribou and signs of their activity on and around a small lake in Northern Quebec. The tracks link feeding craters on the shores to bedding sites on the lake itself. See article by P. DesMeules *et al.*, in this issue. Photograph courtesy of the Quebec Wildlife Service.

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The Canadian Field-Naturalist

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The Case for Mutagenic Testing of Chemical Pollutants

It is now widely recognized that chemical pollutants present a genetic hazard to man of sufficient importance to warrant intensive genetic investigation. Many chemicals of both natural and synthetic origin have mutagenic properties. For example, nitrates and nitrites, natural chemicals which are used as preservatives, can form nitrosamines which are mutagenic in microgram doses. Their presence has been suggested in tobacco, fish meals, flour, dairy products and smoked fish and meat. Natural products of fungi, bacteria and higher plants may be mutagenic under certain conditions of collection, storage and processing. But it is the great increase in the production of synthetic chemicals which has given rise to the urgency for mutagenic testing. These chemicals have many diverse applications, such as adhesives, household chemicals, and pesticides, and may be ingested intentionally or inadvertently by man and animals. Routinely, animals are treated with pesticides, antibiotics, tranquilizers and fatteners which may in turn be ingested by man as hidden contaminants. In addition, chemicals such as stimulants, tranquilizers or hallucinogens are directly consumed for therapy or pleasure.

That chemicals can produce mutations and chromosomal aberrations has been known since 1942 when mustard gas was shown to produce the same kind of effects as X-rays. The lack of interest in chemical hazards to the genetic apparatus of man is probably due to the absence of any immediate effects which can be readily seen and clearly established in a cause-effect manner. It may require a number of years, or generations, for genetic mutations or cancer to manifest itself. The peak incidence of leukemia is about six years after exposure to irradiation.

The subject of testing for chemical mutagenicity has been clogged with contradiction and confusion. It has also been complicated by an unwillingness or inability of many people responsible for public welfare to investigate the problem in a way that would elicit answers, or even to agree on the kind of questions that should be asked. An apropos example concerns the herbicide 2, 4, 5-T which has been used widely to control weeds in crops and utility right-of-ways, as a turf treatment on home lawns and golf courses and as a defoliant in Vietnam. According to H. Wellford of the Nader Center, the subject of 2,4,5-T "has become a battleground of opposing philosophies about the relationship between technological risk and human safety. Arrayed on one side are typically the classical toxicologists, food technologists and agri-chemical engineers, who are trained to look for the short-term effets of pesticides, both in their impact on the human body and on the pests in the field. On the other side are typically the microbiologists and geneticists, the specialists in the causes of cancer, birth defects and mutations, who are professionally concerned with the long-term effects of chemical contaminants on human health. At stake is the question of who is to set the standards upon which the proposed safety of a pesticide (or any chemical) it to be judged".

Although data on toxicology are required before chemicals may be marketed, a toxicity test is not a test for mutagenicity and does *not* tell us whether a chemical will cause a heritable change in the genetic apparatus which is transmitted to successive generations. Toxicologists have long considered that "anything is safe if you go low enough, and anything is toxic if you go high enough". It was considered that by decreasing the dosage of irradiation, a "no effect" level was reached. However, at a Conference on Evaluating Mutagenicity of Drugs and Other Chemicals, Dr. W. L. Russell of the Oak Ridge National Laboratory, Oak Ridge, Tennessee, stated that in his long term inheritance studies on the effects of low doses of irradiation any dose of irradiation, no matter how small resulted in the production of mutations. The relationship between dose and induction of mutations is not known for most environmental chemicals, however, chromosome aberrations have been produced by some pesticides with concentrations of ¼ to 1/24 the recommended dosage.

Concern about potential damage to the human gene pool by environmental chemicals has increased substantially among geneticists in the last ten years. An "Environmental Mutagen Society" was formed in 1969 (for information, write to Dr. M. S. Legator, Cell Biology Branch, Food and Drug Administration, Washington, D.C.), a newsletter is published by the Society (Editor, Dr. F. J. de Serres), and an "Environmental Mutagen Information Center" has been organized at Oak Ridge National Laboratory to accumulate, register and distribute information on all compounds tested for mutagenicity. Recently the "Committee on Genetics as it Relates to Social Problems" of the Genetics Society of Canada established a sub-committee "to study the problems of environmental mutagenesis in its manifold aspects, to evaluate the present state of knowledge and to recommend any means by which study of this urgent topic could be fostered in Canada" (Dr. H. F. Stich, Chairman).

Many classical tests with plants have been providing information on the degree of mutagenicity of chemicals for a number of years, however, practical, sensitive, and relevant methods for detecting and measuring the effects of chemical mutagens in *mammalian* systems are now available (see Book Review section in this issue).

The Food and Drug Directorate does not require tests for mutagenicity of chemicals, but the announcement in June by Dr. R. A. Chapman that "we are now actively considering (genetic) tests and in what manner they may bst be incorporated into our requirements for safety" is certainly considered a welcome step by geneticists.

Since there are already some 45,000 pesticide formulations and 400 food additives, and each year some 2,000 new synthetic chemicals are produced which may come in contact with a large segment of the population, considerable effort by many individuals will be required to adequately screen these chemicals for their mutagenic properties. Greater financial support should be allocated for research and testing programs in order to protect future generations from genetic diseases.

It has been argued that without testing there may be only a moderate increase in the mutation rate in the general population; nevertheless, it should be realized that an increase in the non-productive or hospitalized person may rapidly become a not insignificant economic burden to society. At the present time, 20 percent of all the hospital admissions to children's service are for hereditary defects such as congenital anemia, cystic fibrosis, and mongolism. We know that the increase in population and lengthening of our life-span, which has been brought about partly through the use of new chemicals, improvements in nutrition and mastery of infectious diseases, has made it possible for large segments of the population to live long enough so that the slow accumulation of chemicals, or their interactions become of increasing importance, for example, in the induction of cancer.

A small investment for the screening of possible mutagenic properties of chemicals is a small price to pay for the safeguard of the present and future generations.

WILLIAM F. GRANT
Genetics Laboratory,
Macdonald Campus of
McGill University.

Mailing date of previous issue August 12, 1971
Mailing date of this issue September 7, 1971

Population Ecology of the Great Blue Heron with Special Reference to Western Oregon[1]

CHARLES J HENNY[2] and MICHAEL R. BETHERS

Department of Fisheries and Wildlife, Oregon State University, Corvallis

Abstract. Great Blue Heron (*Ardea herodias*) begin nesting in western Oregon about 1 month earlier than reported from the Philadelphia region and about 2 months earlier than reported from Southern Alberta. The number of young fledged per nesting pair in Oregon was 2.04 in 1970 which was nearly identical to the 1.91 believed necessary to maintain a stable population in the northern United States. The level of p,p'DDE reported from two eggs in Oregon was within the same range as that reported from 40 eggs in Alberta. Although some thin-shelled eggs were being laid in Alberta, the observed production was believed sufficient for maintaining a stable population. Production rates reported from a heronry in central California suggested that the population there was also remaining fairly stable.

Introduction

Many ornithologists have noted declines in various populations of birds during recent years. In discussing the present status of our avian species, Moore (1966), Peterson (1969), and Keith (1969) considered the effects of contamination of food chains by pesticides and made some predictions on the fate of populations based on the food habits of the species. Peterson (1969: 529) noted,

> ". . . the most likely food chains to be contaminated and to affect the top predators would be chains involving birds and fishes. In other words, the bird-eating birds and the fish-eating birds would be most vulnerable. Mammal-eating birds would be less affected . . ."

Henny (in press) reported no increase in post-fledging mortality rates of 16 species of birds, including the Great Blue Heron, during the last 25 years and concluded that observed declines in several of the species were the result of lowered reproductive rates.

Realizing that the diet of the Great Blue Heron consists of approximately 72 percent fish (Palmer, 1962), and that only two "complete" nesting studies had been published (Vermeer, 1969; Pratt, 1970), we conducted a nesting study at a heronry on the Willamette River near Albany, Oregon, during the spring of 1970. The study was designed to determine the number of active nests in the heronry, the number of nests from which young successfully fledged, the number of young fledged per nesting attempt, and the levels of pesticide residues in eggs and chicks.

Methods

All nests in the heronry were located in living trees. Eleven of the trees were Black Cottonwoods (*Populus trichocarpa*) and one was a Big Leaf Maple (*Acer macrophyllum*). The Black Cottonwoods were approximately 120 feet in height and 6 feet dbh. The nests ranged in height from 70 to 110 feet. The 55 nests in the heronry were concentrated in two trees which held 19 nests and 13 nests, respectively. Only nests in the two principal trees were studied.

The trees were first climbed on April 11 or April 16. At these times, the nests were numbered from the highest in the tree to the lowest for future identification on subsequent visits. Each tree was climbed three times during the study with the last climb made on June 17 to determine if any renesting occurred.

Pesticide residue analyses were conducted by the Department of Agricultural Chemistry at Oregon State University. Electron capture gas chromatography was used and confirmed by microcoulometric detection. The index to eggshell thickness was obtained by the formula [Weight (mg.)/Length (mm) $\times$ Breadth (mm)] (Ratcliffe, 1967).

Results

Nesting Phenology

When the nests were first visited (April 11 and April 16), young had hatched from more than half of the nests. In fact, in each tree a nest

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TABLE 1. — Nests that still contained unhatched eggs on April 11 and 16, 1970 when the nests were first visited.

Part of tree nest located in	Number of nests	Percent with unhatched eggs
Upper	8 (1)[1]	12.5
Middle	8 (3)	37.5
Lower	8 (6)	75.0
Total or mean	24 (10)	41.7

[1]Nests with unhatched eggs (in parentheses).

was found with eggs pipping at the time of the first visit. The oldest young were then probably not more than 10 days old.

It was apparent that eggs from nests near the top of the trees had hatched earlier than the eggs from the lower nests (Table 1). Evidently the first birds to nest choose the highest sites in the trees.

Bent (1926) stated that the incubation period was about 28 days. Vermeer (1969) reported a mean incubation period of 26.7 days (range 26-27 days). By backdating the dates of hatching (based on size of young at first visit) in the Willamette Valley of Oregon, we estimated that incubation of the eggs began about March 4. Vermeer (1969) reported that eggs were laid at 2-day intervals; therefore, the first eggs were probably laid in late February. This earliest "egg date" is about 1 month earlier than reported from the Philadelphia region (Miller, 1944) and about 2 months earlier than reported from southern Alberta (Vermeer, 1969). Pratt (1970) reported egg laying began February 21 in Central California.

Nesting Success

Only one nest, which fell from the tree beforefore incubation was completed, did not yield hatched young in this study. Comparable information from other studies was not available, although Miller (1944: 19) reported that, "the commonest number of eggs is 5, and most of them hatch."

Most of the young were "branchers" (able to climb out of the nest onto the tree limbs) and nearly ready to fly by May 2. It is probable that the number of young observed per nest at this date closely represents the number of young fledged per nest. We observed that 78 percent of the pairs were successful and that two or three young usually were produced (Table 2). This is in agreement with Pratt (1970) who found 76 percent and 82 percent of the pairs nesting successfully in two successive years in central California and Miller (1944: 19) who stated, "infant mortality exceeds 40%," and "I have never found a nest with more than 3 young over ⅓ grown, and often there are only 2." The 2.61 fledged per successful nest in this study is very similar to the 2.51 fledged per successful nest (92 nests) in Alberta in 1967 (Vermeer, 1969). Vermeer estimated that between 2.2 and 2.3 young were fledged per nesting attempt in Alberta in 1968 from eleven nests (adjustment made for one egg taken from each nest for pesticide analysis), while we found 2.04 young fledged per nesting attempt in the Willamette Valley from 23 nests (Table 3).

Pratt (1970) reported 1.5 and 1.7 young fledged per breeding pair in central California in two successive years. The percentage of the eggs per nest which successfully yielded fledged young was similar in all three locations (range 44% to 49%); thus, the variation in clutch size (Table 3) appeared to be the major factor influencing the number of young fledged per nest. This, of course, assumes that the clutch size data from each area are comparable. The clutch size data from California and Oregon are known to be comparable as they were collected by the same early "egg collectors." Egg collectors traditionally collected full sets of eggs, likewise, Vermeer (1969) indicated his clutch

TABLE 2. — Fledging success in 23 nests of Great Blue Herons in the Willamette Valley, 1970.

Number of fledglings per active nest	Number of nests
0	5
1	1
2	6
3	10
4	1

Mean no. fledged per active nest 2.04
Mean no. fledged per successful nest 2.61

TABLE 3. — A summary of reproduction parameters for the Great Blue Heron

Location and Latitude	Years	Clutch Size	Percent of nests successful	No. young fledged per successful nest	No. young fledged per nesting pair[1]	Source
Southern Alberta (49° – 55°)	1967–68	5.00 (11)[2]	—	2.51	2.2 to 2.3	Vermeer 1969
Western Oregon (44°)	1970	4.19 (32)[3]	78	2.61	2.04	This paper
Central California (38°)	1967–68	3.66 (41)[4]	76–82	—	1.5 to 1.7	Pratt 1970

[1]Includes pairs which were unsuccessful in their attempt to produce young.
[2]Sample size in parentheses.
[3]From Oregon and Washington (Henny, in press).
[4]From California (Henny, in press).

size data from Alberta were based on an in depth study. It was concluded that the data were comparable. The clutch size of Great Blue Herons decreased from north to south, as did the number of young fledged per nest.

Pesticide Residues

Levels of p,p′DDE in two eggs collected from the same nest near Albany, Oregon in 1970 ranged from 3.3 to 4.5 ppm wet weight (Table 4). A day-old chick found freshly dead in another nest in the same heronry had a p,p′DDE level of 10.1 ppm (whole body). Levels of residue from within eggs of Great Blue Herons collected in Alberta in 1969 by Vermeer and Reynolds (1970) varied considerably in local breeding populations (range 0.7 to 234.4 ppm) (Table 4). It can only be concluded that DDE levels from Oregon fall within the range of the Alberta results. Prestt (1970) reported 7 ppm of p,p′DDE and 4.5 ppm of dieldrin in 25 eggs of Gray Herons (*A. cinerea*) from East Anglia. Prestt's birds were laying thin-shelled eggs, but three-quarters of the pairs eventually fledged young (including production from renests), which he considered good success. The overall nesting success in Oregon was similar, although renesting did not occur.

Species of fish found in the nests at the heronry in Oregon included northern squawfish (*Ptychocheilus oregonensis*), largescale sucker (*Catostomus macrocheilus*), cutthroat trout (*Salmo clarkii*), and white crappie (*Pomoxis annularis*). Henderson, Johnson, and Inglis (1969) reported insecticide residues from fish of these species taken from the Willamette River in 1967 and 1968. Levels of DDT and its metabolites detected in the fish range from 0.29 ppm (white crappie) to 2.65 ppm (largescale sucker). Dieldrin levels ranged from 0.01 ppm (white crappie and largescale sucker) to 0.03 ppm (largescale sucker and northern squawfish).

The same two eggs that were taken on May 2, 1970 for pesticide residue analyses were also measured and weighed to determine egg-

TABLE 4. — Variation of DDE residues in ppm wet weight in samples of Great Blue Heron eggs.

Location	Year	n	Mean	Range	Source
Belly River, Alberta	1969	10	9.95	1.5– 24.0	Vermeer and Reynolds, 1970
Battle River, Alberta	1969	10	5.71	1.4– 13.5	Vermeer and Reynolds, 1970
Jamieson Lake, Alberta	1969	10	6.61	1.0– 31.8	Vermeer and Reynolds, 1970
Chip Lake, Alberta	1969	10	37.01	0.7–234.4	Vermeer and Reynolds, 1970
Albany, Oregon	1970	2	3.90	3.3–4.5	This paper

TABLE 5. — Eggshell thickness data for Great Blue Herons in the Pacific Northwest.

Years	n	Thickness index[2]	Shell Thickness (mm)	Source
pre-1947	130 (64)[1]	2.02±0.02	0.389±0.005	Anderson and Hickey, in press
1956–1959	9 (4)	1.83±0.09	0.390±0.005	Anderson and Hickey, in press
1970	2 (0)	1.98±0.54	No data	This paper

[1]Number in parentheses refers to sample size for shell thickness (mm).
[2]From Ratcliffe (1967).

shell thickness. Embryos in these eggs were nearly ready to hatch. Measurements of the eggs were compared with those reported by Anderson and Hickey (in press) from the Pacific Northwest (Table 5). No significant difference in the eggshell thickness index was detected between this admittedly small sample of two eggs collected and the 130 eggs collected prior to 1947; however, Anderson and Hickey (in press) reported a 9 percent decrease in nine eggs collected between 1956 and 1959 in the same general region (Pacific Northwest). They did not note any change in actual shell thickness (Table 5). Anderson and Hickey (in press) also reported decreases in the eggshell thickness index of 9 percent and 4 percent in Ontario and Utah, respectively. No significant changes were reported from southern California or Florida. Vermeer and Reynolds (1970) reported some Great Blue Herons in Alberta laying thin-shelled eggs and showed a highly significant inverse correlation between shell thickness and DDE residues in the eggs.

Production Requirement for Stable Population

With knowledge of the mortality rate schedule of a population and the age of sexual maturity, the production necessary for maintaining a stable population may be estimated with the aid of a mathematical model (Henny, Overton, and Wight, 1970). Henny (in press) provided mortality rate estimates for Great Blue Herons. These rates were calculated from recoveries of Great Blue Herons banded as nestlings in North America between 1946 and 1965.

Bent (1926: 108) reports that young Great Blue Herons are "ready to breed" after their second winter (2-year-olds), although they do not attain full adult plumage until the following post-nuptual molt. Cottrille and Cottrille (1958) found most of the herons in a colony in Michigan were in full breeding plumage, although some immature birds were present. A. J. Meyerriecks (personal communication) indicated that some 1-year-old birds come to the breeding colonies and may "fool" with nest twigs, etc., but do not breed. Apparently, Great Blue Herons begin breeding as 2-year-olds.

Given the age-specific mortality rates, and assuming that Great Blue Herons begin breeding as 2-year-olds, Henny (in press) estimated that 1.91 young must be fledged per breeding pair to maintain a stable population. A large percentage of the Great Blue Herons in the sample used to estimate the mortality rates were banded in the northern United States (average 43.4° N. latitude). Therefore, the mortality rates probably best reflect the mortality sustained by a population in the northern United States. Mortality rates are known to be higher in the northern United States than in the southern United States for the Barn Owl (*Tyto alba*) (Henny, 1969). Similar geographical variations in the mortality rates of the Great Blue Heron probably occur also, although banding data was insufficient for making separate mortality estimates. The production rate observed in the study area in the northern United States (Oregon latitude 44° N.) was virtually the same as that caluculated necessary for maintaining a stable population.

Conclusions

Based on the current productivity in western Oregon and the production standard necessary for maintaining a stable population, we concluded that the Great Blue Heron numbers were remaining fairly stable, even with the present levels of pesticides in the eggs. In view of the probable geographical variation in mortality rates of the Great Blue Heron, the population in southern Alberta would require a higher production rate than the population in Oregon. Similarly, the population in California would require less young produced per nesting pair. Vermeer (1969) and Vermeer and Reynolds (1970) reported higher recruitment rates in Alberta than we reported from Oregon although residue levels in the eggs were reported within the same range in both areas. The fact that Vermeer and Reynolds (1970) reported finding an egg pipping which contained 78.0 ppm DDE (wet weight) indicates that Great Blue Herons can withstand fairly high levels of DDE. Recruitment in California was lower than Oregon, as was expected. In view of the similarity in the percentage of the eggs in the clutches which yielded fledged young in Oregon, Alberta, and California and, that the difference in the annual recruitment rate between locations was a function of clutch size, it seems reasonable to conclude that all three populations were remaining fairly stable. A similar conclusion was reached by Prestt (1970) for the Gray Heron in Britain. He stated, "Probably because of the mode of intake of the chemicals and its greater breeding adaptability its population numbers have remained unaffected, in contrast to other predators such as the Peregrine Falcon (*Falco peregrinus*)."

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Mercury in Fish and Fish-eating Birds near Sites of Industrial Contamination in Canada[4]

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Abstract. Concentrations of mercury were determined in fish muscle, livers and eggs of fish-eating birds, and bivalve molluscs. Most of the material was collected near sites of industrial contamination: a mercury mine, chlor-alkali plants and pulp mills known to use or have used mercury. Most sites showed substantial mercury contamination, especially downstream from the above sources. Mercury levels exceeding 0.5 ppm were found in practically all samples of freshwater fish. Individual walleye (Lake St. Clair), pumpkinseed (St. Clair River), and lake trout (Pinchi Lake) contained concentrations up to 5.01, 7.09, and 10.50 ppm of mercury respectively. Lower levels were found in marine fishes from coastal waters. A positive correlation was found between body weight and mercury concentration in most fish samples, and also between the trophic feeding level and mercury concentration in both fish and fish-eating birds. The highest mercury level in the livers of fish-eating birds was 17.40 ppm (Red-necked Grebe). Four Common Tern eggs averaged 0.58 ppm and two Red-breasted Merganser eggs averaged 0.81 ppm. The mercury concentrations are discussed in terms of published data on hazard to human health and to reproduction in fish-eating birds.

Résumé. On a déterminé la concentration de mercure dans la chair de poisson, dans le foie et les oeufs des oiseaux piscivores et dans des mollusques bivalves. La plupart des échantillons ont été prélevés près de lieux de pollution industrielle: une mine de mercure, des fabriques de chlore et de soude et des papeteries; ces industries font ou ont déjà fait usage de mercure. On a constaté dans la plupart des cas des traces de contamination par le mercure et notamment en aval de ces usines. La teneur en mercure excédait 0.5 ppm dans pratiquement tous les échantillons de poisson d'eau douce. Chez des dorés (le lac Sainte-Claire), crapets-soleil (la rivière Sainte-Claire) et truites grises (le lac Pinchi) on a trouvé des concentrations individuelles de mercure aussi élevées que 5.01, 7.09 et 10.50 ppm respectivement. Les poissons d'eaux côtières étaient moins contaminés. Dans la plupart des échantillons de poisson, on a constaté un rapport positif entre le poids corporel et la teneur en mercure; un rapport également positif entre le niveau dans la chaîne alimentaire et la teneur en mercure a été observé chez les poissons et aussi chez les oiseaux piscivores. La concentration de mercure la plus grande dans le foie des oiseaux piscivores était 17.40 ppm (Grèbe jougris). Quatre oeufs de Sterne commune et deux oeufs de Bec-scie à poitrine rousse contenaient une moyenne de 0.58 et 0.81 ppm de mercure respectivement. Les concentrations de mercure sont discutées à la lumière de donées publiées sur les dangers que comportent ces concentrations sur la reproduction des oiseaux piscivores et sur la santé humaine.

Introduction

Elevated mercury levels in freshwater fish in Sweden and Finland have been reported by several authors (Johnels *et al.*, 1967; Norén and Westöö, 1967; Westöö 1967a, b; Westöö and Norén, 1967; Häsänen and Sjöblom, 1968; Westöö and Rydälv, 1969). According to Löfroth (1969) about 1% of the total Swedish water areas were inhabited by fish containing more than 1 ppm (part per million) mercury in muscle tissue.

Borg *et al.* (1969), in a comprehensive study on the occurrence of mercury in Swedish wildlife found elevated levels in tissues of a number of fish-eating birds such as gulls (*Larus* spp)., Cranes (*Grus grus*), and White-tailed Eagles (*Haliaeetus albicilla*). They reported residues of 3.5 to 11 ppm in six White-tailed Eagles' eggs from five different nests and suggested that the decline in reproduction of this species could be attributed to mercury poisoning. A corresponding decline in the White-tailed Eagle population in Finland was likewise associated with mercury contamination (Henriksson, Karppanen and Helminen, 1966).

The loss of mercurials used as slimicides in the pulp industry was considered as a major source of mercury contamination of waters in Scandinavia but other industrial mercury discharges, especially those from the chlor-alkali industry, undoubtedly were also important.

In Japan, mercury in effluent from plastics factories resulted in high mercury levels in fish, and consumption of the contaminated fish caused both severe neurological disorders and death in humans (Kurland, Faro, and Siedeler, 1960; Irukayama, 1966).

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[4]An early draft of this paper entitled "Mercury Contamination of Canadian Fish and Fish-eating Birds" was inadvertently published under the senior author's name in the November, 1970 issue of the trade journal *Water and Pollution Control*. The paper has been rewritten and new data inserted. The decision to republish was taken in order to present this evidence to a wider range of the scientific community than that covered by WPC.

Fimreite (1970) has shown that many Canadian industries use and discharge to the environment considerable quantities of mercury. Mercury contamination of many Canadian wildlife species would therefore be expected. Recent studies by Bligh (1970) and Wobeser *et al.* (1970) also revealed severe mercury contamination of fish from the Wabigoon-English River system and the Saskatchewan River respectively, while Sprague and Carson (1970) reported low or moderate mercury concentrations in fish from the Gulf of St. Lawrence.

The present paper reports the mercury content of selected fish and wildlife species from areas where contamination was anticipated, and discusses the results in relation to the effect on these animals and on humans.

Materials and Methods

A total of 156 individual fish, 48 bird livers and 6 bird eggs were analyzed. In addition four analyses were made of three species of bivalve molluscs and three of pooled fish samples. Walleye (*Stizostedion v. vitreum*) was chosen as the chief test species from the Great Lakes as it is a typical predaceous fish and, because of the cumulative properties of mercury, such fish were likely to have high concentrations where contamination occurs. Elsewhere, other species likely to be near the top of the food chain or utilized by fish-eating birds were selected. In most cases, samples were taken in the vicinity of chlor-alkali plants or pulp mills from which mercury was known or believed to have been released. Where possible, samples were collected upstream and downstream from suspected sources. The specimens from Pinchi Lake, B.C., were taken within one and two-thirds km of Cominco's mercury mine, some before and some after the mine was reopened in 1968. Most of the avian material consisted of fish-eating birds. The eggs included were of Red-breasted Merganser (*Mergus serrator*) and Common Tern (*Sterna hirundo*). Specimens from the Great Lakes, the St. Maurice River, Qué., the Baie des Chaleurs, N.B., and some of the Pinchi Lake specimens were collected in the summer and autumn of 1969 and all others during the summer of 1968.

All specimens were frozen shortly after collection, except the Ottawa River and some of the St. Maurice River fish which were stored in formalin.

Samples taken from the lateral musculature of fish, liver of birds, and the homogenized content of eggs and molluscs, were then prepared and freeze-dried by the Ontario Research Foundation and sent for neutron activation analysis to Gulf General Atomic Incorporated, California, where radiochemical separation was done by the method of Sjöstrand (1964). Details of the procedure are given in Fimreite, Fyfe and Keith (1970). Some of the samples from the St. Maurice River were analyzed by L. M. Reynolds, Ontario Research Foundation using flameless atomic absorption spectrophotometry. The two methods were checked against each other with very good agreement ($\pm$ 10%). Values are expressed on a ppm wet (fresh) weight basis.

The common and scientific names of fishes and birds referred to are in accordance with those adopted by the American Fisheries Society (1970) and the American Ornithologists' Union (1957) respectively.

Results

Elevated mercury concentrations were found in all freshwater fish (Table 1). The highest levels occurred in lake trout (*Salvelinus namaycush*) from Pinchi Lake, pumpkinseed (*Lepomis gibbosus*) from the St. Clair River and walleye from Lake St. Clair, with maximum concentrations in muscle of 10.50, 7.09 and 5.01 ppm respectively. Of the 27 fish taken upstream from the chlorine plant on the St. Maurice River, Que., only 12 had levels below 0.5 ppm.

The levels were generally highest in fish collected downstream from suspected sources and t-tests revealed highly significant ($P < 0.01$) differences in mercury content between samples of the same species, Walleye and Sauger (*Stizostedion canadense*), taken upstream and downstream from chlor-alkali plants on the St. Clair and St. Maurice Rivers and a pulp mill on the Ottawa River respectively.

TABLE 1. — Mercury residues in lateral muscle of fish from Canadian inland waters where mercury contamination was suspected

LOCALITY/Species	N	Mercury residues (ppm)		Body weight (grams)		Correlation (r) between body weight and Hg residues in muscle tissue
		$\bar{x}$	Range	$\bar{x}$	Range	
PINCHI LAKE, B.C.						
Salvelinus namaycush (lake trout)	2	5.78	1.07–10.5	1700	1700–1700	
Mylocheilus caurinus (peamouth)	1	0.84		50		
Prosopium williamsoni (mountain whitefish)	4	0.65	0.30–1.50	307	230– 429	0.96*
Salmo gairdnerii (rainbow trout)	4	0.38	0.25–0.68	243	161– 322	0.86
LAKE HURON, ONT., South end						
Stizostedion v. vitreum (walleye)	8	1.08	0.58–2.74	807	725– 984	0.40
ST. CLAIR RIVER, ONT.						
Ambloplites rupestris (rock bass)	6	2.80	0.55–4.64	646	55– 368	0.29
Lepomis gibbosus (pumpkinseed)	3	2.64	0.26–7.09	64	46– 95	−0.55
Morone chrysops (white bass)	1	1.62		75		
Stizostedion v. vitreum (walleye)	6	1.60	0.89–2.43	646	370–1018	0.90*
Esox lucius (northern pike)	1	1.00		2265		
LAKE ST. CLAIR, ONT.						
Stizostedion v. vitreum (walleye)	8	2.88	1.29–5.01	819	363–1928	0.37
LAKE ERIE, ONT., West end,						
Stizostedion v. vitreum (walleye)	8	0.71	0.58–0.90	595	462– 907	0.32
OTTAWA RIVER, ONT., Downstream from pulp mill						
Stizostedion canadense (sauger)	10	1.48	0.47–2.73	144	23–389	0.90**
OTTAWA RIVER, ONT., Upstream from pulp mill						
Stizostedion canadense (sauger)	10	0.72	0.42–1.00	165	117– 217	0.18
ST. MAURICE RIVER, QUE. Downstream from chlorine plant						
Stizostedion v. vitreum (walleye)	4	2.09	1.96–2.15	390	312– 482	0.44
Catostomus catostomus (longnose sucker)	1	0.88		397		
Semotilus corporalis (fallfish)	2	0.84	0.73–0.94	128	114– 142	
Esox lucius (northern pike)	1	0.75		312		
Catostomus commersonii (white sucker)	4	0.73	0.52–0.95	118	4– 454	0.63
Perca flavescens (yellow perch)	4	0.65	0.26–0.82	49	2– 142	0.50
ST. MAURICE RIVER, QUE. Upstream from chlorine plant						
Stizostedion v. vitreum (walleye)	18	0.69	0.48–1.20	487	142–1988	0.50*
Esox lucius (northern pike)	5	0.42	0.30–0.73	494	198–1448	0.86
Perca flavescens (yellow perch)	2	0.20	0.19–0.20	1.5	1–2	
Culaea inconstans (brook stickleback)	2	0.19	0.19–0.20	1	1–1	

*Significant correlation ($P < 0.05$).
**Significant correlation ($P < 0.01$).

Many of the marine fish sampled (Table 2) had lower levels than the fresh-water fish. On the Atlantic coast mean levels ranged from 0.04 ppm in Atlantic herring (*Clupea h. harengus*) to 1.10 ppm in winter flounder (*Pseudopleuronectes americanus*).

On the Pacific coast, specimens of copper rockfish (*Sebastes caurinus*) and lingcod (*Ophiodon elongatus*) from Port Alberni contained somewhat more mercury than did those from Nanaimo, both collection sites being near pulp mills which either did use mercury for slime control (Port Alberni) or had discontinued such use two years previously (Nanaimo). Single specimens of copper rockfish and lingcod from Horsehoe Bay, with no known mercury source in the vicinity, contained 0.18 and 0.08 ppm of mercury respectively.

All species samples, except one, showed a positive correlation between mercury level and weight, indicating that larger fish contained relatively more mercury per unit weight than did smaller fish (Tables 1, 2). The exceptional sample, three pumpkinseed fish, showed a negative correlation between weight and mercury level because one of the smaller specimens had a very high level of mercury (7.09 ppm).

We took four invertebrate samples from New Brunswick, each a composite of 10 animals. Soft-shelled clams (*Mya arenaria*) taken 3 km below a mercurial slimicide-using pulp mill at Bathurst contained 0.93 ppm mercury. In contrast we found levels of only 0.08 ppm in fresh-water clams (*Margaritifera margaritifera*) taken from the same river at a point above the reach of the tide 15 km upstream from the mill. Soft-shelled clams collected in an area just below the chlor-alkali plant at Dalhousie contained 3.59 ppm mercury; edible mussels (*Mytilus edulis*) collected about 11 km to the south-east contained only 0.11 ppm.

The mercury levels in birds (Table 3) were highest in the Red-necked Grebes (*Podiceps grisegena*) from Pinchi Lake where one specimen contained 17.40 ppm in the liver. Lower, but still considerable levels were found in Pelagic Cormorants (*Phalacrocorax pelagicus*) from Nanaimo, Marbled Murrelets (*Brachyramphus marmoratum*) from Horseshoe Bay, Double-crested Cormorants (*Phalacrocorax auritus*), a Great Blue Heron (*Ardea herodias*), and Common Terns from Bathurst, and in Double-crested Cormorants from Dalhousie. Gulls of three species from the three collection sites in British Columbia carried rather low mercury concentrations. Eggs of the Common Tern and Red-breasted Merganser, also from the Bathhurst area, contained an average of 0.58 and 0.81 ppm mercury respectively.

Specimens of four bird species with different feeding habits collected at one site suggested that a positive correlation between mercury concentration and the proportion of animal food in the diet may exist (Table 4).

TABLE 2. — Mercury residues in lateral muscle of fish from some Canadian coastal waters

LOCALITY/species	N	Mercury residues (ppm)		Body weight (grams)		Correlation (r) between body weight and Hg residues in muscle tissue
		$\bar{x}$	Range	$\bar{x}$	Range	
PORT ALBERNI, B.C.						
Sebastes caurinus (copper rockfish)	4	0.60	0.07–1.13	636	332–870	0.93
Ophiodon elongatus (lingcod)	2	0.26	0.24–0.27	823	789–857	
NANAIMO, B.C.						
Sebastes caurinus (copper rockfish)	4	0.37	0.26–0.48	1130	765–1656	0.48
Ophiodon elongatus (lingcod)	1	0.08		871		
HORSESHOE BAY, B.C.						
Sebastes caurinus (copper rockfish)	1	0.18		353		
Ophiodon elongatus (lingcod)	1	0.08		610		
BAIE DES CHALEURS (Bathurst, N.B.)						
Pseudopleuronectes americanus (winter flounder)	2*	1.10	0.86–1.33	215		
Anguilla rostrata (American eel)	4	0.32	0.28–0.38	205	129–324	0.41
Microgadus tomcod (Atlantic tomcod)	1*	0.18		100		
Alosa pseudoharengus (alewife)	2*	0.10	0.10–0.10	81		
BAIE DES CHALEURS (Dalhousie, N.B.)						
Clupea h. harengus (Atlantic herring)	4	0.04	0.03–0.06	236	186–288	0.89

**P. americanus* and A. *pseudoharengus* – two analyses of two pooled samples each containing four fish. M. *tomcod* – one analysis of a pooled sample of four fish.

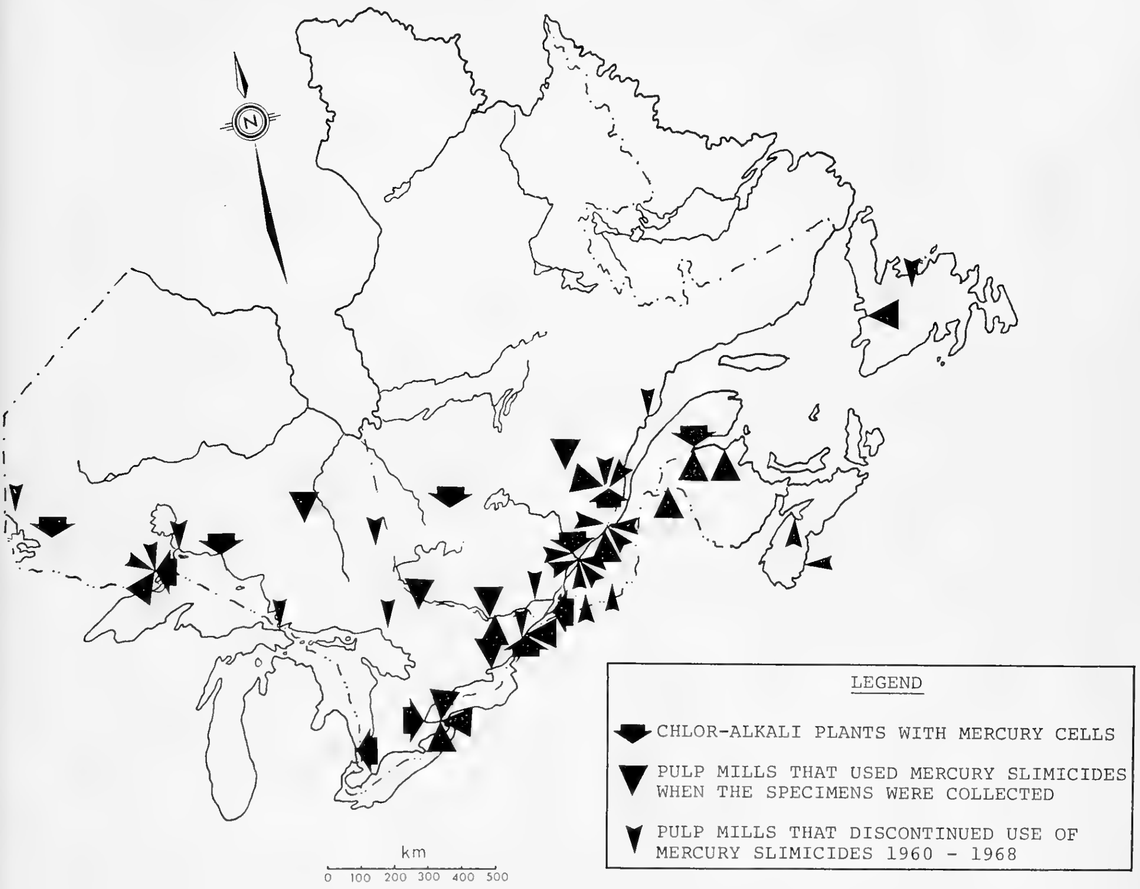

FIGURE 1. Distribution of important sources of mercury contamination of water in Canada's eastern provinces.

The locations of possible sources of aquatic mercury pollution in Canada are shown in Figures 1 and 2.

Discussion

Data in this study are representative only for areas near sources of mercury contamination; uncontaminated areas were not sampled because of financial limitations. Our results indicate serious contamination in several waterways in Canada, especially in the Lake St. Clair area and Pinchi Lake. Some coastal waters also seem to be contaminated, in particular, the Baie des Chaleurs, where the contamination is best reflected in fish-eating birds such as cormorants, herons, terns, and mergansers, and predaceous fish such as winter flounders.

A chlor-alkali plant in Sarnia is thought to be largely responsible for the high levels shown in this study in Lake St. Clair and the St. Clair River, as the levels in walleye there are significantly higher than in specimens from above this plant in Lake Huron. Fish taken downstream from the chlor-alkali plant on the St. Maurice River also had significantly higher mercury levels than did fish collected upstream from the plant. The high levels in sauger downstream from a pulp mill in Ottawa presumably can be traced back to the use of mercury slimicides in that mill as the specimens collected downstream from the mill contained significantly more mercury than those taken upstream from it. That chlor-alkali plants may be responsible for mercury contamination is support-

TABLE 3. — Mercury residues in birds predominantly from areas where mercury contamination was suspected*.

LOCALITY/Species	N	Mercury residues (ppm)	
		$\bar{x}$	Range
INLAND WATERS			
PINCHI LAKE, B.C.			
Podiceps grisegena (Red-necked Grebe)	3	10.32	0.45–17.40
OTTAWA RIVER (Baie Noire)			
Megaceryle alcyon (Belted Kingfisher)	1	0.94	
Bucephala clangula (Common Goldeneye)	1	0.63	
Anas rubripes (Black Duck)	5	0.38	0.02– 0.77
Aix sponsa (Wood Duck)	3	0.16	0.10– 0.21
COASTAL WATERS			
PORT ALBERNI, B.C.			
Larus glaucescens (Glaucous-winged Gull)	3	0.39	0.09– 0.65
Brachyramphus marmoratum (Marbled Murrelet)	3	0.38	0.33– 0.46
NANAIMO, B.C.			
Phalacrocorax pelagicus (Pelagic Cormorant)	5	2.06	1.22– 3.68
Larus occidentalis (Western Gull)	3	0.25	0.12– 0.37
Larus glaucescens (Glaucous-winged Gull)	1	0.10	
HORSESHOE BAY, B.C.			
Brachyramphus marmoratum (Marbled Murrelet)	3	2.23	0.19– 4.90
Larus glaucescens (Glaucous-winged Gull)	4	0.51	0.24– 0.80
Larus philadelphia (Bonaparte's Gull)	4	0.19	0.10– 0.28
BAIE DES CHALEURS (Bathurst, N.B.)			
Phalacrocorax auritus (Double-crested Cormorant)	1	11.30	
***Ardea herodias* (Great Blue Heron)	1	4.53	
Sterna hirundo (Common Tern)	4	2.50	2.28– 2.70
****Mergus serrator* (Red-breasted Merganser)	2	0.81	0.45– 1.17
****Sterna hirundo* (Common Tern)	4	0.58	0.18– 1.42
BAIE DES CHALEURS (Dalhousie, N.B.)			
***Phalacrocorax auritus* (Double-crested Cormorant)	3	3.51	3.08– 4.01

*Liver of adult birds analyzed if not otherwise stated.
**Immatures.
***Eggs.

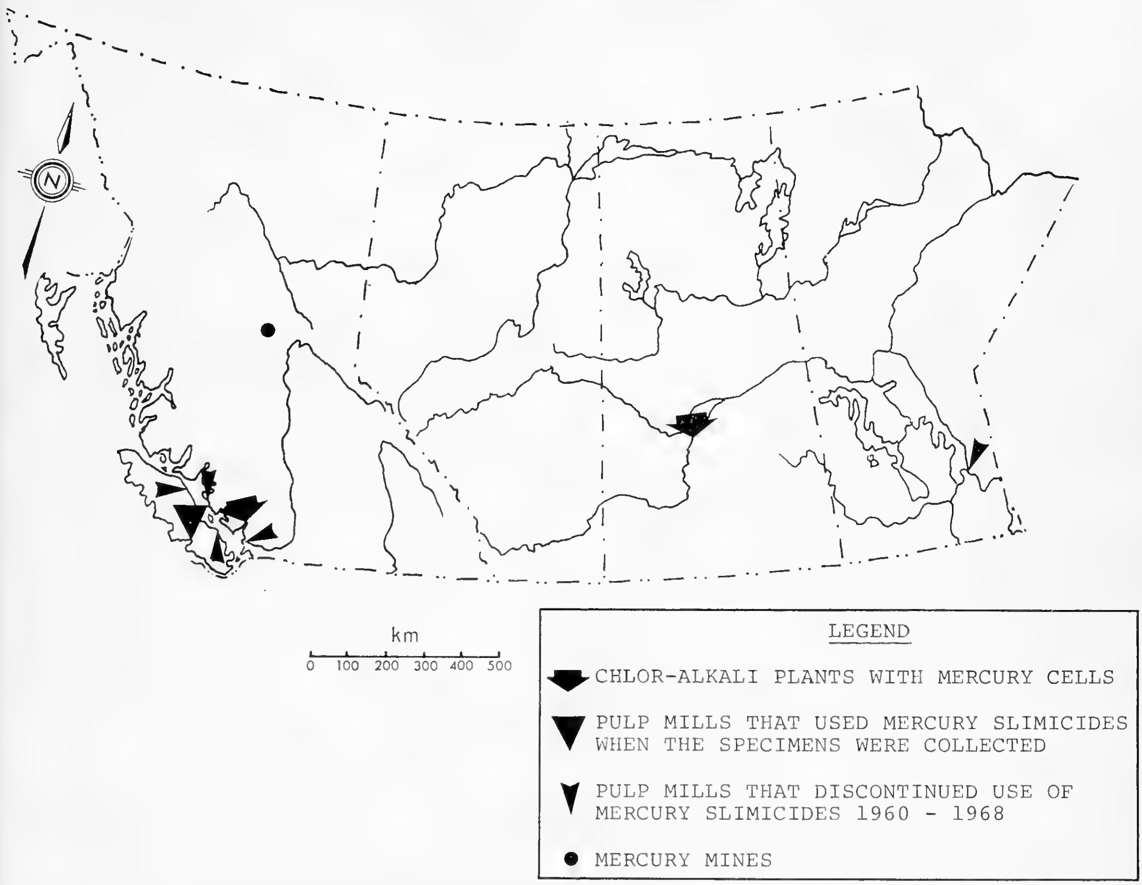

FIGURE 2. Distribution of important sources of mercury contamination of water in Canada's western provinces.

ed by the recent work of Bligh (1970) and Wobeser *et al.* (1970).

Sprague and Carson (1970) investigated marine fish from the Gulf of St. Lawrence and found only moderate or low mercury levels, the most elevated (0.40 ppm) being in cod (*Gadus morhua*). Even in a remote area such as La Verendrye Provincial Park in Quebec, elevated mercury levels (1.40 ppm) have been found in pike (*Esox lucius*) (J. A. Keith and L. M. Reynolds, unpublished data). This may be due to air-borne pollutants, or to extraordinarily high natural background levels. Swedish studies suggest that levels below 0.2 ppm in fish muscle indicate natural contamination (Löfroth, 1969).

Since birds and fish collected before the mercury mine at Pinchi Lake reopened in 1968 also contained abnormally high mercury concentrations, we suggest that mercury or cinnabar tailings released during mining operations nearly 25 years ago are still an important source of contamination. Previous use of mercury slimicides may be responsible for the elevated mercury levels in copper rockfish and Pelagic Cormorants from British Columbia, as some of these specimens were taken in the vicinity of a pulp mill that discontinued use of mercury slimicides less than 10 years ago (Figure 2, Table 2).

Löfroth (1969), on the basis of data collected in Sweden, suggests that contamination may last for 10 to 100 years unless the mercury is somehow made biologically inactive. High background levels could also be expected in British Columbia where elevated mercury levels in soils and plants have been reported from several

TABLE 4. — Relationship between mercury levels in liver of four species of birds collected at Baie Noire, Ottawa River, and the percentage of animal food in their diet.

Species	N	Mean mercury levels in liver (ppm)	Animal food in diet (%)*
Megaceryle alcyon (Belted Kingfisher)	1	0.94	100
Bucephala clangula (Common Goldeneye)	1	0.63	74
Anas rubripes (Black Duck)	5	0.38	24
Aix sponsa (Wood Duck)	3	0.16	10

*Kortright (1942).

areas of cinnabar occurrence (Warren, Delavault and Barakso, 1966). Recent investigations (L. J. Nicholson, personal communication) however, do not indicate that such cinnabar occurrences are necessarily reflected by high mercury levels in fish. A large number of lake trout and mountain whitefish (*Prosopium williamsoni*) collected upstream from Pinchi Lake but still in the Pinchi fault zone where cinnabar occurs as well, contained an average of 0.57 and 0.11 ppm of mercury respectively while the corresponding figures for Pinchi Lake specimens were 2.62 and 0.76 ppm. The difference is highly significant ($P < 0.01$) for both species. We found wide variation in mercury concentration to be common both within and among species, and even among specimens from the same site. Similar variation has been demonstrated experimentally by Hannerz (1967) in fish exposed to identical amounts of mercury.

When comparing mercury levels in fish, both body weight and trophic level of the fish should be taken into account. Johnels *et al.* (1967) found a positive correlation between weight and mercury concentration in muscle, and we have shown that same relationship with almost all of our samples. Seasonal fluctuations in mercury levels, dependent on the rates of food intake and metabolism of the fish, may also occur. This has been demonstrated experimentally by Hasselrot (1967) who exposed salmon to mercury-contaminated water and recorded higher figures in the summer investigations than during corresponding exposure in the winter. Accumulation of mercury through the food chain is indicated by our finding the highest levels in species at the higher trophic levels. The pelagic, planktivorous and wide-ranging Atlantic herring appeared to be little affected by mercury pollution, having residue levels of 0.06 ppm or less. The predaceous American eel and winter flounder had higher levels, as well as the piscivorous copper rockfish. The flounder and rockfish, however, are also very stationary, and so have had more consistent exposure to the nearby mercury sources than the herring. Furthermore, in four bird species taken from a single area, we demonstrated a positive relationship between mercury in the bird livers and the proportion of animal food in the diet.

Levels found in Canadian fish-eating birds are comparable to those from Sweden (Borg *et al.*, 1969) if birds found dead are excluded from their data. The very high levels of mercury in Finnish White-tailed Eagles reported by Henriksson, Karppanen and Helminen (1966) refer only to specimens found dead, presumably poisoned by mercury.

In Sweden, about 90% of the mercury in fish is in the methyl form (Norén and Westöö, 1967; Westöö and Norén, 1967). Confirmation that the mercury in walleye from Lakes Huron, St. Clair, and Erie is also mainly in the methyl form has been received from the Department of Public Health, Stockholm, Sweden, where five of our specimens were analyzed. On the average 96% of the mercury was in the methylated form (G. Westöö, personal communication). Although mercury is released into the environment in several organomercury compounds, and even in the metallic or inorganic form, conversion to the methyl form frequently occurs as a result of bacterial action (Jensen and Jernelöv, 1967, 1969; Wood, Kennedy, and Rosen, 1968).

Little is known about the toxicity of methyl mercury to fish. Experimental work with ethyl mercury phosphate, phenyl mercury acetate and mercuric chloride indicates that mercury in these forms is toxic to fish at relatively low doses (Boëtius, 1960; Amend, Yasutake and Morgan, 1969). However, these authors did not report the muscle concentrations associated with toxic action. Symptoms of poisoning associated with degeneration of nerve cells in different parts of the brain were reported in methyl mercury-contaminated fish from Japan (Kurland *et al.*, 1960). Miettinen *et al.* (1969) reported severe damage to liver, kidneys and gills in pike exposed experimentally to methyl mercury, and that the lethal dose was 20-25 mg/kg fresh weight when administered orally with intervals of a few days between doses. In Japan, M. Berlin, C. Ramel and A. Swensson (unpublished data) concluded that severly poisoned or dead fish (*Hemibarbus* spp) carried more than 20 ppm of mercury. The levels found in the present study are probably well below lethal limits, but no conclusions can be drawn as to the potential sublethal effect.

With regard to fish-eating birds, Red-necked Grebes from Pinchi Lake have accumulated very high concentrations of up to 17.4 ppm in the liver. This is close to the level that Fimreite and Karstad (1971) found to be lethal in Red-tailed Hawks (*Buteo jamaicensis*). Sublethal levels almost certainly affect the reproductive capacity of wild birds. Under experimental conditions, pheasants' eggs containing 0.5 to 1.5 ppm of mercury had significantly lower hatchability than controls (Fimreite, 1971). As the mercury content of tern and merganser eggs from the Baie des Chaleurs averaged 0.66 ppm, it is not unlikely that the reproduction of these wild birds is being affected, but possible interspecific differences must be taken into account.

If contaminated fish are consumed regularly, harmful effects on humans must be considered. On the basis of data collected in Niigata, Japan, Birke *et al.* (1967) concluded that daily consumption of fish containing 5 to 6 ppm of mercury might be lethal. The highest levels of mercury in fish from the St. Clair River, Lake St. Clair, and Pinchi Lake are therefore in the range where prolonged daily consumption could be lethal.

Mercury in fish in the methyl form may produce serious effects. Its affinity for the nervous system may lead to destruction of brain cells with subsequent neurological disorders (Hook, Lundgren and Swensson, 1954; Kurland *et al.*, 1960; Irukayama, 1966). Furthermore, methylmercury acts as a mitotic disturbing agent (Ramel, 1969), and the ease with which it penetrates the placental barrier may lead to accumulation in the unborn child (Tejning, 1968), which in turn may result in congenital neurological disorders even when the mother appears unaffected (Kurland, Faro and Siedler, 1960; Irukayama, 1966).

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A Technique for the Capture of Caribou, *Rangifer tarandus*, in Winter

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Abstract. A new technique for the capture of caribou in winter was developed in Northern Quebec, by the authors. Basically, the method consists of locating herds of caribou in the vicinity of large lakes that are used as loafing areas. Nets are set upright, across trails linking the lake to the surrounding forest. With the aid of two light aircraft, the caribou are then driven towards the nets where they become entangled. Eighty-seven caribou were caught during the experimental phase of this project. Once the technique had been perfected an average of eight caribou were captured per drive.

Introduction

As part of a caribou restoration programme in Laurentide Park, Quebec (DesMeules, 1968), it was necessary to capture and transport approximately 50 caribou.

It was felt that a new approach had to be developed since no method of capturing caribou in winter other than pursuing individual animals and immobilizing them with darting equipment was known to us. In view of the large number of animals required, this method was too time-consuming and costly to be adopted.

In late winter and early spring, caribou in Northern Quebec are concentrated in sizeable herds (50-150), using lakes as loafing and escape "cover", and the adjoining forest as feeding grounds. Well established trails link these areas together (Figures 1 and 2).

The technique described herein takes advantage of both of these types of caribou behaviour.

Date and Location of Experiment

The technique was tried in March 1965, in the Lake Chakonipau area (56°29'N-68°35'W) and perfected in March 1966 at Lake Raimbault (53°19'N-68°25'W) and in March 1967 at Lake Dolbel (55°33'N-65°05'W). The forests surrounding these lakes belong to the North-eastern Transition Section of the Boreal Forest Region (Rowe, 1959). An idea of the forest density in those areas can be obtained from Figure 4.

Method

Briefly, the method involves the following steps:

(1) locating a herd of caribou on or near a large lake where well-beaten caribou trails link the lake to the surrounding forest;
(2) installing nets across these trails;
(3) driving the herd with two aircraft so as to force them into the nets (where several caribou will become entangled);
(4) freeing the caribou from the nets, fettering and releasing them into a pen erected nearby to wait final transport.

Characteristics of the capture site

In selecting the capture site several criteria must be considered:

a) The lake must be large enough to allow ski-equipped aircraft to land, and to take off with a load of animals.

b) The ice thickness and snow conditions must be investigated. The requisites are determined by the type of aircraft involved. The lake should be devoid of slush and of high snow drifts. The latter will prevent the use of aircraft for driving the caribou at an appropriate speed, after landing.

c) Trails linking the lake to the forest at deep and narrow bays are ideal sites for the location of the nets since the caribou are reluctant to leave the hard packed snow of the lake to enter in the soft snow of the forest, the forested shores of the bay act as wings, funnelling the animals towards the nets.

d) The forest bordering the lake must be dense enough to conceal the set-up from the view of the approaching caribou.

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FIGURE 1. A fairly large lake showing Caribou scattered over its surface.

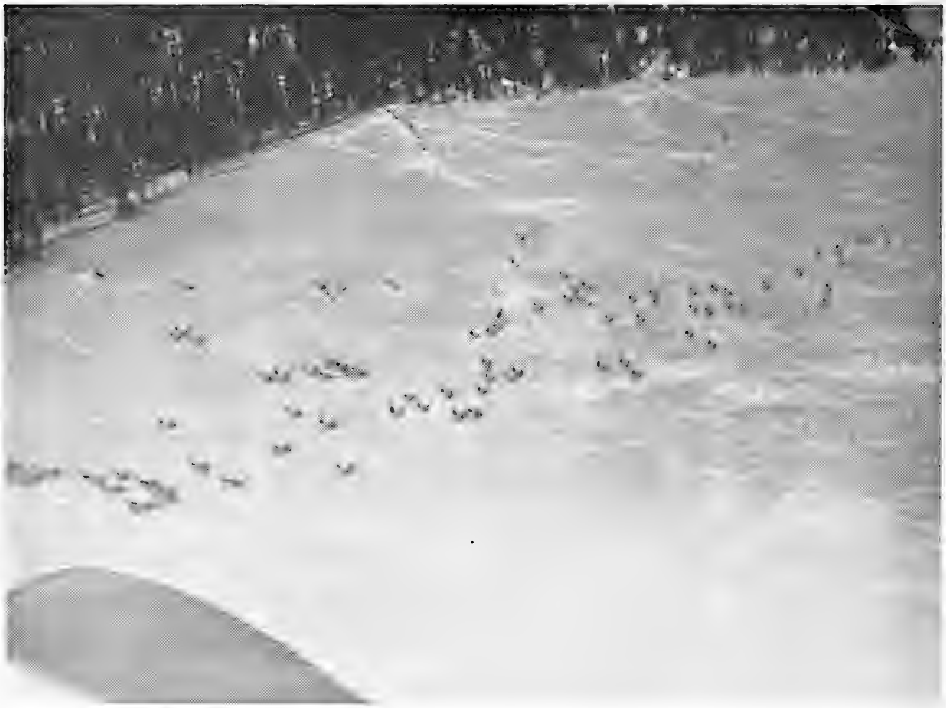

FIGURE 2. Well established Caribou trails linking the lake to the forest.

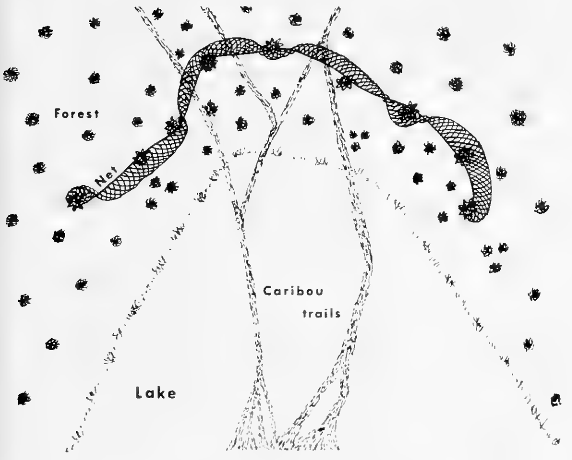

Figure 3. Sketch showing the U-shaped vertical net setting.

e) The set-up should be located downwind (considering dominant wind.) A strong wind has always proven advantageous.

Characteristics of the herds

Because most caribou get entangled in the nets by their antlers (Figure 8), it is important that the herd selected for capture be made up predominantly of antlered animals. In March and April, most adult stages have shed their antlers and are found in segregated, "bachelor", herds. The herds of predominantly antlered animals are made up of adult does, and young stags. Such herds are easily caught and ideally suited to provide stock for introduction purposes.

Large lakes with many herds of caribou in their vicinity are preferred, because several capture attempts can be made without moving the installations. Often the same herd can be driven more than once toward the same setting.

Description of the nets and of their installation

Several types of netting were used, either singly or in combination; a) cotton or nylon "salmon nets", 10 feet high by 100 feet long, with 4-inch mesh, and b) cotton "seal nets" (twine ⅛"), 20 feet high by 100 feet long, with 10-inch mesh.

Between 300 and 400 feet of netting were used in a single installation. The nets were set in a U-shaped fashion, hooked upright on broken tree tops or branch stubs within the forest, some 50 to 100 feet from the shore (Figures 3 and 7). The bottom of the net was spread either inward or outward on the surface of the snow. On certain occasions leg and/or body snares were placed in front of the nets.

Leg snares were laid flat on the surface of the snow, with a noose diameter of 18-24 inches. Body snares were set 18 inches from the ground across trails. The diameter of the noose varied from 36-48 inches. Both types of snares (½ inch hempen or tergal ropes) were fastened to trees.

In addition to this type of installation, capture attempts were made with nets laid flat on the snow surface, and with corrals made of wood or netting.

Drive

Two light, ski-equipped aircraft were used to herd and drive the caribou. In the course of the project, the following combinations of airplanes were used: a) two Cessna 180/s, b) one Dornier 128-B and one Norseman, c) one Dornier 128-B and one piston driven de Havilland (Beaver), d) one Dornier 128-B and one Cessna 180.

The aircraft took off from the lake after the nets and snares were set up and by circling above the scattered caribou herded them into a tight group. Then by making low passes directly behind the band they began to drive them toward the nets (Figure 4). During this portion of the drive it was important that the aircraft stay behind the band; should they pass directly overhead the animals will scatter, thus hampering the success of the operation. Once the band was well on its way and had come within a few miles of the set, both aircraft landed behind the herd and continued to drive them by taxiing on the lake (Figure 5). It was found that caribou could be driven best when the aircraft remained at a reasonable distance (a few hundred feet behind the animals and at a speed which kept the band moving at a slow trot). This position and speed enabled the aircraft to

Table 1. — Summary of all caribou capture attempts, Northern Quebec, 1965–1967

Location of Drive	Date	Site	Drive number	Number of animals: in herd	caught in nets	caught in snares	Total captured	No. of animals captured in nets: adult stags	adult does
Lac Effiat (56°00′N–66°30′W)	3/13/65	A	1	28	0	—	0	—	—
,,	,,	A	2	28	1	—	0	0	0
,,	,,	A	3	1	1	—	1	0	1
Lac Chakonipau (56°20′N–68°35′W)	3/15/65	B	4	100	4	—	2	1	1
,,	3/18/65	C	5	50	0	—	0	0	0
,,	,,	C	6	25	4	1	3	1	1
,,	3/20/65	D	7	15	—	1	1	0	0
,,	,,	E	8	3	0	0	0	—	—
,,	3/21/65	F	9	18	0	—	0	—	—
,,	,,	F	10	12	0	0	0	—	—
,,	3/21/65	F	11	7	0	0	0	—	—
,,	,,	G	12	4	0	—	0	—	—
,,	,,	H	13	100	5	—	3	—	—
Lac Opiskotéo (53°10′N–68°10′W)	3/13/66	(A)	1	100	0	—	0	—	—
Lac Raimbault (53°10′N–68°25′W)	3/15/66	(B)	2	75	5	—	4	1	4
,,	,,	(B)	3	4	0	—	0	—	—
,,	,,	(B)	4	80	9	5	14	2	6[1]
Lac Dolbel (55°33′N–65°05′W)	3/9/67	a	1	50	0	—	0	—	—
,,	3/10/67	b	2	100	4	—	4	0	4[1]
,,	3/11/67	b	3	75	0	—	0	—	—
,,	,,	b	4	75	1	1	2	0	1
,,	3/12/67	b	5	75	9	4	13	1	8
,,	3/15/67	b	6	N.A.	1	0	1	0	1
,,	,,	b	7	N.A.	0	1	1	0	0
,,	,,	b	8	N.A.	1	0	1	0	1
,,	3/16/67	c	9	N.A.	5	3	8	2	3
,,	,,	c	10	N.A.	2	0	2	0	2
,,	3/17/67	c	11	N.A.	6	0	6	2	4
,,	,,	c	12	N.A.	2	0	2	0	2
Lac Rosée (55°32′N–65°02′W)	3/24/67	d	13	75	0	0	0	—	—
Lac Go (55°28′N–65°05′W)	3/25/67	e	14	50	6	0	6	2	4
,,	3/26/67	e	15	50	9	0	9	0	9*
,,	3/27/67	e	16	15	4	0	4	2	2
Total		15	33	—	79	16	87	14	57

[1]one antlerless doe in each case.

be most efficient for directing the band's movements and for intercepting any individuals that strayed from the band. It was our experience that very small bands (less than 10 animals) were more difficult to drive than larger bands. Once the animals were within a thousand feet of the set, the pilots applied full throttle and drove the band at a gallop as near to the set as was feasible for the aircraft.

Four to six men concealed themselves at the tips of the net wings until the majority of the band was well within the wings. They then raced in behind the band, in order to retain the animals within the set and to force them into the nets.

When heavy snow drifts were present on the lakes, it became impossible for the aircraft to taxi behind the caribou. Under such circum-

Figute 4. Dornier-128B making a low pass behind a herd at the beginning of a drive.

stances, the aircraft had to remain in the air at all times and direct the drive from the air until the caribou were within the set and in such a position where they could be stampeded towards the nets by the members of the ground-crew.

Fettering

After the drive, the entangled caribou were fettered with ½″ tergal rope as rapidly as possible. In the first year of the operation, caribou entangled in the nets were drugged with succinyl-choline, injected with the aid of Cap-Chur equipment, before being tied. In subsequent years, drugging was found unnecessary as the crew became more experienced in manipulating caribou. Fettering was achieved by two members of the crew after they had thrown and held the animal down, (Figures 9 and 10). Each bound animal was then moved by sled to a nearby holding pen where it was released to await transport to final destination.

Figure 5. Two Cesna-180s taxiing behind the band toward the set.

FIGURE 6. Final stage of the airplane drive.

Results

Thirty-three drives were made during the three capture periods, resulting in 87 captures[2] (Table 1). Of these, eleven drives were made from the air only and resulted in the capture of 19 caribou, twenty-one drives were made using the air-ground technique and 60 caribou were captured, one drive was made with one aircraft in the air and one oversnow vehicle on the lake. This resulted in the capture of 8 animals.

Only four out of the 87 animals (4.5%) captured were antlerless (Table 1).

Table 2 shows the relative efficiency of the methods when all three methods of driving were used under similar conditions. Air ground drives yielded far better results than air drives. The number of caribou captured with the various types of setting are indicated in Table 3. Nets set vertically were the only ones in which animals remained entangled. Foot snares placed before the nets improved the catch by 20 to 25%. Several animals were caught in body snares but injuries (bruises, contusions and broken bones) suffered by these animals led us to abandon this practice.

In two attempts to capture caribou in a net corral (drive 7, and drive 13, 1965), we were successful in catching the entire herd of 15 in the first instance and about 25 out of 100 in the second instance. However, in both cases the

[2]Animals which were injured or which escaped, were not considered as captured, but only as caught.

FIGURE 7. Caribou entering the set.

Figure 8.
Entangled Caribou.

caribou broke through the corral and escaped shortly after being captured.

Table 4 shows the number of caribou captured using the most successful technique (air-ground drive and vertical nets) under favorable wind and snow conditions.

In order to give an idea of the time required to complete all phases involved in one capture operation, reference is made to drive number 9, site c, 1967 (Table 1) during which 8 animals were captured. Six experienced men participated in the ground operations. The erection of the nets and the installation of the snares required approximately one hour; the drive took 15 minutes; tying up the animals, transporting them to and releasing them in the corral was achieved in 30 minutes. Therefore a total of one hour and 45 minutes were required to complete this particular operation.

Discussion and Conclusion

The method described above resulted in the capture of 4 to 14 caribou per attempt, with an average catch of eight animals. Unless more than six men are on hand, no more than 12 to 15 animals should be captured at one time. Otherwise, additional animals would have to stand unattended too long thus increasing the chances of escape, exhaustion or injuries.

Figure 9. Two members of the crew throwing a Caribou before fettering it.

FIGURE 10. One man holding the Caribou down while the other fetters it.

Table 2. — Number of caribou captures yielded by varoius types of drives, Northern Quebec, March 1967.

Type of drive	No. of Drives	No. of caribou captured	Av. no. of caribou captured per drive
Air only	11	19	1.7
Air-ground (aircraft)	4	32	8
Air-ground (aircraft & over-snow vehicle)	1	8	(8)

Table 3. — Comparison between the number of caribou captured by various types of set, Northern Quebec, 1965–1967.

	No. of attempts	Total No. of caribou captured	Av. no. of caribou captured per attempt
Horiz. net (layed flat on the snow surface)	2	0	0
Vertical net	27	71	2.6
Wooden corral	7	0	0
Snares in front of net	22	16	0.7
Net corral	2	40	20*

*All escaped shortly after capture.

The most frequent reasons for failure of a capture attempt were:

1) improper direction of the wind; Site F, drive 9, 10, 11.
2) improper concealment of the set (or) of the attendants, or both; Site b, drive 3.
3) improper location of the set: too far away from the shore of the lake; Site (A), drive 1.
4) too few animals in the herd; Site (B) drive 3, Site (E) drive 8.

Animals can be driven more than once towards one set. However, trampling and subsequent hardening of the snow brought about by

Table 4. — Number of caribou caught per air-ground drive under favorable conditions, Northern Quebec, 1965–1967.

Site	Drive	Number of caribou in herd	No. of caribou caught		
			in nets	in snares	Total
H	13	100	5	—	5
(B)	2	75	5	—	5
(B)	4	80	9	5	14
b	5	75	9	4	13
e	14	50	6	0	6
e	15	50	9	0	9
e	16	15	4	0	4
Av./drive		60–65	6.7	1.8	8.0

the repetitive use of a site will decrease the success because improved footing on the hardened surface allows the animals to struggle more efficiently which increases their chances of escape. In addition, such snow conditions greatly hamper the handling and fettering operation and also decrease the efficiency of the foot snares placed before the set.

"Trap-shyness" developed very slowly in the caribou and cannot be termed important because the site condition usually became deteriorated before shyness appeared.

As previously indicated, several types of nets were used. Cotton salmon nets did not prove resistant enough as they could not be used for more than a few capture attempts. Nylon salmon nets, although more resistant, were found to cause skin injuries. Moreover, caribou caught in this type of netting became severely entangled and consequently were more difficult to free .Cotton seal nets proved more suitable since they were highly resistant, easier to erect and dismantle, did not tend to tangle when manipulated and they inflicted less injury to the enmeshed caribou.

Although emphasis was placed on the capture of animals for translocation purposes, the technique was found to be very well adapted for the capture of caribou for tagging purposes in forested areas. In this case, since no time was involved in fettering and transporting the animals, more animals were handled both per capture and per day.

Although we failed to capture caribou in wooden corrals, we are convinced that this could be achieved provided that the corral is properly located and concealed. The number of animals captured in the net coral, in our two attempts (Table 3), strongly indicates that such an approach could yield high results if an escape proof net corral could be designed.

Acknowledgements

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Changes in Carrying Capacity of Deer Range in Western Nova Scotia

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Abstract. Comparison of proportional changes in land classes from two forest inventories between 1910 and 1956 suggest that the yield of browse in western Nova Scotia dropped a minimum of 30 per cent. Selective feeding by white-tailed deer (*Odocoileus virginianus*) has further reduced the availability of desirable deer food plants. Decreases in the volume of mast-producing hardwoods, lowered agricultural acreage and poorer range balance also adversely affected the carrying capacity of the habitat for deer.

White-tailed deer were introduced into western Nova Scotia shortly after 1890 (Dodds 1963: 6), when the only native browsing mammals were moose (*Alces alces*) and snowshoe hare (*Lepus americanus*). Within 30 years deer inhabited the entire region (consisting of the counties of Kings, Lunenburg, Annapolis, Queens, Shelburne, Yarmouth and Digby and numbers increased until about 1945 despite annual hunting kills of approximately 1.8 animals per square mile (Dodds 1963: 8). The der population appears then to have remained reasonably stable until 1955.

Deep, long-lasting snow covers have been reported to be an important cause of deer mortality (Severinghaus 1947: 220). Snow conditions were abnormally severe in the winter of 1956-57. Snowfalls of 165.6 and 107.8 inches were recorded at Greenwood and Liverpool respectively in western Nova Scotia, compared to 10-year means of 90.9 and 58.8 (Thomas 1957: 19). Abnormal snow depths probably contributed to the heavy winter mortality of deer reported by Dodds (1963: 16). The harvest dropped from 2.0 per square mile in 1955 to 1.6 in 1956. The decline in harvest continued until the early 1960's (Dodds 1963: 9). The deer population has since increased somewhat but has remained below the level of 1955 and earlier (Nova Scotia 1969: 2).

Although sportsmen have blamed liberal hunting regulations for the lower populations since 1956, the effect of past excessive deer populations may have reduced the carrying capacity of the winter range which in turn has resulted in lower populations (Dodds 1963: 7).

Changes in deer range have been estimated by comparing the extent of land classes from forest inventories carried out by Fernow (1912) and Hawbolt and Bulmer (1958), and by unpublished data on land class areas from the latter inventory (R. M. Bulmer, letter of March 15, 1967).

Fernow's (1912) report was compiled in 1910 from existing timber cruise reports and maps, and was less accurate that that of Hawbolt and Bulmer (1958) which was based on a modern forest inventory conducted in 1956. However, for the total area of the seven countries mentioned, 7,350 square miles, Fernow's percentages for the various classes are probably reliable. An inventory conducted in 1965 (Nova Scotia 1966) provided more recent information on Queens and Lunenburg Counties. In comparing the report of Fernow (1912) with that of Hawbolt and Bulmer (1958) the main problem was their different classifications for forest lands. However, studies of terminal twig yield in western Nova Scotia (Telfer, unpublished), suggested that forest types could be classified according to browse-producing capacity. The classes chosen are shown in Table 1. The "open" forest class consists of stands that were found to have less than 25 percent crown closure and heights of less than 20 feet in the 158 inventory. Equivalent classes in Fernow's (1912) report were labelled "severly culled" and "young growth". All other forest stands were classified as "dense". Field studies in 1967 showed that the "open" classes had a relatively high browse production. Range carrying capacity was assumed to vary directly with

TABLE 1. — Changes in proportions of various land classes in western Nova Scotia as indicated by two forest inventories.

Land classes		Inventory Dates	
		1910[1]	1956[2]
		%	%
Agricultural		20.5	11
Conifers	— dense stands	4	27
	— open stands	5	20
Mixedwood	— dense stands	14	18
	— open stands	22	10
Deciduous	— dense stands	1	1
	— open stands	0.5	0.5
Brushland		33	12.5

[1]From Fernow 1912.
[2]From Hawbolt and Bulmer, 1958, and Bulmer (personal communication, 1967).

changes in the proportion of the area in stands having high browse production.

The diet of Nova Scotia deer changes from herbaceous material to woody browse by the first snowfall (Dodds, no date: 4). In western Nova Scotia snow depths in most winters are sufficient to cover foods other than browse for one to two months and to restrict activity to concentration areas for a shorter period (Potter 1965: 46) Snow seldom reaches the 20-inch depth associated with maximum restriction of deer movement (Hosley 1956: 223). Thus deer in western Nova Scotia appear to use more of the available browse and to be less dependent on dense forest cover than deer in other parts of eastern Canada.

To estimate probable changes in browse yield, percentages in the non-agricultural land classes shown in Table 1 were weighted by values for browse yield per acre, obtained from a reconnaissance survey in 1967 by the author.

Table 1 shows that between 1910 and 1956 the combined area of brushland and open forests — types yielding much browse — decreased from 60 to 43 per cent. Concurrently, browse yields declined an estimated 31 per cent. By contrast, dense coniferous forest, with the lowest browse yield, increased from four to 28 per cent. This increase in coniferous area may be due partly to the deers' feeding activities (Dodds, no date: 67, and as reported from other areas by Leopold *et al.* 1947: 172, Graham 1954: 531 and Beals *et al.* 1960: 79).

These land class changes suggest that carrying capacity was at least 30 per cent lower in 1956 than in 1910. This figure is based on quantitative changes only. When browsing mammals are introduced into a new area, such as Nova Scotia, frequently there exists an accumulation or "storage" of palatable shrubs (Leopold *et al.* 1947: 173). Although quantitative data are lacking on the shrub and sapling vegetation in western Nova Scotia at the time of deer were introduced, there has been a change in the status of at least one species, ground hemlock or yew (*Taxus canadensis*). This species is an excellent and preferred deer food (Hosley 1956: 199) that was formerly abundant in western Nova Scotia, Roland (1945: 70) described it as "Rather common throughout . . .". Schierbeck (1931: 29) said it was ". . . very prolific on the edge of lakes." and that deer used to gather on the frozen windswept surface of nearby lakes to feed on the ground helmock in old eastern hemlock (*Tsuga canadensis*) stands. Transeau (1909: 278), stated "The undergrowth is principally the yew (*Taxus canadensis*)" (in a spruce-larch stand in Yarmouth County). In contrast, recent studies of western Nova Scotian shrub flora have re-

TABLE 2. — Range balance derived from two forest inventories.
(Figures are percentages of total land area).

Land class	Ideal proportions[1]	Western Nova Scotia	
		1910	1956
Agricultural	25.0[5]	20.5[4]	11.0[4]
Brushland	50.0	60.5[2]	43.0[2]
Woodland	25.0	19.0[3]	46.0[3]

[1]From Leopold (1948:133).
[2]Brushland + open forest.
[3]Dense forest stands of all types.
[4]Cultivated and grassland grouped.
[5]Leopold distinguishes between cultivated (12.5%) and grassland (12.5%).

corded no ground hemlock (Dodds, no date; Nowosad 1967; Telfer, unpublished). Heavy browsing by invading deer killed all the ground hemlock on Espinore Island in Lake Huron in only two winters (Leopold *et al.* 1947: 173).

Other shrubs may also have been severely reduced, their stems killed by browsing mammals. Selective feeding may have affected the quality and quantity of available browse in western Nova Scotia as reported by Pimlott (1963: 113) on Anticosti Island and on certain areas in New Zealand as reported by James and Wallis (1969: 3). Values for browse yield and composition on the various land classes, such as those used in the present study for weighing both the 1956 and 1910 area figures, may thus be low for 1910.

Mast is an important winter food for deer during periods when it is not too deeply covered with snow (Hosley 1956: 197). Red oak (*Quercus rubra*) and beech (*Fagus grandifolia*), two important mast-producing species, comprised more than six per cent by volume of standing timber in western Nova Scotia in 1956 inventory (Hawbolt and Bulmer 1958: 100). Beech volume in Queens and Lunenburg Counties declined to 63 per cent of the 1956 estimate in the suceeding decade (Nova Scotia 1966). Beech bark disease has been killing beech in Nova Scotia since 1920, according to Boyce (1961: 284), who also reported a 40 per cent loss of trees in one stand in 14 years. However, detailed quantitative data on the extent of beech mortality is lacking. Beech is being replaced by species that do not produce mast. Red oak also dropped slightly between 1958 and 1966 but there is no indication of a long-term decline.

Between 1910 and 1956 the agricultural land area in western Nova Scotia declined from 20 per cent of the total land area to 11 per cent (Table 1). Abandoned fields and pastures yield browse and wild apples (*Malus pumila*) for the first few years, but these areas are soon diminished by forest succession. The decrease in agricultural land has contributed a long-term decrease in deer range quality. In Table 2 the land-class proportions in 1910 and 1956 are compared with Leopold's (1948: 113 and 135) estimate of the ideal proportions of land classes for deer range in an area where a mixture of farm and forest is combined with winters mild enough so that wintering cover is not a critical need. By the standards of Leopold the range in western Nova Scotia was well-balanced in 1910 but less so in 1956.

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Characteristics of Pre-spawning American Brook Lampreys from Big Creek, Ontario

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Abstract. Mature adults of the American brook lamprey, *Lampetra lamottei* were collected in the spring from Big Creek, at Delhi, Ontario. The sex ratio was 2 males: 1 female. The average length of 100 individuals was 179 mm, showing no difference in the lengths of males and females. A significant difference in weight did exist, the average of 57 males being 9.7 g and 28 females, 10.9 g. Livers of females were significantly larger than those of males. The mean number of trunk myomeres for 15 specimens was 68.8. Mean fecundity and mean relative fecundity of 16 females were 3787 eggs per female and 357 eggs per gram body weight. The results were compared with data on Quebec populations of this species, which were composed of smaller individuals with a much higher relative fecundity.

Introduction

The non-parasitic American brook lamprey, *Lampetra lamottei* (*Lethenteron lamottei*: Vladykov and Follett, 1966) is present in Ontario in streams draining into the Great Lakes. Valdykov (1949) has described Quebec populations of this species, however litttle information is available on transformed individuals of this species from Ontario waters. This report describes individuals of this species collected from Big Creek, a river draining into Lake Erie.

Materials and Methods

Specimens were collected during their evening movements at the foot of Leman's Dam. This dam is on a tributary of Big Creek at Delhi, Ontario. Most specimens were frozen; the rest were preserved in 10% formalin.

Individuals were sexed, weighed to the nearest 0.1 g and measured to the nearest millimeter. The number of myomeres, or muscle bands between the last gill slit and the anal opening were counted. The underside was slit open and both liver and ovary were removed. After noting the colour of a liver it was weighed to the nearest 0.01 g. Ovaries were stored in 10% formalin, and later total counts of eggs present were made.

Results

Time of spawning movement

Although the American brook lamprey, *L. lamottei,* does not undergo extensive migrations as does the more familiar sea lamprey, *Petromyzon marinus,* local movements do occur so that brook lamprey tend to aggregate in particular sections of a stream. Since Leman's Dam prohibits upstream migration of lampreys, lampreys aggregate at its base. Brook lamprey were first noticed here on April 16, 1970 when five individuals were collected. Movement of lampreys reached a peak during the week of April 26. By May 5 migratory movements were over and only two specimens were collected on that day. Although the area was revisited at weekly intervals until the end of May, no more brook lamprey were seen.

Stage of Maturity

The stage of maturity of these specimens is similar to stage 4: pre-spawning as defined by Vladykov and Mukerji (1961) for the sea lamprey, *Petromyzon marinus.* The gonads were easily distinguishable by the naked eye and occupied almost the entire body cavity. Also, many individuals possessed the secondary sexual characteristics of spawning adults. In the American brook lamprey these consist of a prominent post-anal keel and dorsally flexed tail in females, and a protruded urogenital papilla and ventrally flexed tail in males (Smith, *et al.,* 1968). Although stage 4 sea lamprey have a greenish liver only a single brook lamprey had a greenish liver.

Sex Ratio

Individuals were sexed by examination of the gonads. Of the 85 specimens which were sexed 57 were males and 28 were females. The

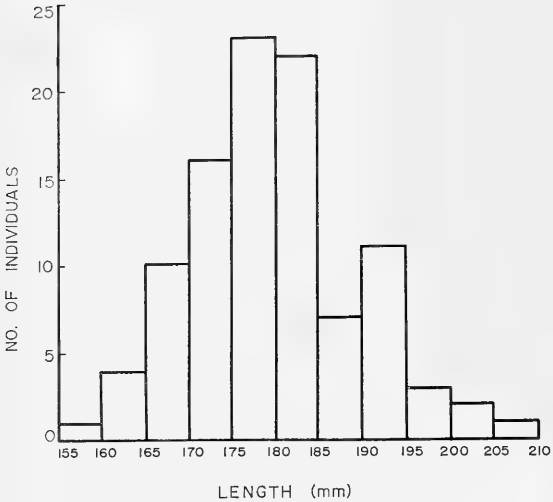

FIGURE 1. Length distribution of mature *Lampetra lamottei* from Big Creek, Ontario.

male to female ratio in this population was approximately 2:1. The male to female ratio during the first half of the migratory period was 2.1:1 and during the second half 2.0:1.

Lengths, Weights and Liver Weights

Lengths were obtained for 100 individuals. Mean length was 179 m with a range of 159-205 m. Vladykov (1949) gives as a maximum size for this species 187 mm. In the present sample 19% of the individuals were longer than 187 mm and 3% were longer than 200 mm. The frequency distribution of lengths is given in figure 1. The modal category was 175-179 mm, with the possibility of a second minor peak in the 190-194 mm category. No statistically significant sexual difference in length existed (male 160-205 mm, female range 159-197 mm).

Eighty-five individuals and their livers were weighed. Mean weight of 57 males was 9.7 g (7.0-14.1 g) and of 28 females was 10.9 g (7.9-15.2g). Mean liver weight of males and females was 0.12 g (0.07-0.17 g) and 0.21 g (0.13-0.31 g) respectively. Liver weight when expressed as a percent of body weight was 1.2% (0.9-1.5%) in males and 1.9% (1.3-2.5%) in females. Figure 2 ilustrates the linear relationship that exists between liver weight and body weight. Females were significantly heavier than males, and their livers were also significantly heavier. The liver weight as a percent of body weight was also greater in females. The slope of the female line (0.0192) in Figure 2 was significantly greater than the slope of the male line (0.0124). Livers of all but one individual ranged from an orange to a yellow-brown colour. One male had a green liver.

Myomere Count

A count was made of the number of myomeres between the last gill slit and the cloacal aperture for 15 individuals. Individuals ranged in size from 165 mm to 205 mm. In six individuals the count was 68, in six it was 69, and three had a count of 70. The mean was 68.8 myomeres.

Fecundity

The total number of egg in the ovaries of 16 females were counted. The mean was 3787 eggs per female with a range of 2698-5185 eggs. The results are shown in Table 1.

There appears to be a relation between body size and number of eggs. Mean egg count for individuals less than 9.0 g was 3331, for individuals 9.0 g to 12.0 g the mean was 3541, and for those 12 g and over it was 4337 eggs.

To compare fecundities of lampreys of different size, Hardisty (1964) used relative fecundity which he defined as:

$$\frac{\text{egg number}}{\text{body weight}}.$$

For brook lamprey from Big Creek the mean relative fecundity was 357.

Discussion

Ammocoetes of the American brook lamprey, *Lampetra lamottei* and the sea lamprey, *Petromyzon marinus* often occur in the same beds in Big Creek and its tributaries. In Big Creek the brook lamprey spawns in late April and early May, whereas the sea lamprey's migratory peak occurs two to three weeks later. A similar situation exists in Quebec. Vladykov (1949) found that the spawning peak occurred in the month of May for brook lamprey and in June for sea lamprey. Since ammocoetes of both species have similar requirements, a two week difference in spawning time could have a significant effect in reducing competition between the species. Smith, *et al.* (1968) found that the brook lamprey hatches two weeks after eggs are fertilized, so that as sea lamprey are just starting to spawn, youg brook lamprey have already hatched. If both species have the same growth rate, in beds containing amocoetes of both species, brook lamprey would be larger in size. Competition for food would be reduced if the larger ammocoetes select a larger food particle size.

The difference in spawning times could be largely temperature dependent. Piavis (1961) found that 18.4°C was the optimum temperature for the hatching of sea lamprey eggs. At this temperature 78% of the eggs developed to the prolarval stage. Using the data of Smith, *et al* (1968) one can calculate at 23% prolarval development from eggs of brook lamprey at 18.4°C. Vladykov (1949) found that 17°C was the optimum temperature for spawning in brook lamprey. McCauley (1963) has shown that the optimum range for hatching of sea lamprey eggs is very narrow. If this is true for lampreys in general, a 2° lower optimum for the brook lamprey would necessitate an earlier spawning time to ensure a maximum spawning success.

Samples were available from the beginning, the peak, and the end of the spawning movements. Although the sex ratio may change as the spawning run progresses, with females being more frequent towards the end of the run, no significant change in this ratio occurred in the population investigated.

In this brook lamprey spawning population, as in spawning populations of other species of lampreys, males predominate (Applegate, 1950; Wigley, 1959; Hardisty, 1960; Purvis, 1970). In ammocoete populations, Hardisty found that the sex ratio was approximately equal in parasitic and non-parasitic species of lamprey. Purvis also found that the ratio was about equal in ammocoete populations of *Ichthyomyzon fosser*, from northern Michigan streams. Applegate and Thomas, (1964) found that even in newly transformed sea lamprey, *P. marinus,* the ratios were almost equal or else females predominated. Hardisty believed the difference between sex ratios in ammocoete populations and spawning populations was due to a higher mortality rate in females between the time of metamorphosis and spawning.

Wigley (1959) for *P. marinus* and Hardisty (1961) for *L. planeri*, a non-parasitic brook lamprey, have shown that the number of males in the population is correlated to population size. The larger the population the greater the proportion of males. The high proportion of males in the Big Creek population of *L. lamottei* indicates that a large population of these brook lamprey exists in the river. A sex ratio linked to population size also provides a mechanism for population regulation. It is known that during spawning often more than two lamprey will occupy the same nest. Since one male can fertilize the eggs of more than one female, at low population size a high proportion of females would ensure a maximum number of young

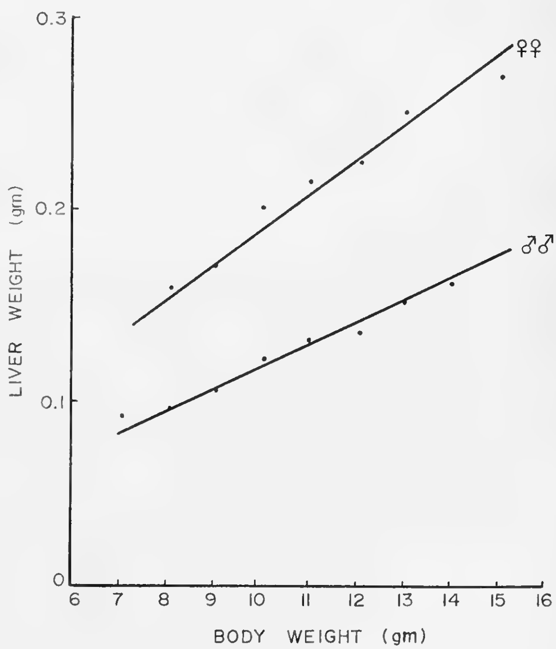

FIGURE 2. Liver weight — body weight relationship of male and female *Lampetra lamottei*. (mid-points of 1 gm intervals are plotted).

TABLE 1. — Fecundity and Relative Fecundity of *Lampetra lamottei*

(1) Length (mm)	(2) Wt. (g)	(3) No. of eggs	Relative Fecundity $\left(\frac{3}{2}\right)$
159	8.7	3865	444
169	7.9	2698	342
170	8.7	3743	430
170	9.0	4080	453
174	9.2	3064	333
176	8.9	3016	340
176	9.0	3517	391
179	10.8	3342	309
182	11.4	3826	336
183	11.9	3417	285
187	12.0	4442	370
190	13.5	5185	384
191	12.2	4684	384
192	12.5	4442	370
192	13.3	3831	287
194	12.5	3427	274
Mean 180	10.7	3787	357

hatching. At high population sizes when high reproductive rates are no longer desirable a low proportion of females in the spawning population is best.

Hubbs (1925) has shown that the body of the American brook lamprey shrinks very little in length during the two months preceding, and during actual spawning. The brook lamprey in the present study were almost the same length they would have been at the start of actual spawning.

American brook lamprey from Big Creek ranged in size fgrom 159-205 mm and were much larger than Quebec individuals (112-187 mm, Vladykov, 1949). These specimens were also larger than reports from other areas. The size ranges of 77 adult males and 65 females collected by Okkelberg (1921) from a small stream near Ann Arbor, Michigan, were 135-190 mm and 133-185 mm respectively. From New Hampshire, Sawyer (1960) collected 13 specimens that ranged in size between 106 and 132 mm. Big Creek may provide habitat which is very favourable for the growth of lamprey ammocoetes for other species of lamprey from this river also appear to be larger than those from other areas. A single *Ichthyomyzon fossor*, northern brook lamprey, was collected with *L. lamottei*. It measured 163 mm. The maximum length for the species given by Vladykov (1949) was 150 mm. Kott (1970), found that sea lamprey, *P. marinus* collected from Big Creek were larger than those from other Great Lakes waters. (Maximum size personally collected was 558 mm. Maximum sizes recorded by Applegate, 1950 and Wigley, 1959, were 523 mm and 534 mm respectively).

Although small sample size may not accurately reflect the size distribution in a population, there is a suggestion that the adult length-frequency curve is bimodal with a major peak in the 175-179 mm range and a minor peak in the 190-194 mm range. Purvis (1970), and Hardisty and Huggins (1970) report several examples in which not all the ammocoetes metamorphose at the same age. The bimodal length-frequency curve for spawning *L. lamottei* indicates that this must also be true for this species, and that the spawning population is composed of two age groups.

At spawning, in different species of lampreys, generally there is no significant difference between the lengths of males and females (Applegate, 1950; Wigley, 1959; Sterba, 1962). The same can be said for *L. lamottei*. The significant difference in the weights of the two sexes can be attributed to the heavier weight of the female gonad, and to a much lesser extent the heavier female liver.

Typically, in lampreys, the female liver is heavier than the male liver (Sterba, 1962, Table p. 319; Kott, 1970 and unpublished data). *L. lamottei* exhibits a similar dimorphism. If this dimorphism is also present in the ammocoete stage, a liver weight to body weight curve may provide a means of sexing ammocoetes.

During the spawning migration, the liver of other species of lamprey changes from an orange-red colour to some shade of gren due to an accumulation of the pigment biliverdin (Applegate, 1950; Sterba, 1962; Kott, 1970). In the present sample only one individual had a green liver. *L. lamottei* differs from parasitic species in that livers become green later in the migratory phase than is the case for parasitic species.

The number of trunk myomeres are an important lamprey taxonomic characteristic. For Quebec populations of *L. lamottei* Vladykov (1949) found that the mean was 67.5 myomeres, and a range of 67-70 myomeres. Big Creek individuals had counts which fall into this range, the mean however, was 68.8 myomeres. The sample from Big Creek is too small to determine whether this difference is significant.

All females used for fecundity measurements had well developed secondary sexual characteristics so their fecundity would be the same as that of spawning females. The fecundity of the Big Creek population was greater than that of the Quebec populations, but this is to be expected since the Big Creek population is composed of larger size individuals. Relative fecundity which is the ratio of egg number to body weight (Hardisty, 1964) is a measure of fecundity that takes into account the weight differences of individuals. The relative fecundity of the Big Creek population was 357 which is considerably lower than 450 for Quebec populations based on Vladykov's (1951) data. It is similar, however, to that of the other non-parasitic brook lamprey *I. fossor*. The differences in fecundities of the Ontario and Quebec populations is similar to what has been found in other species of lamprey in that larger forms had a reduced relative fecundity (Hardisty, 1964).

The major differences between an Ontario population of the American brook lamprey, *L. lamottei* and Quebec populations are the larger size of the individuals in the Ontario population and the lower relative fecundity of this population. A feature of lamprey populations in general, is that populations from different localities exhibits a wide variability in size and fecundity.

Big Creek itself is an interesting lamprey river. Mature individuals of the four Ontario species of lamprey — *Lampetra lamottei, Petromyzon marinus, Ichthyomyzon fossor,* and *Ichthyomyzon unicuspis* — spawn in this river (personal collection). *Petromyzon* and *Lampetra* are the common species, while the other two are rather rare. Typically individuals of all four species appear to be larger than individuals from other areas, suggesting that the river provides a very favourable habitat for the growth of lampreys.

Since the nesting requirements for adults and habitat requirements for ammocoetes of the species are similar (ammocoetes of *Petromyzon, Lampetra* and *Ichthyomyzon* are found in the same beds in this river), the river is ideal for studying ecological differences between sympatric species with similar requirements in order to understand how competition is reduced between such species. One mechanism already discussed is the earlier spawning time of *L. lamottei* as compared with *P. marinus*. The difference is great enough so that the *L. lamottei* eggs can hatch and the ammocoetes start to feed before the *P. marinus* eggs are laid. The earlier start would mean that *L. lamottei* ammocoetes would be larger and so would utilize a different food particle size. Little is known however about the two species of *Ichthyomyzon.*

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Homing of the American Eel, *Anguilla rostrata*, as Evidenced by Returns of Transplanted Tagged Eels in New Brunswick

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Abstract. On September 29, 1968, 222 eels, ranging in length from 351 mm to 825 mm, caught in the Shediac River, were transported on the same day by automobile in a wooden box with wet marine plants, tagged and released about 50 miles (80 km) away in the Kouchibouguacis River. These New Brunswick rivers along the Northumberland Strait are separated by 8 rivers, 4 brooks and numerous sea inlets. Up to December 31, 1969, 15 recaptured eels (or nearly 7%) were reported of which four were retaken in the Shediac River, their home stream. These recaptures and data from controls suggest that homing was involved. At present there is no definite explanation how the transplanted eels were able to find their home river.

Introduction

Homing and orientation behaviour of anadromous fishes, particularly Salmonidae, has been well studied (Hasler, 1966; Jones, 1968). On the other hand, knowledge of homing of catadromous fishes, such as freshwater eels (*Anguilla*), is rather limited.

Following Gunning (1963), the term *homing* is defined as "The return of a fish to a home range following experimental or natural displacement". the term *home range* is used in the sense of an "area over which an animal normally travels" (Gerking, 1953).

Some observations on the movements of the American eel (*A. rostrata*) over its home range in rivers were made by Vladykov (1956), Gunning and Shoop (1962) and Gunning (1963). Medcof (1969) reported fishermen's observations on eel migrations in certain Nova Scotia rivers. However, the homing ability of the American eel has never been subjected to proof by tagging experiments.

Observations on the movements of the European eel (*A. anguilla*) over its home range in the River Elbe were published by Mann (1965) and Tesch (1966). The homing of the European eel was studied by Tesch (1967), who tagged and transplanted 1,538 eels from the German Bight in different areas of the southern North Sea during June-August 1966. In the first 5 months, recaptures of 77 eels (5%) were reported. About 64% of these recaptures had been made over the home area. Deelder and Tesch (1970) reported additional information on homing in 2,828 tagged European eels, which had been transplanted in 1968 and 1969 over distances up to 253 km in the North Sea off the coasts of Germany and the Netherlands. Noteworthy recaptures include eels returning to their home area from a range of more than 200 km.

Methods

Area of Study and Method of Fishing

A regular eel fishery is practised in all New Brunswick rivers along the Northumberland Strait, from the Pokemouche River to the north and the Shediac River to the south. Eels are usually caught in the tidal zone (estuary) of rivers with hoopnets made of nylon netting with 1-inch stretched mesh. The description of this method of fishing is given by Eales (1968) and Doiron (1969).

In the present article, particular attention is given only to the southern section of the Northumberland Strait, between the Kouchibouguac and Shediac rivers, where 1,252 eels, taken in hoopnets by local fishermen, were tagged and released.

Tagging

To study the movements of *A. rostrata* in freshwater streams and in the sea, 3,657 eels were tagged and released in six New Brunswick rivers, including the two under discussion, along the Northumberland Strait, between October 1, 1967 and October 4, 1968.

Specially designed tags were used of the "split-ring and plate" type. The stainless steel

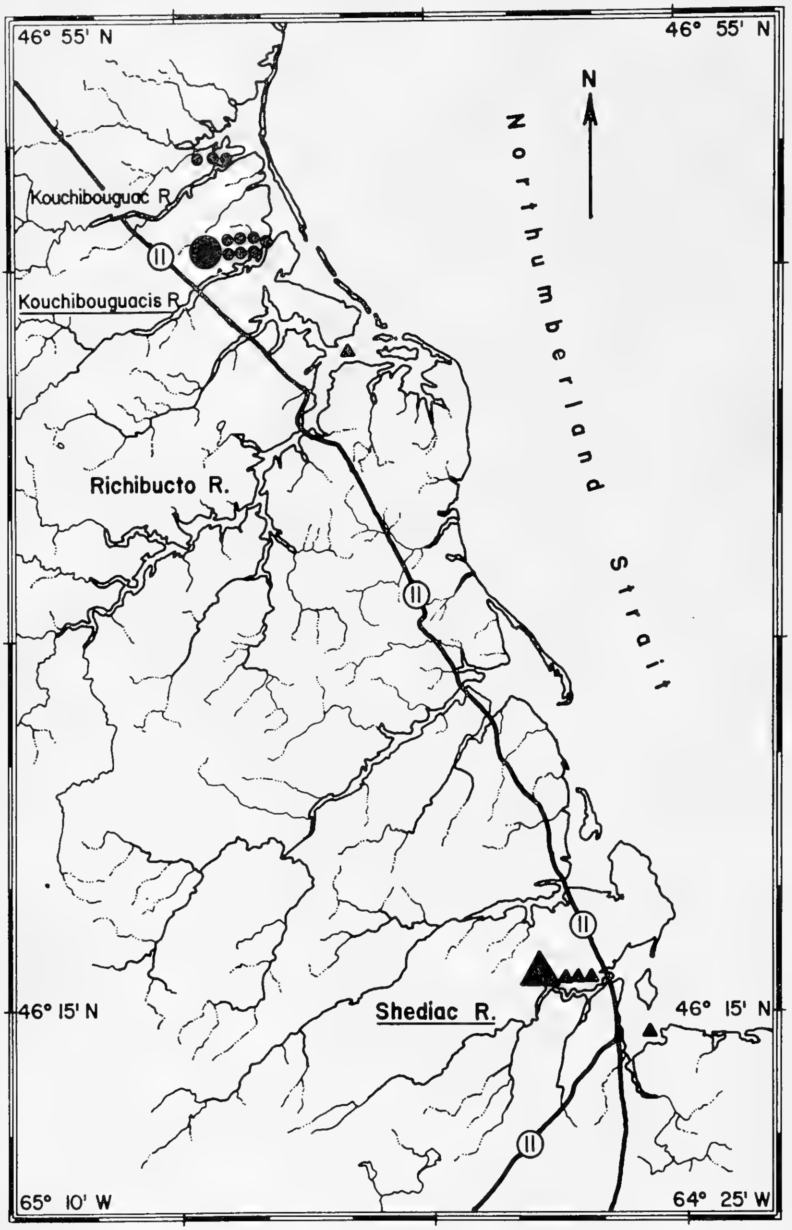

FIGURE 1. A schematic map showing New Brunswick rivers where the experiment on transplanting of tagged eels was made. The large closed triangle indicates the area in the Shediac River where eels were originally caught on September 29, 1968. Small closed triangles indicate the number and location of recaptures of transplanted eels in or on the way to the Shediac River, their home river. The large closed circle indicates the Kouchibouguacis River where the transplanted eels were liberated. Small closed circles indicate the number and location of recaptures made in or near the Kouchibouguacis River. Open circles with figure 11 indicate the New Brunswick route along which the eels were transported from the Shediac to the Kouchibouguacis River.

ring with the vinylite plate was placed around the lower jaw of the eel. To prevent the accidental opening of the split-rings, the ends were welded by a portable electric spot welder. The mortality of eels tagged by this method was practically nil. The description with illustrations of this method of tagging was given by Vladykov (1970).

Observations on Eels

Length of eels. — Before tagging all eels were anesthetized in a solution of approximately 1 part tricaine methanesulfonate (MS-222) to 3,000 parts water for a duration of 10-20 minutes. As soon as the active movements of the eels ceased, they were placed on a wooden measuring board and their total length, from

TABLE 1. — Details of recaptures of tagged eels transplanted from the Shediac River to the Kouchibouguacis River on September 29, 1968.

Tag No. (Series "G")	Sex of eels	Observations at tagging		Date of recapture	River of recapture	Fisherman
		Length (mm)	Color*			
30	—**	433	B – Y	October 26, 1968	Kouchibouguac	S. Doucette
469	—	559	G – Y	October 26, 1968	Kouchibouguac	S. Doucette
494	—	461	G – Y	October 26, 1968	Kouchibouguac	S. Doucette
5	—	483	Y	December 3, 1968	Richibucto	I. Roberts
41	♀	567	G	June 1969	Kouchibouguacis	K. Callender
47	♀	456	B – Y	June 1969	Kouchibouguacis	K. Callendar
430	♀	555	B – G	June 1969	Kouchibouguacis	K. Callendar
436	♀	492	B – G	June 1969	Kouchibouguacis	K. Callendar
439	♀	605	B – Y	June 1969	Kouchigoubuacis	K. Callendar
482	♀	451	B – Y	June 1969	Kouchibouguacis	K. Callendar
496	♀	482	B – G	September 1969	Kouchibouguacis	K. Callendar
422	—	584	Y	August 21, 1969	Shediac Harbour	D. Arsenault
505	♀	443	G – Y	September 5, 1969	Shediac	C. Leblanc
508	♀	556	B – Y	September 10, 1969	Shediac	C. Leblanc
407	—	599	B – G	October 1, 1969	Shediac	C, Leblanc

*Significance of abbreviations: B – G – bronze with green; B – Y – bronze with yellow; G – Green; G – Y – green and yellow; and Y – yellow.
** – only tags received.

the tip of the lower jaw to the posterior end of the middle caudal ray, was measured in a straight line to the nearest millimeter. Throughout the paper the eel length refers to the total length.

Colour of eels. — The colouration of an eel helps to determine the degree of its fatness, and, hence, its maturity without dissecting it. The most important colour phases fall into two principal categories: a) half-grown, lean immature fish, predominantly *yellow* or *green* in colour; and b) adult, fat maturing fish, predominantly *bronze* (Vladykov, 1955). However, in early maturity, eels display a combination of yellow or green and bronze tints.

Sex of eels. — Apparently the sex of all the 3,657 eels tagged in New Brunswick, from the Shediac River to the south and the Big Tracadie River to the north, was female. Recaptured eels proved invariably to be females. Moreover, examination of supplementary samples taken during the tagging operations revealed the sex of all 401 eels from the Big Tracadie River and all 299 eels from the Black River, to be female.

Transplantation Experiment

The aim of the experiment was to test the homing ability of *A. rostrata* by moving them to a different locality, which, moreover, is separated from the home river by several other streams.

Transplanted Eels

On September 29, 1968, 222 semi-adult and adult eels, caught in the tidal zone of the Shediac River, were placed in a wooden box among wet marine plants, and recovered with a wooden lid. The box was placed on the top of a station wagon and transported on the same day to the Kouchibouguacis River. There the eels were marked with green tags and released in the estuary. These fish will be called "transplanted eels" throughout the article.

The distance between the estuaries of the Shediac and the Kouchibouguacis rivers is about 50 miles (80 km), and they are separated by 8 rivers, 4 brooks and numerous inlets (Figure 1).

The length, sex, and colouration of the transplanted eels will be discussed together with the control specimens.

Control Eels from Two Rivers

Prior to undertaking the transplantation experiment, eels from two New Brunswick rivers, the Shediac and the Kouchibouguacis, were selected as controls.

The Shediac River. — On September 28, 1968, 382 eels, caught in the same area as the transplanted specimens, were marked with white tags and liberated close to the fishing area. Their length, sex, and colouration will be discussed together with the eels from the other control river and the transplanted fish.

The Kouchibouguacis River. — During May 29-31, 1968, 648 eels taken in the tidal zone were marked with yellow tags and liberated in exactly the same place where the transplanted fish from the Shediac River were released subsequently.

Length of Eels

The ranges and averages of eel lengths in the three samples were as follows:

Sample	Range (mm)	Average (mm)
Transplanted eels	351–825	488.6
Shediac River	340–744	498.2
Kouchibouguacis River	301–844	536.5

It may be seen that both samples from the Shediac River were represented, on the average, by smaller sizes than those from the Kouchibouguacis River.

The length frequencies of the tagged eels in the three samples were as follows. The length-classes 400-99 mm and 500-99 mm were the predominant ones. In the case of the Kouchibouguacis fish, the 500-99 class amounted to 54.5% while both the local and transplanted samples from the Shediac River contained less than 30% of the class. The 400-99 class occurred in 62.7% of the transplanted fish, 43.4% among the local fish from the Shediac River and only 19.4% in the Kouchibouguacis River sample.

Colour of Eels

The colour frequency of eels in the three samples can be summarized as follows:

Sample	Number and percentage of eels in various colour groups					
	Bronze		Bronze with yellow or green		Yellow and/or green	
	N	%	N	%	N	%
Transplanted eels	8	3.6	110	49.4	104	47.0
Shediac River	21	5.7	101	26.4	260	67.9
Kouchibouguacis River	5	0.8	184	28.5	459	70.7

Bronze eels. — The number of bronze eels was very small (less than 6%) among the fish in the three samples. These eels were more advanced in sexual maturity and would have left, no doubt, for the sea during the fall of 1968.

A mixed group of eels of bronze and green or bronze and yellow colour was particularly high among the transplanted fish (49.4%). In the two other samples this group was represented by less than 30%. The high occurrence of eels of mixed colours among the transplanted fish is a possible result of their being out of water for approximately 2½ hours during transport. The bronze reflections of these fish became more pronounced than those of eels from the other samples which were kept in water continuously.

Green and yellow eels. — The immature eels of these colours were equally represented among the Kouchibouguacis and Shediac samples, namely by about 70%. Their occurrence among the transplanted fish was only 47%. This apparent discrepancy may be explained by the reason stated above.

Recaptures of Tagged Eels

During the period from May 29, 1968, to December 31, 1969, the recaptures of tagged eels in the three samples were reported as follows:

Sample	Number of eels tagged	Recaptures	
		N	%
Transplanted eels	222	15	6.8
Shediac River	382	15	3.9
Kouchibouguacis River	648	31	4.5

Since the recaptures of transplanted eels and of those released in the respective home rivers are of different significance, they will be treated separately.

Recaptures of transplanted Eels

Altogether 15 recaptures of transplanted eels have been reported. Only one recaptured eel was 605 mm in length at the time of tagging, while the remaining fish were from the two predominant length-classes: 400-99 mm and 500-99 mm. The details of recaptures are found in Table 1, while the summary of their recoveries in different seasons and different rivers is given in Table 2.

The reported recaptures of the transplanted eels were nearly one and a half times more numerous (6.8%) than recoveries of control eels from either river. This probably indicates that the transplanted eels were more active in their movements, since they were trying to relocate the Shediac River, their home stream. To do so, they were forced to swim along the Northumberland Strait, principally in a direction from North-West to South-East.

During the first month after their liberation in the Kouchibouguacis River, some eels had already moved out of this river to a neighbouring one. For instance, on October 26, 1968, 3 eels were recaptured at Tweedy Shore of the Kouchibouguac River, approximately 6 miles from the sea (Table 1). The estuary of the Kouchibouguac River is located about 3 miles north of the Kouchibouguacis River estuary (Fig. 1). The beds of these two rivers are parallel to each other, and their waters empty into the same Kouchibouguac Bay. Most probably, the physico-chemical and biological conditions of these two rivers are very similar,

TABLE 2. — Recaptures of tagged eels transplanted from the Shediac River to the Kouchibouguacis River on September 29, 1968, by three-month periods.

Period	Number of recaptures in rivers				
	Kouchibouguac	Kouchibouguacis	Richibucto	Shediac	Total
Oct. – Dec. 1968	3	–	1	–	4
Jan. – Mar. 1969	–	–	–	–	–
April – June 1969	–	6	–	–	6
July – Sept. 1969	–	1	–	3	4
Oct. – Dec. 1969	–	–	–	1	1
Total	3	7	1	4	15

hence, the transplanted eels can hardly discriminate between them. Although there are several rivers farther north, as, for instance, the Big Tracadie and the Pokemouche, where rather intensive eel fisheries are practised, the transplanted eels have never been caught there. The Kouchibouguac River was the most northerly stream in which the transplanted eels were captured.

By December 3, 1968, at least one eel (No. G-5) had reached the estuary of the Richibucto River, at a point about 15 miles from the sea. The mouth of the Richibucto River is situated approximately 12 miles south of the Kouchibouguacis River estuary in direction to the Shediac River.

From January to March 1969, regular hoopnet fishing was impossible and no recaptures were made (Table 2). During these rigorous months, temperatures in salt water estuaries usually remain around —1.5°C for long periods (Needler, 1941).

As soon as regular fishing with hoopnets was resumed in the Kouchibouguacis River, 6 tagged eels were recaptured there in June 1969. During the period July-September 1969, some transplanted eels still remained in the Kouchibouguacis River, where one (No. G-496) had been taken in September 1969.

There were two different periods in the movements of the transplanted eels. During the first period, from October 1, 1968 to June 30, 1969, 9 recaptures had been made in or close to the place of release, namely in the Kouchibouguacis and Kouchibouguac Rivers. However, one eel succeeded in reaching the Richibucto River, situated between the river of release and the home stream.

During the second period, from July 1 to December 31, 1969, 4 recaptures had been made in the Shediac River, the home stream. However, in September of 1969, 1 eel was also captured in the Kouchibouguacis River, which suggests that not all the transplanted eels moved out of the river of release at the same time and at the same speed.

In more details the following situation existed during the fall of 1969. During August and September of that year, at least 3 transplanted eels already had succeeded in reaching their home river. One of them (No. G-422) was caught on hook and line in the Shediac Harbour, near Pointe-du-chêne, on August 21, 1969, while two others were recaptured in the same section of the Shediac River where they were originally caught on September 29, 1968 (Table 1 and Figure 1). On October 1, 1969, when the eel fishery normally terminates, one more eel (No. G-407) was retaken in the Shediac River (Tables 1 and 2).

In conclusion, the homing ability of *A. rostrata* might be suggested by recoveries of at least four eels, or nearly 27% of all reported recaptures, in the Shediac River which was accurately relocated by transplanted eels. By adding one more eel, taken in the Richibucto River in its movement towards the home range, the total of homing eels then would be 30%. In contrast, only 3 eels (20%) had strayed in a direction away from the home range (the remainder of recaptures were near the release site).

The dates of recapture were closely related to the place of recapture: early recaptures were generally close to the site of release, while later recaptures were closer to or in the home range. This correlation suggests a movement from the release site to the home range and provides stronger evidence for homing than the number of recaptures for each locality.

Recapture of Control Eels

During the period from May 29, 1968 to December 31, 1969, among control eels from the Shediac River, 15 specimens (3.9%) were recovered, while in the Kouchibouguacis River, 31 eels (4.5%) were recaptured. All 46 tagged eels were caught not in the sea but always in rivers. In not one case were control eels from either the Shediac River or the Kouchibouguacis River retaken in rivers other than their respective home streams. In other terms, during the period of 15 months, yellow or green eels from these rivers were travelling only in their home ranges.

A similar situation prevailed in four other New Brunswick rivers, where local eels were tagged and released. In these rivers the immature eels, yellow or green, remained in their home ranges for at least 1 or 2 years. The details on the recaptures of tagged eels in these rivers will be reported in a separate paper.

Discussion

All species of *Anguilla* have keen olfactory perception as shown by the very elaborate structure of their nasal apparatus (Liermann, 1933). Several authors (Hasler, 1954, 1957; Teichmann, 1959; Gajewski, 1967; Kleerekoper, 1969) considered the olfactory apparatus of eels to be particularly helpful in discriminating between the specific odours of their home river and other streams.

In the case of the European eel (*A. anguilla*), Tesch (1967) gave sufficient evidence that this species possessed homing abilities. However, the explanation of how eels transported from their home range to new areas relocate their home water is still not very clear. He speculates that the homing tendency of the eels is probably based on long-term non-genetic adaptation to the environment at the home area, in the sense of Kinne (1964). His conclusion is that "the successful re-migrations observed cannot be explained on the basis of the eel's olfactory capacity alone; other sensual abilities such as salinity preferences, sensitivity to light, and magnetic compass-orientation may be involved".

In homing studies of *A. anguilla* off the coasts of Germany and the Netherlands, Deelder and Tesch (1970) stated emphatically that: "the long distance (East-West) homing certainly excludes olfactory orientation because of the North-East flowing residual current of the southern North Sea".

Tesch (1967) and Deelder & Tesch (1970) studied the homing ability of the European eel by transplanting them from one locality to another along the North Sea coasts. Therefore, the principal difficulty for the eels to relocate their home area would be extensive spaces of the open sea and not the discrimination between individual rivers.

In our experiment, *A. rostrata* were forced to discriminate between the river of release (Kouchibouguacis) and the home stream (Shediac River). It seems that a keen olfactory perception helped the eels to do so. In the case of two controls, the olfactory perception, no doubt, enabled the eels of these rivers to recognize their home ranges and remain there until they reached advanced sexual maturity. The latter condition urges them to undertake a seaward migration, leaving their home ranges located most often in the fresh and brackish sections of the rivers.

The orientation of adult American eels (*A. rostrata*) caught on their spawning migration downriver was studied in a laboratory experiment by Miles (1968). However, his experiment did not give any new information on the migratory direction of mature eels leaving the fresh water for the sea. Irrespective of the area in eastern North America, where adult eels can be found in fresh water, sooner or later they orient themselves southward, towards the region of the Sargasso Sea, which is presumably their spawning area (Schmidt, 1924; Vladykov, 1964).

Due to its homing ability, the American eel (*A. rostrata*) displaced naturally (due to a strong flood, for instance) or by man from its home range to other areas, is able to find its home river. In the present experiment, this is particularly striking as, along the shore of the Northumberland Strait, between the Kouchibouguacis River (transplanted area) and Shediac River (home area), eight other rivers are present, some of which (Richibucto, Buctouche, Little Buctouche and Cocagne) are rather large. In addition there are at least four brooks and numerous sea inlets present in this area.

It is not possible as yet to explain which other senses, in addition to the olfactory perception, are responsible for relocation of the home river by transplanted eels. Celestial navigation is always a possibility and temperature and salinity gradients could also help the eels locate stream mouths.

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The live eels from New Brunswick used for the present study were obtained from fishermen Mr. Clovis Leblanc of the Shediac River, and Mr. Arthur Richard, of the Kouchibouguacis River.

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Preliminary Notes on Changes in Algal Primary Productivity Following Exposure to Crude Oil in the Canadian Artic

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Abstract. Mackenzie Valley Crude oil which had been exposed for 2 months to natural arctic summer conditions was added to bottles containing algae taken from a marsh near Inuvik, N.W.T. Carbon 14 primary productivity was ten times lower in the oil treated samples (0.59 ± 0.30 mgC/m^3/hr.) than in the untreated control samples (5.12 ± 1.2 mgC/m^3/hr.) after a four hour incubation period.

Small flagellates such as *Cryptomonas* spp. and *Chlamydomonas* spp. comprised nearly 80% of the primary producers in the Inuvik marsh samples.

Some implications of the significance of these preliminary findings are discussed in view of the proposed 800 mile Mackenzie Valley Pipeline route.

Oil spills, whether they stem from major pipeline ruptures as in the Athabaska spill or in spills from fuel oil storage tanks such as occurred at Deception Bay, will rapidly contaminate aquatic systems. Once oil enters an aquatic system it coats everything it contacts, killing birds, aquatic mammals and insects as it moves downstream. The purpose of this study was to determine whether oil significantly reduces plankton primary productivity as well. This is particularly relevant in the Arctic where lakes and streams comprise some 30% of the total area and where there is a rapid production of algal species during their Arctic growing season in contrast with the slow growth displayed by Arctic terrestrial plants. A major portion of the energy retained by Arctic environments may therefore be fixed by the aquatic plants in the numerous Arctic lakes streams and marshes.

It is common knowledge that crude oil (a complex mixture of hydrocarbons) is composed of both volatile and relatively stable compounds. The more volatile "lighter fractions" are the components which are chiefly responsible for the high initial toxicity of fresh crude oil to aquatic organisms (Warner, 1969). Warner states that, in tropic and temperate environments, the "lighter fractions" rapidly evaporate leaving the more inert and persistent "heavier fractions" on the water's surface. However, in cold Arctic waters, evaporation rates of the highly toxic "lighter fractions" of crude oil are believed to be greatly slowed prolonging the time during which sensitive aquatic organisms are exposed to the toxic influence of the lighter hydrocarbons. Mirinov (1968) has recently shown that surface films of oil are especially toxic to the hyponeuston, that special community found in the uppermost layer of water (from 0 to 2 cm. in depth). Numerically, the plankton are far more important than the hyponeuston, but being more distant from the floating oil layer, they may be unaffected by the oil save for the fact that the oil substantially reduces light penetration. By removing water from a marsh and adding C^{14} and 2 month old crude to it, the null hypothesis proposed above can be tested. The reduction in light penetration from the oil film can be avoided by illuminating the sample from the side instead of the top.

Methods and Results

Five litres of water were removed from a marshy area approximately 2,000 meters northwest of Inuvik along the east side of the main road (134° 45′ E longitude and 68° 22′ N latitude at approximately 45 feet in elevation). This type of marsh was typical of much of the Mackenzie Valley area and was so chosen. There were dense patches of aquatic plants such as *Ranunculus* sp. and *Hippurus* sp. near the collecting site of this shallow marsh (maximum depth was 0.5 m). Microscopical analysis of the water samples at the Inuvik Research Laboratory revealed that flagellates, mainly *Cryptomonas* and *Chlamydomonas*, predominated in these samples. Densities were relatively low in all samples (2-15 $\times$ 10^3 cells per litre).

The water samples were taken at dusk on 23 Sept. 1970 and placed in a covered opaque container to prevent light shock. These samples were taken to the Inuvik Research Laboratory where after proper mixing ten light and four dark 275 ml glass bottles were filled with the marsh water and inoculated with 5 microcurries of C^{14}, shaken and divided into two groups (control and treated). Each group had two dark bottles. Next 0.5 ml of crude oil which had been collected from below the test site spill made by Dr. L. Bliss (University of Alberta, Botany Dept.) in July 1970 was carefully added to the tops of the seven (treated) bottles without mixing it with the sample water. Oil from the test site instead of fresh crude was chosen because it had weathered under natural conditions. It was the purpose of this study to determine whether the toxicity of crude oil remains even after it has been exposed for two months to Arctic conditions.

All fourteen bottles were placed inside a Comparison Primary Productivity Incubator of the Hawaiian pattern, designed by Doty and Oguri, 1959 (available from the G.M. Mfg. Co., 134 West 26th St. N.Y. 1, N.Y.). The light intensity inside the incubator was the same as Doty used in his studies (approximately 10 g-cal/cm^2/hr.). The light intensity in the field near the sample site was recorded using a Belfort Pyrheliometer. The mean light intensity from 9 A.M. to 6 P.M. on that day (23 Sept. 1970) was 8.1 g-cal/cm^2/hr. with a maximum of 11.3 g-cal/cm^2/hr. recorded at 11 A.M. Shortly after this peak, the skies clouded over and it snowed lightly for a short time. Incubator water temperatures were maintained between 2 and 4° C. The water temperature at the sample site was 3° C. at 5:50 P.M. when the samples were taken.

The samples were incubated for four hours. The incubator lights were then switched off and 100 ml of each sample was filtered (after first decanting the surface layer of oil) through a Millipore^R 0.45 micron pore diameter membrane filter at a maximum pressure of 15 lbs/sq. in. The fourteen numbered filters were placed in a dessicator and dried for 24 hours. Analysis of the filters was made by the International Agency for Carbon 14 Determination, Charlottenlund, Denmark.

Analysis of the marsh water for total CO_2 was done using the methods given in *Standard Methods* (American Public Health Association, 1969). Total CO_2 at the time the samples were taken was 31 $\pm$ 4mg/litre. The mean amount of carbon fixed during the four hour incubation period in the oil free control bottle was 5.12 mg C/m^3/hr. The 95% confidence limits (n = 5) was $\pm$ 1.2/mgC/m^3/hr. These figures reflect the dark bottle correction, i.e. the mean carbon uptake in the control dark bottles (0.31 mg C/m^3/hr) was subtracted from the light bottles' productivity. The five oil treated samples had a mean of only 0.59 $\pm$ 0.30 mg C/m^3/hr after dark bottle corrections were made.

Discussion

The species composition of the water samples taken from the Inuvik Marsh in late September differed substantially from those described by Hilliard (1959) for an Arctic lake on Kodiak Island, Alaska. Over 65% of the species in Hilliard's samples were diatoms while diatoms comprised less than 5% of the species found in the Inuvik samples. Instead, nearly 80 percent of the species in the Inuvik marsh samples were small flagellates. This is similar to the findings of Kalff (1967) and Nauwerck (1967) as reported by Kalff (1970). A high degree of variation in species composition between different Arctic lakes is not uncommon. Such variation was observed by Prescott (1953) in a study which he conducted concerning several lakes and ponds in the Alaskan Arctic slope region. This variability is emphasized because future studies directed along these lines should include a broad range of species as well as oil concentrations and types.

Phytoplankton density and productivity was low in all the samples taken from the Inuvik Marsh. The addition of crude oil to the samples nevertheless reduced their already low primary productivity nearly tenfold (from 5.12 to 0.59 mg $C/m^3/hr$).

The point should be emphasized that even though the crude oil selected had been exposed to Arctic summer conditions for 2 months it still retained sufficient toxic properties to reduce algal primary productivity to a negligible level in the treated samples. The classic concept that oil and water don't mix must be questioned. Recent findings of the Woods Hole oceanographic Institute (*Conservation News*, September 15, 1970) indicated that certain toxic fractions of oil were soluble in sea water. Dr. T. C. Hutchison (Department of Botany, University of Toronto) confirmed the fact that a few oil fractions have significant solubility in water and are toxic to *Chlorella pyrenoidosa* and *C. vulgaris* in laboratory studies (personal communication).

Without knowing the relative importance of the algae to the Arctic energy pyramid it is impossible to predict the consequences of a ten fold reduction in algal productivity. Moreover, this may be a conservative estimate as the bottles were illuminated from the side during incubation. Had the light come from above the oil layer, as it would have done in the field, the light intensity reaching the primary producers would have been greatly reduced. What effects would this have on the Arctic food chain in areas contaminated by a crude oil spill? Such questions are far from academic at a time when a 48 inch pipe which would carry over four hundred thousand gallons of crude in each mile of its 800 mile length through the Mackenzie Valley is being considered. A break in such a pipe following an earthquake or landslide or even from self-induced thermokarst would release more oil into the arctic environment than was spilled by both the Arrow and the Torrey Canyon combined, as cut-off valves are to be installed in the pipe at 25 to 50 mile intervals.

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Notes

A Cougar Kills an Elk

Abstract. On December 19, 1967 a cougar, *Felis concolor* killed an adult male elk, *Cervus canadensis* in Banff National Park. The carcass and kill site were examined in detail the following day. Fresh snow permitted reconstruction of the probable sequence of events leading up to the kill. These events and the manner in which the cougar fed on the elk are described in detail.

On the evening of December 19, 1967 District Park Warden, F. Bamber discovered a freshly killed elk, *Cervus canadensis,* surrounded by cougar, *Felis concolor,* tracks on the Spray River Fire Road in Banff National Park.

Bamber, having proceeded up the road in his vehicle no more than an hour earlier, was returning home when the discovery was made. This, plus the apparent freshness of the kill and the fact that the cougar had not yet fed, indicated the kill was only a few minutes old. In all probability the cougar had been frightened from the kill by the returning vehicle The following morning Bamber reported the kill to Chief Park Warden, A Corrigal and me. The three of us returned to the kill site shortly after noon.

The elk, a mature six point bull in poor physical condition, was lying on its right side in the roadside ditch. Despite the freezing temperature of the previous night, only the extremities of the animal were stiff and frozen. The torso, neck and heavily muscled portions were still flexible.

Fresh cougar tracks and the fact that the carcass had been fed upon indicated the cat had returned to the kill. A great amount of elk hair was strewn about suggesting the cougar had scratched away the hair prior to feeding.

The skin, portions of the left rib cage and associated musclature had been eaten. The ribs had been effectively sheared from the spinal column. An estimated four pounds of flesh had been eaten from the back. Portions of the posterior upper shoulder and anterior hind quarter had also been eaten. The skin and musclature covering the left side of the viscera had been eaten without disturbing the organs. There was no evidence that the cougar had made any attempt to feed on any of the internal organs. The amount of meat consumed suggested that the cat had fed twice, probably once on the previous evening after Bamber had left the scene and again in the morning prior to our arrival.

The elk's neck was cleanly broken at the atlas. The vertebrae were completely disarticulated and it was possible to bend the head over and feel the end of the cervical vertebrae. This was apparently the cause of death.

There were deep short claw marks around the left side of the muzzle and face of the elk. From this evidence it was speculated that the cougar had been on the elk's back and had hooked the elk in the muzzle with its right paw. By applying pressure the cat had bent the elk's head back until the neck broke. There was no evidence of claw or teeth marks in the throat region or back of the neck.

Four inches of snow had fallen the day prior to the kill and it was possible to backtrack along the flight path and reconstruct the probable sequence of events leading up to the kill.

A group of three or four elk had been walking in a northerly direction through a mature stand of spruce at a slightly uphill angle. The cougar had approached from a 30 degree angle on the downhill side. The elk bolted and the cougar pursued them in great bounds for approximately 30 yards, at which point the bull left the group and angled downhill to the right. A few yards beyond this point there was evidence that the bull had stumbled to its knees. It is speculated that this was the point of initial physical contact. The elk regained his footing and ran thrashing and bucking down hill through clumps of thick spruce and lodge pole pine. Tufts of elk hair were evident on the tree trunks and on the ground.

About 75 yards beyond the point of initial physical contact antler punctures were noticed in tree trunks and small spots of blood were seen in the snow. The cougar had probably hooked the elk in the muzzle and pulled its head down and back at this point.

About 150 yards from the point of initial contact, there was evidence of something being dragged through the snow on the right side of the elk. At one point the elk cleared a fallen tree lying horizontally about three feet above the ground. Small tufts of cougar hair were evident on the trunk. Presumably the cougar had partially lost its grip and was being dragged by the elk when the elk cleared the tree. Additional spots of blood were encountered in this area. The blood did not appear to be free flowing but rather was blood that was being expelled through the nostrils or deposited where the elk's muzzle had dug into the snow.

A few yards short of the kill-site the elk was still on his feet though obviously staggering. The elk then backed off at an angle a few yards, staggered forward and fell. From the point of initial physical contact to the kill-site was estimated to be about 250 yards. Along this flight path, numerous rotten stumps were broken apart and at several points the elk had plowed through thick clumps of trees. There was no indication that the elk had ever been completely down until the very end. It would appear that, after contact, the elk had bucked blindly down the hill while the cougar, hanging on its back, succeeded in hooking the elk in the muzzle, bending its head back until the neck was broken.

After feeding, the cougar retired about 100 yards from the kill and bedded down under an overhanging tree. the bed was stained with blood, presumably from the elk. Melted snow indicated the cougar had bedded down here for some time. The cougar then moved back another 100 yards where it again bedded down. There was no evidence of blood in the second bed.

The cougar's paw prints, measured about 4 inches across, suggesting the animal was not a large one. A female with two kittens had been seen in the area during the fall. This could have been the same animal although there was no evidence of young.

The kill-site was again visited on the afternoon of December 27th, eight days after the kill. Fresh cougar tracks at the site indicated the cougar had probably been feeding when we approached.

Both hind quarters of the elk had been completely eaten or removed from the site. The left front shoulder, left rib cage, lower neck and all internal organs except the stomach and intestines had been eaten. Snow had been systematically scratched onto the stomach and intestines and packed down. Only a small portion of flesh attached to the spinal column and right front shoulder remained. The neck and head were intact and completely undisturbed. Considerable quantities of dehaired skin had been eaten. A portion of leg bone about 14 inches long was found covered with twigs and debris about ten feet from the kill. Other portions may have been previously removed and covered.

The cougar continued to visit the kill-site for over a month. During this time it removed or consumed all portions of the elk except the hair and paunch.

Throughout this entire period the cougar was apparently undisturbed by the occassional vehicle on the road and the periodic visits of the observer.

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A Young Albino Snapping Turtle, *Chelydra serpentina* L., in Southern Ontario, Canada

Abstract. In the first week of September, 1970 a newly hatched albino *Chelydra serpentina* was collected along with six normally-colored ones from the same clutch of eggs in the vicinity of London, Ontario.

In the first week of September, 1970, Neil Vanbakel, son of Harry Vanbakel, R.R. 1, Dorchester, Ontario and a student in Grade 7 of St. David's School, Dorchester, located a clutch of eggs of the snapping turtle, *Chelydra serpentina* L., immediately to the south of Provincial Highway 2 about four and a half miles east of the city limits of London. They were in the soil forming the bank of a drainage ditch which flows through a culvert southward beneath Highway 2 and into Lot 12, Concession I of the north part of North Dorchester Township, Middlesex County. Shortly after 7 September the eggs hatched and Neil Vanbakel captured seven of the emerging young turtles. Six of them were normally colored, being dark brown with a light spot at the edge of each marginal scute, as described and illustrated by Conant (1958). The other turtle was much lighter.

One of the normally colored turtles and the light-colored one were given to the writer on 11 September. In both specimens the carapace was 28 mm long and the tail 30 mm long. The light-colored turtle was white over all its surface with a slight yellowish cast. The pupil of the eye of the normal turtle was black, while that of the white one was bright red, this difference in color being particularly noticeable in the reflected light of a lamp.

Hensley (1959) defines complete albinism in amphibians and reptiles as referring to animals that exhibit no apparent melanin and that possess a pink, or red, eye-color. The white turtle discussed here falls into this category. Hensley (1959) includes two instances of albinism in *C. serpentina*, one involving a specimen hatched from a clutch of eggs found by a small boy at Windsor, Ontario and another kept alive in a museum in Charlotte, North Carolina.

The normal turtle and the albino collected by Neil Vanbakel are deposited in the collection of the Department of Zoology, University of Western Ontario.

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A Range Extension and Basking Observation of the Blanding's Turtle in Nova Scotia

Abstract. Observations in 1970 of Blanding's Turtles (*Emydoidea blandingi*), in southwestern Nova Scotia extended the range of this relict, disjunct population by approximately 15 miles to George Brook, Mersey River, two miles below the outlet of Lake Rossignol. On April 30, observation of basking at Grafton Lake is the earliest spring sighting in the area and contradicts an earlier theory of the existence of separate basking and non-basking populations.

Since its discovery in 1953, information on distribution and ecology of the disjunct, relict population of Blanding's Turtles (*Emydoidea blandingi*) in southwestern Nova Scotia has accumulated slowly (Bleakney, 1963; Powell, 1965). The following observations, made in the area in 1970 while I was Chief Park Naturalist at Kejimkujik National Park, are additions to our knowledge of Nova Scotia populations.

On June 24, 1970, Jim Harding and Brian Purdy collected an adult female Blanding's Turtle on a gravel road at George Brook, near the Mersey River approximately two miles below the outlet of Lake Rossignol, Queens County, Nova Scotia. This is an extension by approximately fifteen miles from the previously known range, as described by Powell (1965); a triangular area between First Lake, Annapolis County, West River, Annapolis County, and Caledonia, Queens County. The specimen collected on June 24, 1970 is thought to be a female searching for (or leaving) a nest site, and further collections will probably show the range of the Blanding's in Nova Scotia to include Lake Rossignol and the numerous lakes surrounding it. The large, shallow inundated portions of Lake Rossignol should provide ideal habitat for this species.

On April 30, 1970, I observed one adult Blanding's Turtle at 2:30 p.m. basking alone on a grassy stump about twenty yards from shore on an inundated inlet at the south end of Grafton Lake, Kejimkujik National Park. The water was shallow, about three feet deep and the Blanding's quickly dove into the water when I approached.

At 2:45 p.m. on April 30, 1970 I observed two additional adult Blanding's basking on a fallen log immediately next to the shore in the same inlet of Grafton Lake as the first observation. The Blanding's were basking in close association with at least six Eastern Painted Turtles (*Chrysemys picta picta*). The log was partially covered by sedge, moss and Leather Leaf (*Chamaedaphne calyculata*). When I approached the turtles slowly by land, they all dove into the shallow water, but the two Blanding's Turtles reappeared amidst the emergent vegetation, mostly Leather Leaf, and stared in my direction. Only their heads were above water and they were difficult to see in the vegetation. This basking note is interesting in that it provides preliminary evidence that there are not separate non-basking poulations of Blanding's on the east and west sides of Kejimkujik Lake, contrary to a suggestion by Bleakney (1963). This is also the earliest spring observation of the Blanding's in Nova Scotia.

Acknowledgment

I wish to thank Francis Cook for reviewing this manuscript.

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Ragged Robin, *Lychnis flos-cuculi* L. (*Caryophyllaceae*), in Canada[1]

Ragged-robin is very distinctive and may readily be distinguished from other *Lychnis* and the closely related *Silene* by its deep rose-red (rarely white) petals which are deeply and irregularly 4-cleft into linear segments. It is a perennial which stands 1 to 2 ft tall, has spatulate rather crowded basal leaves and remote opposite, lanceolate cauline leaves; the stems are rough with retrorse hairs and are somewhat glandular above. This European plant has previously been reported from Newfoundland, Nova Scotia, New Brunswick and Quebec and its occurrence in Ontario is verified in this note.

Camille Rousseau (1968) in his studies of introduced plants in Quebec has noted the increase of *Lychnis flos-cuculi* in the Eastern Townships where it has now become quite common in some low-lying fields, since its first collection there in 1914. A map of the Quebec distribution is given by him.

Hubbert (1867) first recorded this plant as occurring outside cultivation in Canada, but gave no indication as to where it might be found. Indeed, it was listed separately under the heading "Occasionally escaped from cultivation about dwellings, etc." and in his introduction he expanded this statement by ". . . and maintaining a precarious existence; usually disappearing after two or three years."

[1]Plant Research Institute Contribution No. 784.

The only collection cited by John Macoun (1883) in his Catalogue of Canadian Plants, is one which was collected by a Mr. Chalmers at Campbelton, New Brunswick on June 23, 1876 (duplicate specimen ex Herb. James White in DAO). Macoun made no reference to a Hubbert collection so presumably there was no specimen in his hands to substantiate the earlier record.

For Nova Scotia, Roland and Smith (1969) state that it is local in Kings, Yarmouth and Colchester counties but say also that some fields and meadows may be red when it is in flower in late May. They further state "When once it is introduced into a meadow it is persistent but spreads rather slowly".

The only record for Newfoundland is that found in Boivin (1966). This is based on a collection made by David Erskine (No. 3049) which is preserved in the Plant Research Institute Herbarium (DAO), from Holyrood in the Avalon Peninsula.

Boivin (*l.c.*) also doubtfully recorded this plant as occurring in Ontario. The following is a substantiation of the occurrence of *Lychnis flos-cuculi* in that province: ONTARIO: Stormont Co., St. Lawrence Seaway Provincial Park, Morrison Island, in sod in camp area, *W. J. Cody 18498* (DAO). There were about 50 plants at this site. Whether this is a recent introduction or one of long-standing is not known, but it was not collected by Dore and Gillett (1955) during their three year survey of the lands to be flooded or adjacent to the St. Lawrence Seaway. Ragged-robin is quite beautiful when it is in flower and because of this may be transported to new sites from whence it might escape. It is however not likely to become a nuisance in the same manner as more aggressive introductions from Europe.

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Death of Purple Martin Nestlings Apparently Due to Ingested Mollusc Shells

Abstract. In a new Purple Martin colony at Ottawa, most of the young died in the nest. Death of the only two nestlings examined is attributed to gizzard impaction by shell fragments of a locally extinct clam, *Hiatella arctica* (L.).

In August 1970, the carcasses of two nestling Purple Martins, *Progne subis* (L.), about two weeks of age, were submitted to us by an Ottawa resident for examination. They were from a new martin colony of yearling adults in which only one bird had fledged from eight clutches laid in 1970; all the other nestlings had died between ten days and two weeks of age in the fourth week of July.

The condition of the carcasses did not permit a detailed examination; however, we noted that the feathers around the vent of each bird were matted by urates, the intestine was almost empty, and the gizzard was distended and apparently impacted by a mass of clam shell fragments.

The nine fragments from the two birds ranged from 7.5 to 10.5 mm long and from 4.5 to 9.0 mm wide. They were identified by Dr. A. H. Clarke, National Museum of Natural Sciences, as *Hiatella arctica* (L.). Shells of this saxicavid clam are abundant in the vicinity of Ottawa in exposed sediments of the Champlain Sea, which covered this region between 4,500 and 7,000 years ago (Flint 1957). Although Allen and Nice (1952) did not record ingestion of non-living material by martins, Sprunt (1942) referred to observations of martins pulling at oyster shells in a cement wall, ingesting bits of chicken eggshells and feeding pieces of the latter and small snails to the young. We have observed a female Brown-headed Cowbird, *Molothrus ater,* audibly removing and eating minute chips from *Hiatella* remains, but martins are probably incapable of reducing these hard shells to pieces small enough to be digested by nestlings.

Allen and Nice (1952) concluded that the most significant factor in mortality of nestling Purple Martins was weather, unusually high temperatures causing premature fledging and low temperatures resulting in starvation due to decreased food supply. Between July 12 and July 22, 1970, air temperatures at Ottawa averaged about 5°F below normal (data supplied by Department of Transport). This cool weather did not seem to depress insect abundance sufficiently to cause noticeable mortality in other martin colonies in the Ottawa Valley (W. E. Godfrey, Nat. Mus. Nat. Sci., pers. comm.). However, on July 19, air temperatures were 13°F below normal, showers occurred, and there were strong winds throughout the day; consequently, insect availability was probably greatly reduced. Possibly, the inexperienced yearling martins responded by utilizing *Hiatella* fragments to feed the nestlings.

We thank W. Earl Godfrey for information on martin biology and for suggesting several references.

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A Sight Record of the Wheatear in British Columbia

The Wheatear *Oenanthe oenanthe*, breeds in the Arctic and subarctic regions of the new world in Alaska, Yukon, Baffin Island, Ellesmere Island, the tip of northern Quebec, and Labrador. The breeding range is discontinuous with a large gap separating the western and eastern populations which have been described as distinct subspecies. There have been few records of the Wheatear at lower latitudes in Canada and all of these records have been from Ontario and Quebec (Godfrey, W. Earl 1966. The Birds of Canada. Queens Printer, Ottawa.) Wheatears breeding in the American Arctic migrate back to their wintering range on dry savannahs of central Africa via Siberia and Europe (Voous, K. H. 160. Atlas of European Birds. Nelson and Sons, London).

On October 19, 1970, a Wheatear was discovered by Keith Taylor and Ron Satterfield near a small hanger on the airport at Patricia Bay, twenty miles north of Victoria. Other birdwatchers were alerted and in the next two days it was seen by, perhaps, forty persons including the writer.

The Wheatear spent much time on the edge of the flat roof of the hanger, often darting down to the bare ground in pursuit of insects. It was very restless and generally its habitats resembled those of a bluebird. It was in fall plumage with predominately buffy colouration. The black terminal band and black central tail feathers contrasting with the white basal tail feathers and rump which gave a "T" bar effect was striking and distinctive. Colour slides, movies, and black and white pictures were taken. Pictures have been deposited with the British Columbia Photographic records collection at the Museum of Vertebrate Zoology, University of British Columbia, and the sighting has been recorded with the southern Vancouver Island Records Committee for their annual report.

This is, apparently, the first sight record of a wheatear for British Columbia.

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Red Crossbill Breeding in Wellington County, Ontario

A. B. Klugh (Ont. Nat. Sci. Bul. 1: 7, 1905) and J. Dewey Soper (Auk 40(3): 503, 1923) have recorded the Red Crossbill (*Loxia curvirostra* L.) as an irregular winter visitor at Guelph, Wellington County, Ontario (Lat 43° 32′ N Long. 80° 18′ W). Two major flights of Red Crossbills occurred at Guelph between 1955 and 1970, the period of the senior author's residence there, one in the late winter and early spring of 1961, and the other in the winter and spring of 1970. This latter flight extended at least from January 3 until June 22, 1970, according to observations of members of the Guelph Naturalists' Club reported to A. Salvadori. Peak numbers in excess of 50 were judged to have been present within the city during February and March.

The known breeding range of Red Crossbills includes most of central and southern Ontario, according to Godfrey (Bull. Natnl. Mus. Canada 203: 378). The few specific breeding records include one for York County, 60 miles east of Guelph, and a possible record for Middlesex County, 70 miles west of Guelph (Baillie and Harrington, Trans. Roy. Can. Inst. 21: 268, 1937).

Dr. R. H. Manske observed heavily-streaked imature Red Crossbills at his feeding station in Guelph on several occasions between May 19 and June 2, 1970. At times, he observed adults of both sexes feeding immatures. At 5:00 p.m. on the afternoon of June 5, 1970, A. T. Cringan observed an adult male Red Crossbill feeding a heavily-streaked immature in a Norway Spruce at his home in Guelph.

There can be little doubt that these heavily-streaked immature Red Crossbills seen at Guelph during May and early June, 1970, resulted from nestings at or close to Guelph. They represent a new breeding locality, although they do not constitute an extension to the known breeding range.

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A Record of the Passenger Pigeon in Alberta[1]

Abstract. Osteological material excavated from the Fort George archeological site was identified as Passenger Pigeon, *Ectopistes migratorius*; this confirms its occurrence in Alberta.

Several authors (Milton and Cheadle, 1901; Wright, 1911; Cooke, 1912; Farley, 1932) have referred to sightings of the Passenger Pigeon in Alberta but because no specimens collected within the province have been preserved, Salt and Wilk (1968) placed it on their hypothetical list. Recently during an examination of avian osteological material at the Provincial Museum and Archives of Alberta, Edmonton, several bones were identified as those of a Passenger Pigeon (*Ectopistes migratorius*). These bones, recovered in 1966 and 1967 from the Fort George archaeological site, were tentatively identified by comparison with a photograph in an article by Shufeldt (1914). Subsequently, this identification was confirmed by Dr. Howard Savage of the Royal Ontario Museum, Toronto.

Fourteen elements, representing at least two individuals, are in the group of bones and include two portions of the sternum, three humeri, two coracoids, two scapulae, and one each of a tibiotarsus, femur, ulna, furcula, and vertebra. All these bones with the exception of one humerus were found probably in association, and certainly in one locality of the Fort George site.

Fort George was occupied by fur traders of the North West Company from 1792 until approximately 1800. The site, excavated by the Provincial Museum and Archives in 1965-67, is located on the north bank of the North Saskatchewan River, an estimated 170 feet above present river level. It is approximately 5 miles southeast of the town of Elk Point, which is about 35 miles west of the Saskatchewan-Alberta border. Faunal remains were generally abundant at the site and included such species as bison, wapiti, moose, beaver, rabbit, Trumpeter Swan, geese, ducks, and upland game birds. Most of the Passenger Pigeon bones were excavated from a large cellar depression near the northwest corner of the palisaded enclosure; one humerus, however, came from a cellar near the southwest corner. Although no references to Passenger Pigeon were noted in the journal material pertaining to Fort George, Alexander Henry referred to flocks of pigeons at Fort White Earth (Coues, 1897), which was about sixty miles to the west, and was occupied slightly later (1810-13). Excavations at the Fort White Earth site have so far revealed no Passenger Pigeon remains, however.

The range of the Passenger Pigeon in Canada was mainly in the east, although breeding records have been reported from Saskatchewan, a specimen was collected in British Columbia, and the species is also reported to have occurred in the Northwest Territories (Godfrey, 1966). The present record for Alberta helps to confirm its occurrence in this province as well.

We gratefully acknowledge the assistance of Dr. Howard Savage, Research Associate, Royal Ontario Museum, Toronto, in confirming the identification of the Passenger Pigeon material. We would also like to thank Bruce McCorquodale, Head Curator of Human History, Provincial Museum and Archives of Alberta, for additional faunal identifications and John Nicks, Historic Sites Officer, for data on excavations at Fort White Earth.

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News and Comment

The Park in Perpetual Planning: The Kluane Park Reserve, Yukon

In recent years the federal government has placed much emphasis upon the concept of the utilization of Canada's North for the benefit of the country as a whole. The development of national parks in the ecologically fragile north is a part of this policy. Of the proposed national parks the one in the Southwestern Yukon Territory is perhaps the most outstanding and delayed of all (see map). The area is bounded by the White River on the north, the Alaska and Haines Highways on the east, the British Columbia border on the south, and the Alaska border to the west. The area includes 8,800 square miles or but 4.3% of the Yukon's land area, which is currently known as the Kluane Game Sanctuary. A range of absolutely majestic scenic attractions and ecotomes is included which is difficult to find in any one subarctic area.

The park which may be divided into three general landscape types: the high glacierized mountains, the alpine tundra mountain area, and the glaciated river valleys. Most of the high mountain area lies behind a linear "front range" or the Kluane Range which lies along the west side of the Alaska Highway, cut only by a few large glacially fed streams. The Kluane Range summits average 6,000 to 8,000 feet with a few to 10,000 feet. Although some small glaciers lie in this area, the majority of it is an alpine tundra with spruce forest on the lower slopes.

Westward from the Kluane Range the elevations rise steadily and peaks coalesce under ice cover to form a broad, high glacier plateau (8,000 to 10,000 feet in elevation) known as the Icefield Ranges. The plateau forms a base for the high peaks of the St. Elias Mountains.

The St. Elias form the core of the area. They are the most massive and some of the highest mountains in North America. The major peaks, all over 14,000 feet in elevation, include Mt. Lucania, Mt. Steele, Mt. Wood, Mt. St. Elias, Mt. Vancouver, Mt. Hubbard, and the imposing block of Canada's highest peak Mt. Logan (19,850 feet).

These and scores of slightly lesser peaks are encased by the extensive mountain icefield with a network of radiating valley glaciers, such as the

Map showing location of the Kluane Park Reserve.

Seward, Hubbard, Logan, Donjek, Steele (the galloping glacier), and Kaskawulsh. These represent some of the most extensive glacier areas outside of Antarctica and Greenland.

The glaciers spawn numerous major and minor streams. The main watercourses save one, drain to the continental side of the mountains and then to the Yukon River. From north to south they include the White, Donjek, Slims, and Alsek Rivers. The Alsek drains to the Pacific via a narrow gorge.

The northeastern fringe of the Kluane Sanctuary is an expanse of alpine tundra which includes the Kluane Range. Almost all of the wide variety of wildlife and plants are included in this area.

Three major vegetation zones can be recognized: (a) the boreal zone extending from the valley floor — 2,500 to about 3,500 feet elevation, (b) the new sub-alpine zone — 3,500 to 5,000 feet and (c) the alpine zone from 5,000 to 7,000 feet. There are many exceptions to this generalization, depending on aspect, slope and moisture regime. The climate of the reserve is semi-arid with an annual precipitation of less than 10 inches. Characteristic of the landscape are many patches of grassland which can be seen in the valleys as well as on the south and southwest facing slopes. Here they may extend over all three major vegetation types. No native ungulate is present to use these prairie pockets in the valleys. On the slopes, however, they make up the winter

Slims River Valley—Kluane Park Reserve.

range for the Dall Sheep. The dominant species of these grasslands are *Carex filifolia, Agropyron yukonense, Poa glauca* and *Artemisia frigida.* Succession proceeds via *Calamagrostis purpurascens, Arctostaphylos urva-ursi, Juniperus communis, Juniperus horizontalis* to *Picea glauca.* Occasionally Aspen and Balsam Poplar stands occupy alluvial flats. Black Spruce and Paper Birch are only found in the northernmost portion of the reserves; Lodgepole Pine, Alpine Fir and Larch are absent. On northern and eastern aspects White Spruce forest is continuous in the boreal zone and dwarf birch thickets in the sub-alpine zone. Along a moisture gradient from dry to wet, the dominants of alpine communities are the following: *Salix arctica, Carex filifolia, Oxytropis viscida* to *Dryas integrifolia, Festuca altaica* to *Cassiope tetragona, Saxifraga oppositifolia* to *Salix reticulata* to *Salix polaris* to *Eriophorum sp.* From the phytogeopraphical point of view, the occurrence of *Artemisia rupestris* and *Eurotia lanata* is interesting.

The Kluane reserve is the stronghold of the pure white form of the Dall Sheep, *Ovis dalli dalli.* However, a few Black-tailed Sheep have recently been observed. Sheep densities are very high on some winter ranges, the total number for the reserve may be as much as 5,000. Moose are common throughout and particularly abundant in the Donjek River's alluvial flats. The Duke River Plateau supports a small herd of Mountain Caribou. Mountain Goats inhabit the southern portion of the reserve north to the Slims River and Mule Deer have recently made their appearance. Grizzly Bears are very abundant in the Alsek River valley. There are even reports on Alaskan Brown Bears from the Alsek and Tatshenshini valleys. Other large mammals include Wolf, Coyote, Black Bear, Lynx, Wolverine, Red Fox, Beaver, Otter, Muskrat and Mink.

A list of birds compiled by the writers for the Kluane Lake area in recent years stands at 120 species. There is an interesting breeding population of Upland Plovers in the Duke River delta, a pair of Peregrine Falcons was observed in the same vicinity. The Starling made its first appearance this spring.

The Dall Sheep and the Alaskan-Yukon Moose, *Alces alces gigas,* are not found in any existing Canadian National Park. A Kluane National Park may protect some of the few Alaskan Brown Bears on Canadian soil.

The history of human activity in the Kluane Sanctuary begins about 1900. The Kluane area was at first established as a minor mining district about 1903 with its center at Silver City, now abandoned, at the south end of Kluane Lake. During this period, a few smaller placer mines were operated, with no large strikes. Burwash Landing on the west side of Kluane Lake was and is in an Indian village which was utilized before World War II by the Jaquot brothers, outfitters who guided big game hunters in to the St. Elias Range. The community of Destruction Bay (Mile 1083) is mainly a communications and highway maintenance camp.

In addition, a number of biological, geological, and boundary surveys were conducted prior to

World War II. Some oroiginal knowledge of the high mountain section was gained by the first Mt. Logan expedition of 1925 and the Wood expeditions of the 1930's.

World War II, of course, brought the Alaska Highway. With the highway came a number of land use surveys and inventories. The result was the declaration of the current Kluane Game Sanctuary as a National Park Reserve on Dec. 8, 1942 by Privy Council Order 11142. The area had been recommended by the Dept. of Mines and Resources and by the Controller of the Yukon Territory as particularly suited as a National Park. However, the area has been eroded by mining and exploration pressures. Privy Council Order 7101 deleted Kluane Lake and a strip 5 to 15 miles wide along the north Alaska Highway and White River from the Reserve, in 1944. In the same year Privy Council Order 930 allowed prospecting, claim staking, and the granting of mineral rights within the Reserve area.

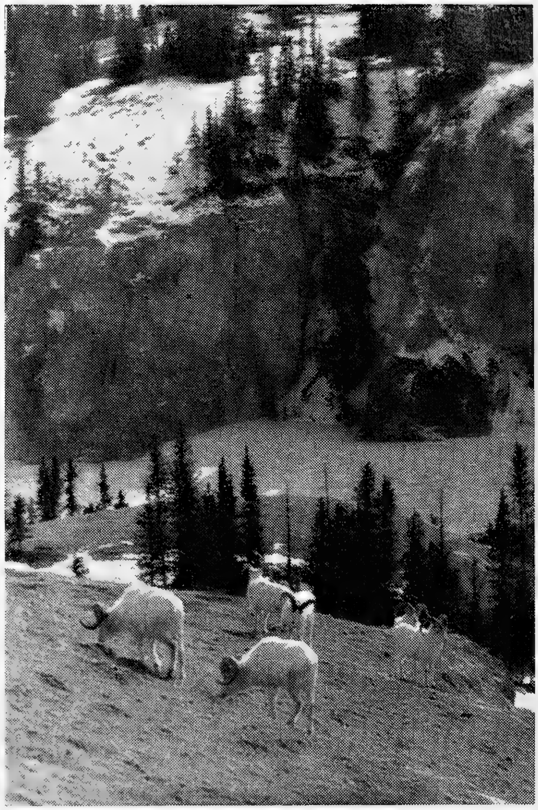
Consequently the title "Reserve" does not convey the land protection of a full national park. Extractive industries may proceed as before, which means no restrictions.

There was a claim staking rush in 1952-53 as a result of a small strike on Quill Creek, near Mile 1111, west of the north end of Kluane Lake. Currently mining activity in the proposed park involves a small mine at Quill Creek, a few small placer claims, and extensive exploration work in the White River area. In the past few summers, the northeastern part of the area has swarmed with prospecting helicopters.

Since 1961, the Icefield Ranges Research Project of the Arctic Institute of North America has conducted extensive physical and biological scientific investigations in the area.

The proposed park has apparently progressed very little. In a letter of Feb. 11 this year, Mr. Nicol, director of the National and Historic Parks Branch, stated that work on planning the park is proceeding and that action could hopefully be taken soon, perhaps by late 1971. It was further stated that delays were mostly legislative in nature.

However, it is difficult to be optimistic in the light of the thirty year delay already experienced. The crux of the matter can perhaps be summed up in the well known opposition of the Yukon mineral industry to the withdrawal of lands for any reason from their possible uses. Primarily for this reason, the Yukon has no national park nor any other kind of park.



Dall Rams — Kluane Park Reserve.

Some members of the Yukon Territorial Council have in the past opposed a national park. It may be said that some Yukon politicians would likely oppose a full-fledged national park on the basis that mining is primary in the Yukon; although this cannot be said of all of them.

Communications have been received from Mr. Nielsen, the Yukon Member of Parliament (March 30), and from Mrs. Watson, a territorial councillor (March 19). They stated that our views would be presented when the time came. A letter from the office of Mr. Smith (April 5), the territorial commissioner, stated that he has long favoured a park. With such statements, one suspiciously wonders why the park has not been long established. A letter from the office of Mr. Chretien, Minister of Indian Affairs and Northern Development (and in charge of parks) on April 3 gave the usual "thank you for your effort" statement, and a reminder that these things "do not materialize quickly."

A key factor which remains to be seen, is whether a regular national park is proposed, or the so-called "multiple use" park which seems popular among some politicians now. This arrangement would allow mining within a national park.

This position is reflected in a public statement this winter on CBC radio by Mr. Nielsen, to the effect that "conservation was one thing, while preservation was stupid", to use the exact words. Another concern is to what extent opposition lobbies will attempt to whittle down park boundaries.

One of the main arguments utilized by opponents of the park is that the people of the Yukon don't want it. This is currently being invalidated by a petition drive within the Yukon which strongly favours quick establishment of the Kluane National Park. At this point about 80 per cent of all residents interviewed have signed the petition. Copies are sent to Mr. Chretien, Mr. Nicol, Mr. Smith, Mr. Neilson, and Mrs. Watson. The petition drive continues and some petitions have already been sent in.

Several suggestions have been made by petition signers reflecting local concerns. These may be summarized as follows:

a. The Yukon has no national park at present, and such an attraction is needed as tourism is important. The Kluane Reserve borders the Alaska Highway, greatly aiding accessibility.

b. The majority of signers fet that as much of the current Reserve should be made into a national park or at least included in the park, as possible.

c. Most signers were concerned that the area should be developed as a park and not just declared so to lie dormant.

d. Most signers were of the opinion that local people should be employed in the park whereever possible.

The crux of the matter now seems to be to get the political decision makers in Ottawa to move, and the man who must take the initiative is Mr. Chretien. While the Yukon officials are certainly consulted, the Yukon is still a Territory. Consequently, the final and theoretical sole decision lies in the Department of Indian Affairs and Northern Development at Ottawa. Thus far the powerful mining lobby has prevented the decision or delayed it on the federal level. A public awareness of this park outside, as well as inside the Yukon is required. More importantly, public action is needed. Parties interested can best help by spreading the word to all interested people and organizations, and by writing to both Mr. Chretien and their own Member of Parliament.

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Reviews

The Biological Aspects of Water Pollution

By Charles G. Wilber, Ph.D. Charles Thomas Publisher, Springfield, Illinois. 1969. 269 p. clothbound $23.75.

There has been a great deal of public concern about the environment and the degradation of the ecosystem, both in local areas and on a global scale. The amount of fresh water available to us is limted, and it is obvious that proper management of this resource will be required if we are not to face an acute shortage of clean water in the next few decades. The marine coastal environment is also being seriously degraded. This has prompted legislators and administrators of pollution control agencies into action. Often so-called environmentalists or eco-activists get involved in demonstrations without too much background information, as a basis for pressing their demands. Since much of the effect of pollution has biological and ecological implications, a suitable reference book on such aspects has been needed for a long time.

Dr. Wilber has written such a book. Although it is a scholarly treatment, the book is not overly academic. A likely candidate as a text book, or important reference, for a senior level or graduate course in ecology or environmental biology, it is quite comprehensible for the average lay reader or for the naturalist interested in the subject. It can also be a useful reference for the researcher, pollution control engineer, administrator and teacher. Profusely illustrated with photographs and line drawings, and replete with tables, the volume should serve as a useful handbook for quick information. An index simplifies finding items.

After introductory chapters on fundamental concepts in water, and general toxicological and ecological considerations, each chapter deals with a different class of wastes. The book is written in a highly readable style, the author obviously being a master of English prose. The subject material covered includes pollution by metals, oil, pesticides, pulpmill wastes, sanitary sewage, radioactive wastes, mine wastes, silt, cooling water and other industrial pollutants. A good survey of the literature of each field has been made, including more obscure documents originating from government sources in the USA and in other countries. These are given at the end of each chapter on specific pollutants. The significant facts and important conclusions have been discriminately extracted.

On principles, the author has emphatically stressed the need to examine more fully the sub-lethal effects of various pollutants. He has rightfully pointed out that populations of fish and other aquatic organisms can be as easily destroyed by sub-lethal effects of pollutants as by mortality. Physiological effects, which lead to reproductive failure, are every bit as damaging to a species as direct death due to poisoning. The fact that an elevated temperature does not kill a certain stage in the life cycle of an aquatic organism is no indication that the temperature is harmless to the species.

The book covers mainly freshwater pollution problems. But where there are good data available on the marine environment, these are also included. Because atmospheric pollutants impinge occasionally their effects on water, air pollution is also discussed briefly. Tabular material has often been drawn together to summarize given subject areas, or appropriate tables of this type have been borrowed from other sources.

Dr. Wilber points out the need to study some rather complex mixtures, even though they may be a toxicologists' nightmare, because these are the types of materials that enter our natural waters. Included in this category are detergents, pulpmill wastes and complex mixtures of chemicals. He notes that even though investigations of mixtures such as these, with potential for synergism, antagonism and other interacting effects, are less tidy toxicologically, they are nevertheless more realistic than laboratory experiments with highly purified single chemicals. Few effluents are made up of single known chemicals. It is the rule rather than the exception that effluents are mixtures.

In this connection, the importance is also stressed of certain ignored wastes, such as storm waters, sewer system overflows and runoff from garbage dumps. It is these so-called incidental contaminants that sometimes add up to serious problems.

A major new water pollution problem emerged when the synthetic chemical industry developed. Dr. Wilber notes the need for intensive examination of these chemicals, both from the acute and long term, chronic points of view, before they are released into the environment. Some, such as DDT and other chlorinated hyrocarbons, have led to serious effects on perpetuation of certain species.

Aquatic systems are generally quick to recover from pollutional effects once most industries cease operation and discontinue to discharge their wastes into the waters. However, Dr. Wilber hastens to point out that certain industries continue to pollute long after their operation ceases. Strip mining is a case in point. Acid pollution, resulting from sulphuric acid formed by oxidation of exposed sulphides, continues long after the operation, if the stripped area is not covered. The effect of silt from erosion during heavy runoff can also be disastrous. For this reason, it is considered that rehabilitation with soil and tree cover of a stripped area is an essential part of such a mining operation and should be done at company expense.

Dr. Wilber generally deals with aquatic organisms throughout his book. But effects on humans of certain pollutants in drinking water and in food are not ignored. This particularly applies in his chapter on Radionuclides, where he attempts an objective assessment of the effects of radioactivity on human beings. He places in perspective the danger of artificial radiation with that of other well-known hazards, e.g. one's normal live expectancy is reduced by: 9 years if one smokes a pack of cigarettes a day; 5 years if one lives in the city instead of the country or is single instead of married, or has a sedentary job instead of a physically-active one; 3 years if one is a man intead of a woman; 1½ years is one is 10% overweight; 1 year for everyone because of automobile accidents; 5 to 10 days if one is exposed to 1 roentgen of radiation; and 1 to 2 days because of exposure to worldwide fallout.

Dr. Wilber clearly emphasizes that there is no panacea to fool-proof biological observations of pollutional effects. Even though sedentary organisms integrate the effects of pollution, there is still much to be learned in properly identifying and classifying, except in the grossest way, organisms associated with a certain degree of pollution. As Dr. Wilber points out, "There is a cloud of ignorance over the question why many of the reputedly clean water organisms begin to disappear from polluted waters." For effective studies with indicator species, experts in benthos taxonomy are required, and these are rare. On the other hand, many bacteriologists and chemists with the requisite skills are available to test and measure bacteriological and chemical effects of pollution on water.

The needs for research in a number of areas are identified. Research must develop new bacterial indices, which will be more meaningful in the assessment of public health hazards from sewage pollution. Sound methods must be developed for evaluating effects of disposal of wastes on water quality in coastal waters. There is a dearth of information on the effects of waste discharges on marine organisms of economic value. Extensive and valid models are needed of ecological systems to predict future changes and steady states in nature.

A minor point of difference might be noted by this reviewer with respect to the word "stress", which Dr. Wilber opposes for expressing an adverse effect on an organism. This happens to be one word in the jargon of pollution investigators which conveys a certain meaning of sub-lethal harm, even though it is difficult to define. In the absence of a good alternative, "stress" will probably continue to be used.

The book suffers from the same shortcoming attributable to any book nowadays in a rapidly growing field. By the time it is printed, an addendum or a revised edition is needed to account for new advances. It is hoped that a new printing or new edition will eliminate the typographical errors which have crept in. One can excuse those errors in word spelling which are obvious; but there are numerical errors, such as the number of Angstroms in a micron (p. 198) which can be misleading for someone using the book for such information. It is hoped that not too many such errors exist in values of median lethal dose.

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Chemical Mutagenesis in Mammals and Man

Edited by F. Vogel and G. Rohrborn. 1970. Springer-Verlag, New York, Berlin, Heidelberg. XIV + 519 pp. 95 Figures, $34.10.

In the last 50 years an enormous number of new synthetic chemicals has appeared. Unlike radiation, many persist in the environment. These chemicals have many diverse uses, for example, fuel additives, agricultural chemicals notably pesticides, food additives, household and industrial chemicals, therapeutic and hallucinogenic drugs. Many of the these chemicals have been shown to damage the chromosomes and to induce mutations. Each year several thousand new chemicals are produced and up to 2,000 of these may come in contact with segments of the population. In addition, there are a number of natural chemicals —

fungal and plant toxins, and secondary compounds — nitrosamines —which like the synthetic chemicals are found in a wide array of products and of which some have been found to be mutagenic. It has also been shown that there are a number of chemicals which become mutagenic after they have been metabolized by man. The fact that chemicals can and do induce mutations has been known to geneticists since the nineteen forties, but it is difficult to extrapolate data with 100 per cent assurance from lower organisms to the human species. Relevant methods have not been available to determine mutagenicity in mammalian systems despite warnings of the potential public health hazards of chemical mutagens by a few individuals. Fortunately, the recent development of practical, sensitive, and relevant methods for detecting and measuring the effects of chemical mutagens in mammalian systems are now available.

Chemical Mutagenesis in Mammals and Man is the outgrowth of a symposium held in Germany in 1969. Its thirty chapters are an exhaustive treatment of the subject providing both theory and technique. Some of the subjects covered are biochemical mechanisms in mutagenesis, spontaneous and point mutations, dominant lethal and multiple loci methods, histological and cytological methods in spermatogenesis, *in vivo* and *in vitro* methods, host-mediated assay, extrakaryotic mutations, alkylating agents, cell culture, virus-induced chromosomal alterations and monitoring of human populations. A chapter by A. Barthelmess, "Mutagenic substances in the human environment", lists 28 pages of mutagenic substances and cites over 1000 references. The Appendix of 42 pages is a chapter on "Statistical Methods in Mutation Research" by J. Kruger. The difficulty which students of chemical mutagenesis have faced in extrapolating results from lower organisms to humans is clearly detailed, especially in the two chapters on caffeine mutagenesis. Caffeine, which is present in coffee, soft drinks and medicines, is highly mutagenic in some microorganisms, but is negative, or only weakly positive, in rodents; and while it causes chromosome breakage in human cells in culture, its mutagenic action in humans is unknown. However, methods are now available for assessing more accurately mutagenic action in humans and the first comprehensive data are provided in this book. Cytogenetic, the dominant lethal, and the host-mediated assay methods show the most promise. The latter technique developed by Legator in 1969 is to treat a mammal with a potential chemical mutagen, inject an indicator microorganism in which the mutation frequency can be measured, withdraw the microorganisms and determine the induction of mutants. After the mutagenic action of the compound on the microorganisms *per se* has been made, it can be determined from the host-mediated assay whether the host can detoxify the compound or if mutagenic products can be formed as a result of the host metabolism. Previous lack of interest in chemical hazards to the genome of man may be due to the absence of readily observed effects such as those produced by carcinogens (various types of cancers) and teratogens (malformed offspring). The large majority of mutations are recessives and although harmless to the individual carrying them, they are passed on to succeeding generations. When two such genes come together at the time of conception, a harmful effect may be produced in the developing foetus. It is estimated that six percent of the babies born have defects of mutational origin such as congenital malformations, mental defects, epilepsy, cutaneous and skeletal defects and visual and aural defects. At the present time, the Food and Drug Directorate requires extensive tests on toxicity. However, no tests are required for mutagenicity for any pesticides or other chemicals before being introduced into commerce. The know-how is now available.

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Ornithology in Laboratory and Field

By Olin Sewall Pettingill, Jr. Burgess Publishing Company, Minneapolis, Minn. 1970. XVII and 524 pp. 4th edition. $11.95 (US).

Pettingill's *Laboratory and Field Manual of Ornithology* has undergone five revisions since it first appeared in mimeographed form in 1937. This latest edition, like its predecessors, "... is intended as an aid to ornithology study at the college or university level." It may be of less interest to the amateur naturalist. For example, in the list of materials required by the student, the author stipulates the following: a human cervical vertebra, the hyoid aparatus from a woodpecker, a dissecting microscope and a collection of skins representing all of the orders and families of North American birds. This edition, which has the title *Ornithology in Laboratory and Field* has 524 pages compared with the 381 in the third edition. It contains several completely new chapters and virtually every section has been re-worked and expanded, and the bibliographies following each chapter have been updated and augmented with new material. Although the author insists that it is still essentially a field and laboratory manual, the hard cover and the $12.00 price tag would tend to place it more in the textbook category.

The twenty sections which comprise the main part of the book are more or less independent units and while they are presented in a fairly logical sequence, they could be taken up in almost any order depending on the number of class hours per week, the time of year and the personal preferences of individual instructors. The introductory section, Birds and Ornithology, which is a feature of this new edition, is intended for reading at the begining of a course in ornithology, its purpose being to show the significance of birds for study and to give an overall preview of ornithology. This is followed by sections dealing with avian topography, feathers and feather tracts, anatomy and physiology. These are all presented very much as they would be in a undergraduate anatomy laboratory manual with instructions for the dissection of specimens and advice on how to label the prepared drawings in the text. While in most cases the treatment of the material is thorough and complete there is a certain unevenness in emphasis. For example, twenty-six pages are devoted to a discussion of feathers and feather tracts while the ovary and ovum are dismissed in a few brief sentences. The practice of separating the text and reference material from the laboratory intructions, I feel is perhaps unwise. The sections dealing with systematics, external morphology, distribution and migration have all undergone some revisions and in all cases the bibliographies have been expanded and updated. The remainder of the book covers various aspects of breeding biology; territory, song, mating, nesting, eggs and incubation, young and parental care. Again the treatment is comprehensive and the reference to current literature is exhaustive. This edition contains several new sections which were not present in the 1956 edition. Some readers may find the introductory chapter somewhat redundant but the new sections on behaviour, ancestry, evolution and decrease are all well done and certainly warrant inclusion in a book of this sort. The appendices, which occupy almost a quarter of the book, contain several particularly useful bibliographies. These alone would justify the cost of the book, although Canadian readers might be disappointed to find that the number of entries in the Canadian section has declined from 157 in the 1956 edition with 77 from the Canadian Field-Naturalist to only 27 in this new 4th edition and with none from the Canadian Field-Naturalist. Appendix I, Ectoparasites of Birds, was obviously added as an afterthought.

From a purely technical point of view, this book has few faults and no typographical errors except for a faulty line drawing on page 351 (the same one incidentally, which appears in the older edition) and the omission of page numbers or words on pages 250 and 510. It is unfortunate that the otherwise excellent illustration of melanin granules in a contour feather had to be reprinted as an erratum because of a printing error. In summary, I feel that students of ornithology in the colleges and universities of the United States and to lesser extent, of Canada, will find this book to be a most valuable asset. The more compact textbook format of this edition almost certainly will be welcomed by its many users although some may question the wisdom of devoting so much space in so valuable a book to student drawings, fill-in-the-blanks and so forth. *Ornithology in Laboratory and Field* is well written, professionally produced and contains one of the most complete digests of ornithological literaure in print today.

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How to Know Pollen and Spores

By Ronald O. Kapp, Wm. C. Brown Co., Dubuque, Iowa. 1969. 249 pp. Available in Canada From Burns and MacEachern, Don Mills.

As the author has stated in his introductory remarks most palynologists in North America depend on European keys and manuals for identifying pollen and spores of plants and resistant remains of algae and protozoa found in peat and other soil samples. Therefore, it is most gratifying to see a publication, of which there is few, touching on all these points based entirely on North American material.

The book begins with general discussions on the morphology and functions of pollen and spores; describes various sampling collecting apparatus and preparation techniques with an up-to-date list of literature references which will be particularly helpful to the beginner interested in palynology and other disciplines in botany.

The keys and descriptions will help direct the American palynologist to the family or genus of unknown grains. It is unfortunate that many of the drawings do not show the detailed descriptions required in a study of this kind. The author emphasizes that available reference collections prepared from authoritively identified plants is essential for final verification of the material under examination.

The scanner electron microscope photographs on pages 240 and 242 show more detail than given under the light microscopes and will be used to better advantage in describing material for future publications.

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The Ecosystem Concept in Natural Resource Management

G. Van Dyne ed. Academic Press Inc., New York. 1969. 383 p. $16.50.

The word "ecology" is too recently popular to have entirely lost its earlier meaning. Like all such words it is being overused, misused and abused. By going back only fifteen years to a dictionary of biology last revised in 1957 we find a simple definition: "study of the relations of animals and plants, particularly of animal and plant communities, to their surroundings, animate and inanimate." The word may be modified to apply to study of species (autecology) or communities (synecology).

The book under review is based on a symposium held at the annual meeting of the American Society of Range Management in 1968. Examples are from temperate and arctic North America. Most of the authors present reviews of their own diverse fields before discussing them in the light of the single unifying concept of the ecosystem.

Chapter I opens by stating that a natural resource ecosystem is an integrated ecological system, one element of which is a product of direct or indirect use to man. Broadly speaking, then, a natural resource ecosystem is an ecological system and we are faced with the disturbingly circular idea of a system pertaining to study of itself. The adjective "ecological" when used to mean anything other than "pertaining to ecology" leads to confusion but we may as well get used to examining contexts to discover the authors' implicit but usually undefined meaning.

Chapter II opens with another definition: "The 'ecology' part of Tansley's idea dates formally from Haeckel (1866) as 'nature's household' and the 'system' part is fixed in English, but derived from Latin and ultimately from Greek, as a meaningful or useful agglomeration." The rest of the chapter gives us a scholarly discourse on the historical development of the ecosystem concept in Europe and North America.

If the reader has been groping for a single precise definition of what the book is all about he can now rest from his labours having achieved realization of the aptness of the title. We are not dealing with a precisely definable expression. We are dealing with an inexact concept, an example of etymological evolution.

Section II is introduced as consisting of three chapters containing examples of research development and research results applying ecosystem concepts. A study of grasslands in Saskatchewan is used to describe the organization of a large co-operative study and how the work of a hundred diversied specialists can be co-ordinated. The watershed-ecosystem concept is illustrated by an example from the White Mountains of New Hampshire. The vocabulary is that of the hydrologist and soil chemist. The tundra at Point Barrow, Alaska is subject to system modelling.

The four chapters of Section III introduce us to the place of the ecosystem concept in range management, forestry, fish and game management and watershed management. The first is the longest — 75 pages of text followed by nearly 400 references. Forestry comes in for a similar, somewhat shorter treatment. The scope of the subject matter, the vocabulary employed and the compactness of presentation is illustrated by a paragraph from the summary and conclusions: "As a result, any kind of information on ecosystems can be referred to a general fundamental matter-energy co-ordinate system of multidimentional ecosystem space. The most important of these ecosystem co-ordinates are the regimes of moisture, nutrients, air, heat, light, and mechanical energy with all their components." The chapter on fish and game management stresses game over fish. It is worded in the scientific terminology of energy flow and population dynamics including mathematical models expressed in terms of the differential calculus. Watershed management is discussed from the point of view of systems analysis utilizing models made possible by recent developments in logic, statistical analysis and high speed computers.

The fourth and the last section consisting of a chapter on instilling the ecosystem concept in training is by the editor. It was with heartfelt concurrence I came to the statement: "Our ability to condense and synthesize the body of information available to us may well limit the growth of ecology. We need more theorists and synthesizers to compact the literature and make it more available to the scientific community." The book is an attempt to do just that.

In this book the meat is concentrated in the seven papers of the second and third sections. There are no concessions to the reader. Compaction has been achieved by the use of languages and terminologies of a score of scientific disciplines and by the traditional use of references. A rough count of the entries in the (useful) author index suggests about 900.

For the practicing professional North American natural resources scientist the book is a valuable, aptly titled, prolifically documented reference work. But it was not written by Robert Ardrey.

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Birds of the Churchill Region, Manitoba

By Joseph R. Jehl, Jr. and Blanche A. Smith. Manitoba Museum of Man and Nature, Special Pub. No. 1, 87 pp., 13 figs. $2.50.

Combining the excitement of birding at treeline with ready accessibility and the luxury of civilized comforts, Churchill, Manitoba, has become a household word among members of the birding fraternity of this continent.

This carefully-compiled inventory of Churchill's bird life accounts for all of the 209 species that have been found in the region. Status data are definite and concise. In addition, the species accounts contain information on maximum counts, periods of abundance, egg dates, and incubation periods when these data are available. That the status of each species is well documented is attested by four pages of references to the literature as well as by the considerable experience of the authors and that of the many others who have studied birds there.

An appendix, based on the examination of hundreds of nests, illustrates variability in clutch size for 47 species.

Introductory material includes three maps, a short description of the region, an account of previous ornithology, and some enlightening observations on changes in the environment. There is a section on bird finding in the region that will be extremely useful to birders visiting the region for the first time.

The colored cover photograph of some Churchill habitat is unusually attractive. Inside, 13 black and white photographs of birds and bird habitat, together with several drawings by J. A. Carson, further decorate the book.

We are told that, "Virtually every train or plane that arrives during the summer months imports a handful of birdwatchers or nature photographers eager to taste natural history north of the treeline." Every one of them should be equipped with a copy of this most useful and attractive little book.

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A New Field Book of Reptiles and Amphibians

By Doris M. Cochran and Coleman J. Goin 1970. G. P. Putnam's Sons, New York. xxii + 359 pages. $7.50. Available in Canada from Longman's Canada Ltd., Don Mills, Ont.

The appearance of this addition to the Putnam Nature Field Book series is a welcome event, particularly when it originates from the combined talents of two distinguished herpetologists. The late Doris Cochran was for many years Curator of the Division of Reptiles and Amphibians of the

Smithsonian Institution (United States National Museum) and perhaps is most generally known for her *Living Amphibians of the World* (1961). Coleman J. Goin of the University of Florida coauthored, with his wife Olive, the university-level text *Introduction to Herpetology* (1962). Both authors have long commanded respect from professional herpetologists through their many research publications.

The present field book is designed to treat all species and subspecies of amphibians and reptiles that have been recorded from the 50 United States, and the publishers stress on the dust jacket that it is the "*only* (italics theirs) guide to the identification of every known species of snake, lizard, alligator and crocodile, salamander, newt, turtle, frog and toad in the United States including Alaska and Hawaii".

There are 96 full-colour photographs on 16 plates (6 to a plate) inserted in the centre of the book, and 100 black-and-white photographs, generally two to a page, scattered throughout the text. All seem generally excellent in original focus and camera angle, but unfortunately, in my copy at least, plates , 12, 13, and 16 are blurred due to poor colour printing control.

Inevitably one compares any new field guide to the Peterson series where North America is divided between two volumes; an eastern guide by Roger Conant (1958) and a western one by Robert C. Stebbins (1966). Unfortunately, the present book, although covering the herpetofauna as a whole rather than in two parts, and including Hawaii which was omitted in the earlier texts, falls far short of these "classics" in usefulness. There is no section on field study or care of captives, no attempt to illustrate any but a small fraction of the included species, no keys or pictorial groupings of similar species, no small diagrams of important diagnostic features, and, perhaps most regrettable of all, no range maps.

As a summary of the United States herpetofauna this volume is a concise, accurate, and extremely readable reference. Particularly disappointing to potential Canadian users, however, is the complete omission of Canada from many of the brief statements of range for species that occur here, and the simple notation "Canada" for some others, leaving the portion of Canada occupied to be surmised from the adjacent U.S. states given. In this respect the text sets international North American herpetology back some 50 years! A more comprehensive inclusion of Canadian distribution would have added only one subspecies (*Bufo amercanus copei*, a race of disputed validity) to the text.

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The Amphibians and Reptiles of New Brunswick

By Stanley W. Gorham. 1970. The New Brunswick Museum, Saint John, New Brunswick. Monographic Series No. 6 ix + 30 pages.

Although excellent, comprehensive, field guides to the amphibians and reptiles of North America exist, there is a great need for regional, state, and provincial guides. These allow local species to be identified quickly without the necessity of tackling pages of description of confusing extra-limital species and without the extensive keys required to sort out the many similar forms over the continent or a large portion of it. An additional benefit in a geographically restricted treatment is that more space is available for observations on natural history, and interesting regional distributions and local variations can be discussed.

The present guide fills this niche for the province of New Brunswick. Twenty-four validated native species are discussed together with two additional ones for which collections will almost certainly be made within the province in future. Also mentioned are three marine turtles which have been occasionally taken offshore from the Maritime Provinces. The bulk of the text (20 pages) is devoted to these species accounts, but additional material includes a section on raising and caring for live specimens (7 pages), a forward discussing amphibians and reptiles in general (1 page), an introduction covering general characteristics of New Brunswick species and preserving directions (3 pages), and a selected references section of 37 titles including both general texts and technical articles specifically on New Brunswick. An adult of each species is illustrated adequately for identification by a text drawing executed by Mrs. R. N. Campbell.

The author, who is on the staff of the New Brunswick Museum, is an outstanding field collector and self-trained researcher with a growing list of scientific publications to his credit. The latter include a comprehensive review of the numbers of genera and species of amphibians of the world, studies of the frogs of Fiji and check-list of world caecilians (a tropical worm-like group of amphibians).

Indicative of the care with which this guide was written are the few important additions that can be appended for a future revision. Since the manuscript was prepared, the writer and the reviewer have established that two forms of the Blue-Spotted Salamander complex, *Ambystoma laterale* and *A. tremblayi* are both present in New Brunswick. The generic name of the Red-Spotted Newt, given as *Diemictylus* in the text, is now *Notophthalmus*. An additional phase of the Red-backed Salamander recorded from Fundy National Park should be added to the description of that species. This phase, commonly termed erythristic, lacks the dark coloration and is red on both the back and the sides. If a general criticism can be made, it is that the text should have been much longer, and included more of the writer's observations on life history and data on local variation.

Any naturalist living in or visiting New Brunswick should have this booklet, and heed the author's request for additional observations. A useful feature of the text is the stress placed on where more information is required, and where and how to send specimens (see Introduction). This publication should also fill an important need for school field and classroom projects to bring nature closer to the students. The authors enthusiasm for his subject communicates itself throughout.

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Biology and Water Pollution Control

By Charles Warren. W. B. Saunders and Co., Philadelphia, London, Toronto. 1971. 434 pp. $11.90.

At a time when books on pollution are appearing much faster than any of us can begin to read them, one realizes the pure necessity of tackling book reviews in this field.

This book begins with a brief history and definition of our present water pollution problems. Then it outlines some basic U.S. water quality standards and describes the physical and chemical conditions necessary to sustain life in freshwater environments. Next, the author describes how animals can adapt or acclimate to incipient pollution within their tolerance ranges and gives relevant tolerance levels and toxicity bioassay results.

In the last three sections, the author discusses bioenergetics, population and community responses to pollution, animal behavior, bioassay techniques and biological waste treatment methods. He also includes a general description of animal development, ecology, production and population dynamics. In conclusion Dr. Warren provides us with his evaluation of the acceptability of ecological change and with his feelings regarding the role of a water pollution biologist.

It should be abundantly clear that the scope of this book is considerable. Unfortunately, parts of the book are wholly inadequate. The author's treatment of the community as a unit of study is perfunctory at best. The research of Fager, Margalef, Hutchinson and many other distinguished scientists in this field is essentially ignored. More pervasive, however, is the author's failure to deal adequately with the botanical side of water pollution control. The concept of eutrophication which is fundamental to pollution studies is described largely in terms of its zoological implications and even this treatment is overly brief.

Consequently, we are left with a text which is too specialized for a general course in biology and is too general for an advanced course in limnology or ichthyology. The latter is true as it fails to give specific reference to many of the significant contributions in those fields which the students of an advanced course should be exposed. Instead, we have a book for non-biologists e.g. sanitary engineers, civil engineers and interested laymen who are concerned with the biological consequences of pollution but lack the background to understand the pertinent biological literature. This is not to say that the book will go unread, however, as there appears to be an ever increasing number of individuals entering this niche.

"At a time when pollution seriously threatens our aquatic wildlife heritage, every naturalist should be aware of what is ours to protect and enjoy" (E. L. Bousfield, Can. Field-Naturalist 84(1) p. 70). Dr. Warren's book indicates what aquatic biologists should be doing about this tragic situation.

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Atlas and Gazetteer of Canada
Atlas et Toponymie du Canada

By Department of Energy, Mines and Resources, Surveys and Mapping Branch. Queen's Printer, Ottawa. 104 pp. including maps. 1969. 10¼ × 14¾ inches. Paper bound $5.00, cloth bound $7.50. In English or in French.

Naturalists and biologists use atlases in studying the distribution of plants and animals. They locate or plot collecting sites and note their proximity to other sites, rivers, coasts or islands. These sites need to be localized with a considerable amount of precision and demand of the maps and index a certain scale and a certain amount of geographic detail. The *Atlas and Gazetteer of Canada* is reviewed from this point of view.

Students of natural history have been well served by the excellent 1:500,000 and 1:250,000 series of National Topographical maps and by the useful volumes of the Gazetteer of Canada. But these are not convenient for the ordinary location of topographical entities. The alternative has been to use Canadian school atlases, the Canadian editions of American, English, or French atlases which had a few Canadian maps thrown in as a sop to the Canadian market, or road maps. These alternative sources suffer from one or more of the following defects: lack of accuracy, too small a scale, lack of latitude or longitude co-ordinates, poor coverage of less populous areas or inadequate indexing. The 1957 *National Atlas of Canada* maps are excellent for determining the geographical distribution of certain factors such as population, temperature, and glaciation, but of little use in finding a certain lake, stream, or town.

The present atlas consists of a brief introduction, a map section and a gazetteer. A useful index map of Canada shows on what pages to find the relevant map. This is followed by a pictorial-style relief map of Canada. A topographical map with marine bathymetry would have conveyed more information to the user. Perhaps the Canadian Hydrographic Service could provide submarine details for a later edition of this and perhaps other maps.

My chief criticism of the atlas is the small scale employed, 1:2,000,000. This scale and the inclusion of a considerable amount of blank space on certain maps means lack of geographical detail. The geographical detail is better than that of other available atlases but is exceeded by most provincial road maps. However, there has been full use of the page size, the maps extend right to the edge without wasted margins. The atlas is conventional in providing smaller scale maps for less settled areas. Many workers in natural history could use an equal amount of detail in these areas. Ideally all Canada might be covered at a scale of about 1:1,000,000.

A one degree spacing of the latitude and longitude grid has been used for most of the maps. I would have preferred a finer grid which would certainly be imperitive if one went to larger scale maps. Other useful additions would be the inclusion in the corner of each map of a subdivided longitude latitude block from which one could step off these subdivisions with dividers on other parts of the map and a kilometre as well as mile scale. The index employs an easy to use location system.

The paper used is of adequate quality and color has been used to good effect. The binding permits the pages to lay fairly flat, but I suspect the binding will not stand up to heavy use. One page has already fallen out of my copy. The physical size of the atlas is convenient.

In summary this atlas is the best of its genre yet published for Canada and sells for a reasonable price. But for students of natural history, and I suspect for certain other disciplines, it does not meet the requirements of suffiicient geographical detail. Who will meet this demand, the Canadian government, the Canadian Geographical Society, or a Canadian publisher?

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Dean Bibliography of Fishes 1968

By James W. Atz, American Museum of Natural History, New York, New York 10024. 512 p., 8½ × 10 inches.

The student of fishes is overwhelmed by a torrent of literature. Every year thousands of papers in hundreds of journals in tens of languages are published. How can he locate publications of immediate interest? A number of annual bibliographic serials are available. *Zoological Record* provides a compact Pisces section with a fairly complete listing, excellent indexing but which has no abstracts and is about 2 or 3 years out of date.

Biological Abstracts is reasonably current, well-indexed, and provides abstracts, but has poor coverage of papers and disperses its fish references through several volumes. The FAO *Current Bibliography of Aquatic Sciences and Fisheries* is fairly current, has moderately good coverage of papers, and is presented fairly compactly in 3-4 annual sections, but has a poor index. None of these serials adequately meets all the prime requirements of completeness, currency and good indexing. There are also several peripheral annual bibliographic serials such as *Sport Fishery Abstracts, Oceanic Index*, etc. But their specialized coverage limits use for more general literature searches.

The *Dean Bibliography of Fishes* appears well on its way to meeting the prime requirements. The coverage appears to be good, 3501 papers are listed for 1968 and additional ones will be listed in the 1969 volume. Presumably the total will exceed the approximately 3550 papers listed in the *Zoological Record* for 1968. References for 1968 in a bibliography compiled from other sources was checked against Dean's; each had 3 references missing in the other. The first number of the *Dean Bibliography of Fishes* is 3 years out of date, but both the 1969 and 1970 issues should be published within a year. It is hoped eventually to issue numbers twice or even four times a year.

The Dean Bibliography is divided into systematic, subject, geographic and author indices (373 pages) and a bibliographic section (137 pages). The broad outer page margin is used to keynote the headings or code numbers on that page. In the Systematic Index 13 major taxa (unfortunately not in larger type) of about class level are arranged phylogenetically. Within each of these, the subtaxa are arranged alphabetically, likewise within these subtaxa and so on down to the binomens. Intermediate taxa may be dropped when there are few included genera. Unfortunately, the superorders used may not be familiar to many readers. Perhaps binomens should always have been placed in families and a subindex provided to families and higher taxons. Both binomens and other subjects are indexed under a given higher taxon with a citation code number which leads to the reference in the bibliography.

It is clear that a considerable amount of planning and effort have gone into the text. There are few errors. It is evident that ichthyologists will soon have a current in-depth survey of the literature to help them with their research. Further ahead is the possibility that the computer stored files may produce output for specific research projects. James W. Atz, his staff, and the American Museum of Natural History are to be congratulated for this project.

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Water: Canadian Needs and Resources. Jack Cram. Harvest House, Montreal. 1971. $2.95. First published in 1968 at the occasion of the Canadian Council of Resource Ministers' Water Workshop Seminar, held in Victoria B.C., the book now has a new preface, a digest of the Canada Water Act and other recently enacted water legislation, and a list of provincial and federal water authorities.

*__Water Pollution.__ C. W. Lavaroni, P. A. O'Donnell, and L. A. Lindburg. Addison-Wesley Pub. Co., Menlo Park, Calif., and Don Mills, Ont. 1971. 94 p. $1.85. Teachers guide and text for grades 6-9.

Water: The Wonder of Life. R. Platt. Prentice-Hall Inc., New York. 1971. $8.95.

Weed Control Handbook. J. D. Fryer and R. J. Makepeace. Blackwell, Oxford and F. A. Davis Co., Philadelphia. 1970. Vol. 2. 332 p. $8.00. 6th edition.

*__The Withering Rain: America's Herbicial Folly.__ T. Whiteside. E. P. Dutton & Co., New York. 1971. 224 p. $5.95. Available in Canada from Clarke, Irwin & Co., Toronto.

The World of the Bison. E. Park. J. B. Lippincott, Philadelphia and New York. 1969. 161 p. $4.50.

The World of the Jaguar. Richard Perry. David and Charles Ltd., Newton Abbot, England. 1971. 168 p. £2.25.

The World of Water. W. C. Walton. Taplinger, New York. 1970. 318 p. $10.00.

*Assigned for review.

Information Governing Content of The Canadian Field-Naturalist

Feature Articles

Beginning with the 1970 issues, the Canadian Field-Naturalist will be open for the consideration of major feature articles whose purpose is to make authoritative reviews of outstanding natural history and/or environment issues of our time. If possible, feature articles should be illustrated. Publication costs are open for negotiation between the author, editor and the business manager of the club.

Articles

The Canadian Field-Naturalist is a medium for publication of research papers in all fields of natural history. Reviews, compilations, symposia, controversial or theoretical papers, historical researches, etc. can also be published. Environmentally related papers are given priority in publication sequence.

News and Comment

Informed naturalists, biologists and others are invited to present documented narratives and commentaries upon current scientific and political events that affect natural history and environment values. This section deals with activities, policies, and legislation relating to land and resource use, national and provincial parks, pollution, natural science education, conservation, natural area and species preservation activites and so on. Contributions should be as short as possible and to the point.

Notes.

Short notes on natural history and environment written by naturalists and scientists are welcome. Extensions of range, interesting behavior, pollination observations, reproductive phenomena, oil and pesticide pollution statistics and many other kinds of natural history observations may be offered. However, it is hoped 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 environment values are welcome. These should be brief, clear, pertinent and of interest to a wide audience.

Reviews

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

Special Notices and other items

The Canadian Field-Naturalist has a flexible publication policy. Hence an item not falling under any of our traditional sections can be given a special place provided that it is judged suitable.

(See Instructions to Contributors inside back cover)

The CANADIAN FIELD-NATURALIST

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The Ottawa Field-Naturalists' Club

FOUNDED IN 1879

Patrons

Their Excellencies the Governor General and Mrs. Roland Michener.

The objectives of the Club are 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 co-operate with organizations engaged in preserving, maintaining or restoring quality environments for living things.

The Canadian Field-Naturalist

The Canadian Field-Naturalist is published quarterly by the Ottawa Field-Naturalists' Club with the assistance of affiliated societies and of a contribution from the Canadian National Sportsmen's Show. All material intended for publication should be addressed to the editor. 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.

Membership and Subscription

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Back Numbers

Prices of back numbers of this journal and its predecessors, (TRANSACTIONS OF THE OTTAWA FIELD-NATURALISTS' CLUB, 1879-1886, and the OTTAWA NATURALIST, 1889-1919), are obtainable from the Business Manager.

Cover Photograph: Great Gray Owl attacking prepared skin of a Meadow Vole being pulled on a string. See article on Observations of the Great Gray Owl on Winter Range by Daniel F. Brunton and Ronald Pittaway, Jr., in this issue. Photograph by J. D. Lafontaine.

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The Canadian Nature Federation

Many readers of the Canadian Field-Naturalist are not yet aware of the recent formation of the Canadian Nature Federation and of the potential importance of the Federation to themselves and to Canada. The Federation was formed to be a national voice for naturalists, to represent and speak on a wide range of matters on which naturalists have special knowledge or feelings. Growing world-wide concern today for nature and the environment seems to make the time right for the new Federation to become a key national organization whose work and activities would be of value not only to a major segment of the public but to governments as well. Since readers of the Canadian Field-Naturalist will have a special interest and stake in the Federation it is important that they understand how the Federation is organized, what it is setting out to do, what some of its current problems are and how individuals could help the Federation to become a creative institution in Canadian life.

The Canadian Nature Federation held its founding conference at Ottawa on September 17, 18 and 19, 1971. The Federation inherited 2,000 members from its predecessor — the Canadian Audubon Society. The national office along with all records and files of the CAS has been moved from Toronto to Ottawa. The Federation has 36 directors — a number which takes into account the sheer size and diversity of Canada. Twelve *National Directors* are elected in odd calendar years by all members of the Federation across Canada; twelve *Provincial Directors* are elected in even calendar years by members residing in each province; twelve *Representative Directors* are appointed by leading provincial naturalists' federations and clubs within each province or territory. The Executive Committee is elected by the Directors from among members of the Board and includes a president, four regional vice-presidents, a treasurer and a secretary. The structure of the Board of Directors is already proving to be most practical in permitting easy communication with grass roots naturalists and their organizations across Canada.

The magazine, *Canadian Audubon,* published by the Canadian Audubon Society will cease publication with the September-December, 1971, issue. For the new year the Canadian Nature Federation will begin the publication of a quarterly magazine to be called *Nature Canada*. The first issue, now in preparation, is expected to be published in late February or March. It will contain about 48 pages plus covers.

Nature Canada should combine the best that Canada has to offer in the fields of nature writing and environmental teaching. The magazine will contain articles that combine the enjoyment, exploration and appreciation of nature and unpolluted environments. It should become the place in Canada where one can find definitive and authoritative information on the environmental issues of our time as these develop or continue. Another section will show the values of nature and environmental art including historical or topical ideas. Four sections of the magazine will be devoted to news. First, the "Federal Scene" will report on federal government initiatives and activities in the field of nature and environment. Second, the "Provincial Scene" will cover provincial governments' moves in this field. Third, activities of conservation oriented citizens' organizations will be reported with particular attention being paid to recognizing and popularizing exemplary initiatives that many such groups are now taking. The fourth news section will cover "Nature- and Technology-Research" since the popularization of purposeful scientific research will be another of the magazine's aims. The Associate Editor responsible for this section has asked several dozen scientists in different fields across Canada to scan research journals in their areas of expertise and write abbreviated accounts of significant discoveries that might be of practical use in helping to recognize or solve environmental problems.

There will be a section called "Information about Information" giving references to literature, briefs, government legislation and regulations, etc., on subjects where an actual or potential problem has been recognized. It will tell what information is available, where it can be obtained and at what cost. In the first issue this section will bring together references about Sable Island where human and other activities are having an impact on the island's ecology. *Nature Canada* will also carry a review section which will assess the worth of books, films, records, etc. An editorial and letters sections will also be regular features.

To set the stage for wide circulation of the first issue the Canadian Nature Federation has enlisted the help of grass roots natural history organizations across Canada. We can only hope that by publication time we will have the financial resources to pay for the publication and widespread circulation of complimentary copies.

Although the magazine will be the principal medium for reaching membership and schools, other activities will also be strongly emphasized once the Federation becomes established on a secure base with adequate staff. From a small nucleus "Nature Bookshop" developed by the Canadian Audubon Society the new Federation would like to create a national information centre through which a wide range of nature and environmental education materials would be made available to members, schools, naturalists' clubs, provincial federations and other groups across Canada. The presentation of briefs and participation in hearings will be among the Federation's important purposes. We have already submitted three briefs to the federal government on issues where natural values were significantly affected and required representation. Closer working relationships with government and industry must be established — something that is becoming essential in the increasingly technological world. Links with international conservation organizations are also being developed for this is an area where Canada as one of the world's affluent nations should be active and fully represented.

The finances of the Federation although improving are still at a critical stage. We do not know at this time whether we will receive the required assistance to publish *Nature Canada* at the level of quality and the required quantities outlined above. Since its formation the Federation has received over $10,000.00 in founding donations from individuals including grants from some of Canada's leading naturalists' organizations. For this support the Federation is immensely grateful. Membership since the founding conference has increased by nearly 40 percent (750 new members since September). The new income has enabled the Federation to meet the tremendous expenses of the changeover from the Canadian Audubon Society — the founding conference, the move to Ottawa, the establishment of the Ottawa office, including furnishings and supplies, retirement and severence pay for CAS staff, costs of publishing the two last issues of *Canadian Audubon* and a host of lesser costs. There is no question that support received up to now has enabled the Federation to bring together many of the essential elements of a viable and potentially dynamic national conservation organization. But now fresh support from new places is needed for additional staff and for the creation and production of a quality magazine. In this regard the Federation has applied for substantial founding grants from government and foundation sources but the outcome of these applications is not yet known. Hence, the Federation simply must continue to look toward individual citizens and private organizations for financial support at this time.

The need in Canada for a major national citizens' organization to be a constructive force for nature and the environment has been apparent for many years. Now there is a chance that this need can be realized through the effective establishment of the Canadian Nature Federation. There is every evidence to indicate that the current need for special assistance is temporary and that once the Federation begins the publication of a quality magazine and becomes more involved in other activities and programs, support from members will ensure its rapid growth. The purpose of this editorial then, is to help make known the Federation, its organization, its goals and its present financial position so that naturalists and others across Canada will have the opportunity to support the Federation. I also hope that readers of the Canadian Field-Naturalist will take out membership and inform their friends and others about the Federation.

Theodore Mosquin, President,
Canadian Nature Federation,
46 Elgin Street, Ottawa K1P 5K6
December 25, 1971

Membership categories in the Federation are:

Regular	$ 6.00
Sustaining	$ 10.00
Active	$ 25.00
Supporting	$ 50.00
Contributing	$100.00 or more

Cheques should be made payable to the Canadian Nature Federation. A receipt for income tax purposes for the amount in excess of regular membership will be sent to you. All members will receive *Nature Canada.*

Subscriptions to *Nature Canada* are available to recognized educational institutions only. Subscription prices are $5.00 per year; $4.50 for bulk orders of 100 or more to a single address.

Mailing date of this issue — December 29, 1971

The Status of the Sandhill Crane in Northern Ontario

HARRY G. LUMSDEN
Ontario Department of Lands and Forests, Research Branch

Abstract. Sandhill Cranes are widely distributed in the post-glacial, marine submerged area of the Hudson Bay lowlands in northern Ontario. In 1969 two nests were found in the Kinoje Lake area about 50 miles northwest of Moosonee. The incubation period of one clutch of eggs collected when fresh and hatched in an incubator was about 27 days.

In the mid-1600s large numbers of cranes were reported migrating through the southern Georgian Bay area of Lake Huron by the missionary Sagard. This population may have wintered on the Atlantic coast in New Hampshire and Vermont until the nineteenth century when it was exterminated.

The northern Ontario breeding population of Sandhill Cranes is referable to the race *G.c. rowani*. There is a summering population in the area south of the Lake of the Woods, but as yet no evidence of nesting. These birds may be referable to the race *G.c. tabida*. The Little Brown Crane *G.c. canadensis* has occurred on migration in Ontario but does not breed in this province

Introduction

Sandhill Cranes *Grus canadensis* were recorded from northern Ontario during the early days of the fur trade. Edwards (1750) and Forster (1772) used material collected by Hudson Bay Company servants. James Isham (*in* Rich and Johnson 1949) gives some fanciful lore but records accurately that cranes "... are scarce by the sea shore in land being more plenty ...". Andrew Graham, who established the first trading post at Fort Severn and who returned from that post in 1775, wrote (*in* Williams and Glover 1969): "This bird migrates with the Hooping (*sic*) Crane and brings forth its young on islands in unfrequented parts". Samuel Hearne's account is more complete than those of his colleagues (*in* Glover 1958). His experience was mostly around Churchill and on the barrens west of Hudson Bay, but he reports that Sandhill Cranes "... visit Hudson's Bay in far greater numbers than the former". Here he refers to Whooping Cranes.

Recently Walkinshaw (1965) described a new race of the Sandhill Crane *Grus canadensis rowani* from Central Canada. He outlined its range in the Coniferous Forest Biotic Community as including southern Mackenzie, Alberta, Saskatchewan, and probably central western Manitoba, and adds that it may occur in northern Ontario where no cranes have been taken in summer. In another paper (Walkinshaw 1960) he lists four sight records of cranes from northern Ontario. They are from the junction of the Ashweig and Winisk Rivers (1), Nikip Lake (2), the Wawa Lakes (3), and Moosonee (4). These localities are designated by number in Figure 1. Godfrey (1966) includes Ontario within the range of the species and lists a number of localities in the northern part of the province where the bird has been seen. He adds that it formerly bred in southern Ontario at Lake St. Clair.

New information on the status of Sandhill Cranes in northern Ontario has become available from observations made by the writer on flights over the area, from the files of the Department of Lands and Forests, from observations made by biologists of the U.S. Bureau of Sport Fisheries and Wildlife, from interviews with the Indians who live there, and from records in the files of the Royal Ontario Museum of Zoology. For permission to use the last mentioned I am grateful to the late Mr. James L. Baillie. The localities mentioned are marked with a spot and a number on the map in Fig. 1. Nesting records are marked with a +.

Records of Cranes in northern Ontario

Junction of the Muketei and Attawapiskat Rivers. Sjörs (1959) records finding tracks in the clay and later hearing and seeing a pair. (5).

Bearhead Lake on the Winisk River. Mallock (1958) reports seeing four cranes on three different occasions, on 17, 22 and 26 September 1958. (6).

Shagamu River, 25 miles from the coast. Macfie (1958) writes that members of his field party saw one flying over their camp in July. (7).

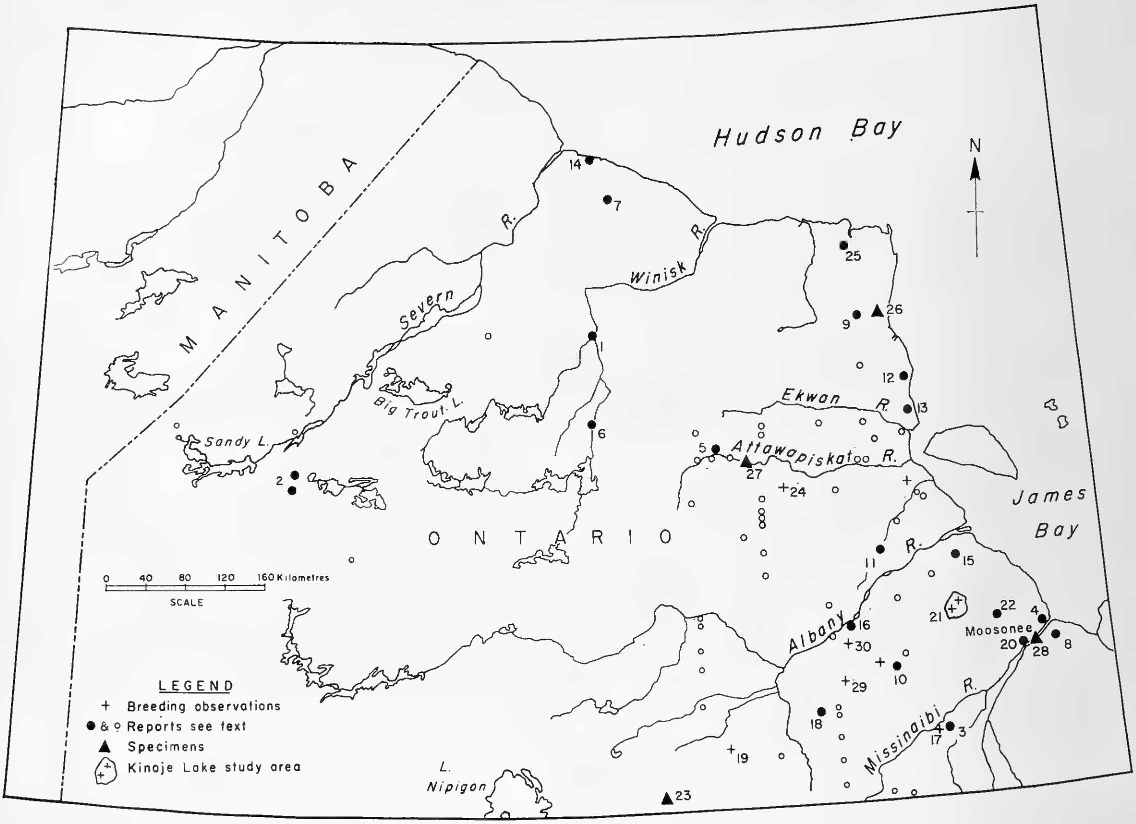

FIGURE 1. Location of crane observations in Northern Ontario.

Partridge Creek near Moosonee at 51° 12′ N 80° 22′ W. The writer and party saw two on 28 June 1958. (8).

Lakitusaki River about 15 miles from the coast. The writer and party saw one crane on 25 June 1958. (9).

Seven miles SW of Sandbank Lake. The writer and party saw two cranes on 15 July 1959. (10).

Otadaonaris River about 40 miles west of Fort Albany. Dr. H. C. Hanson and the writer saw two cranes on 8 August 1961. (11).

Ten miles north of the mouth of the Swan River. The writer and party saw five cranes on 19 July 1967. (12).

Ten miles north of Ekwan Point on the coastal marshes. The writer and party saw one crane on 13 July 1968. (13).

Near the mouth of the Beavertrap River. The writer and party saw three cranes on the sedge flats on the coast on 12 July 1969. (14).

Near Big Island on the lower Kinoje River I saw a single bird from the helicopter on 14 May 1968. (15).

Mouth of the Chipie River. Mr. Andy Gagnon saw cranes in both 1962 and 1963, during the summer. (16).

Boundary between Lambert and Mahoney Townships on the Missinabi River. Alvanik Peltonen and others saw two adult cranes with two 18-inch tall youngsters on 18 July 1965. (17).

Pitikupi Lake. Gerald M. Hendry saw two groups of three and four cranes between 10 August and 11 September 1965. (18).

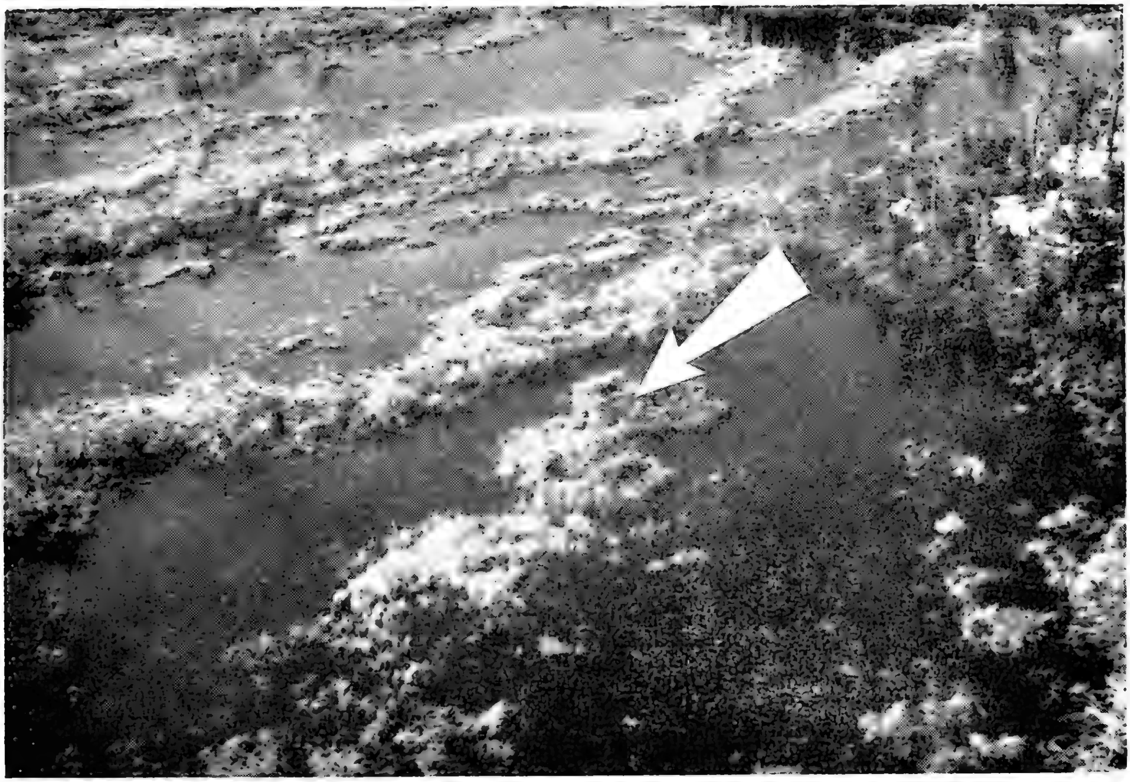

FIGURE 2. (a) Sandhill crane nest no. 1 on a ridge in a fen, 7 May, 1969.

(b) The nest was located on sphagnum substrate with an accumulation of tamarack twigs.

One mile northwest of Jog Lake in early August 1969 Dr. Sparling and his party saw as many as 20 cranes each day they spent afield. The birds were in groups of three to six and some duplication was possible on a day's observations. On 16 August 1969 his student assistants chased a flightless crane but did not catch it. (19).

Nine miles east of Moosonee two cranes were seen on 23 May 1958 and one on 24 May by W. W. H. Gunn and field party. (20).

During parts of April, May, and early June from 1967 to 1969 I participated with Dr. D. G. Raveling in a nesting study of Canada Geese in the area surrounding Kinoje Lake. The study area base camp lay approximately 51° 35′ N, 81° 35′ W (21) and was about 54 miles north-west of Moosonee. The study area itself was about 388 km^2 (150 sq miles) in extent and parts of it were covered almost daily by helicopter.

In 1967, I was present in camp during the second half of April and again in late May and June. Consistent records of the cranes seen were not kept during my absence. I did not see any cranes in April and do not know when the first birds reached the area. In early May one of our Indian guides, Mr. Hezikiah Wynne, shot a crane near Kinoje Lake. I saw pairs of cranes subsequently on 22, 27, 28, and 29 May. This was a very cold, late spring which seriously diminished the productivity of the Canada Geese nesting on the study area. It is unknown what effect the weather had on the nesting of the Sandhill Cranes.

The first crane observation in 1968, which was an early, warm spring, was on 21 April. At this time most of the open ground was snow free, but heavy drifts remained in the timbered areas, the ponds and lakes retained their winter ice with a layer of melt water covering them.

In 1969, the spring was late and cold and the first crane was seen on 25 April. At this time, only 40% of the open ground was snow free and all lakes and ponds, as well as some of the creeks, remained frozen.

In 1968, the field party made 24 observations consisting of 38 cranes. In 1969, there were 26 observations of 37 cranes.

Most observations were of single birds. Two birds together (pairs?) were seen 5 times before 5 May 1968 and twice later, on 15 and 19 May. In 1969, eight pairs were seen before 18 May, and then none until 7, 11, 14, and 15 June when single pairs were seen each day.

The only flock recorded was on 15 May 1968 when nine were seen together at the southern end of the study area. The two nests found will be decribed later. (21).

Commuting between Kinoje Lake and Moosonee I have twice seen cranes about the half way mark. (22).

The Cree Indians of northern Ontario know Sandhill Cranes well, and occasionally hunt them for they find them good to eat. Their name for the species is *o-che-chak*. An Indian shot an adult male on the Chipman Lake Road northwest of Long Lac on 7 May 1962 (23) which is now in the Royal Ontario Museum.

At those villages located on the Precambrian Shield, such as Trout Lake, Kasabanika, Sachigo, and Lansdowne I was told that cranes did not nest locally but were seen migrating in spring and fall. Some of the trappers whose traplines are located on the Palaeozooic limestone formation report cranes present during the summer. However, very few Indians reported ever having seen a crane's nest. Mr. Thomas Toomagatic who lives at Attawapiskat told me that as a young man he would return to his trapping area in July with his dogs to hunt flightless Canada Geese and cranes. He said that some of the cranes he caught were only half grown. His trapline (registered PE 130) lies south of the Attawapiskat River, about 80 miles from the coast. (24).

Mr. Augustine Metat told me of seeing three cranes on his trapline on 8 June 1960 about 16 miles from the coast, near the Brant River. (25).

On 5 May 1960 Mr. Billy Loutitt shot a crane and saw five others near the Lake River Post. (26). He had preserved the legs and gave them to me. Another crane was shot by an Indian near the Big Lake Camp Trading Post

(27) in the spring of 1962. The tail of this bird was saved and is now in the Royal Ontario Museum.

Mr. Anthone Wesley shot another specimen on 25 April 1963 about 3 miles west of Moosonee (28). It also is now in the Royal Ontario Museum.

Eight miles northeast of Pledger Lake a nest was found, about 40 birds seen, and one shot by Simeon Metat in the spring of 1961. (29).

Ten miles southwest of the Ghost River Post a nest with eggs was found by Raphael Spence in the spring of 1961. (30).

For many years the U.S. Bureau of Sport Fisheries and Wildlife have been flying waterfowl surveys along transects in northern Ontario. I am most grateful to Mr. Arthur Brazda and Mr. Everett Chamberlain, Pilot Biologists who have been carrying out these surveys, and who have sent me their observations of Sandhill Cranes seen along their routes.

The transects were along cardinal headings which were divided into 18-mile segments. Observations were recorded by segments and not by exact locality. In the case of each crane observation the heading of the aircraft was known but the birds could have been seen anywhere along the segment on which they were recorded. I have plotted these observations in Fig. 1 as open circles at the mid-point of each segment; thus it is possible that any observation could have as much as a 9-mile error in either latitude or longitude, but not in both. The surveys were made from late May to early July. Mr. Brazda made 38 observations of 66 cranes over a period of 8 years. The groupings ranged from 25 observations of single birds to one observation of seven. The bulk of his observations are concentrated in a block bounded on the west by lat. 85° 40′ W and on the east by Lat. 82° 40′ W and extended a few miles north of the Attawapiskat River. He has two records from the Big Sandy Lake area. Mr. Chamberlain made 13 observations of 23 cranes over a period of 3 years. The groupings ranged from seven observations of single birds to two observations of four birds each. One of these groups of four consisted of two adults with two juveniles. The bulk of the area he covered lay north of the Attawapiskat River to the Hudson Bay coast and west almost to the Manitoba border. Three of his records were close to the James Bay coast and between the mouths of the Albany and Attawapiskat Rivers.

The distribution of crane observations in the map in Fig. 1 may to some extent reflect the distribution of observation rather than the density of cranes. Cranes are reported breeding by the Indians from Shamattawa in the lowlands on the Ontario side of the Ontario-Manitoba border, but we have no observations from that area.

Almost all the summer records come from the area of post-glacial marine submergence or from post-glacial lake beds, such as the one at Nikip Lake. The Canada Geese breeding in northern Ontario also conform to this pattern of distribution.

I think that cranes are more abundant than the observations plotted in Fig. 1 would indicate. Experience with the two crane nests at Kinoje Lake suggests that birds are difficult to see. At both nests the adults flushed at extremely close range when they gave away the location of the eggs. We only once saw a pair of cranes near nest No. 1 before it was found, although we were frequently in the vicinity. After the eggs were taken we saw no sign of the birds in that area again and they may have left.

We were in the general area of nest No. 2 many times before it was found. On the three occasions when it was revisited before hatching neither parent was seen, although we watched carefully to see the incubating bird leave.

These experiences suggest that many cranes may be flushed by an aircraft at a great distance or sit extremely tight.

Sandhill Crane Nests near Kinoje Lake

We found the first Sandhill Crane's nest near Kinoje Lake on 7 May 1969, from the helicopter. The adult flushed from the nest about 100 meters in front of the helicopter as we circled to check the site of a 1968 goose

FIGURE 3. (a) Sandhill crane nest no. 2 on a bog near a pond.

(b) The nest was located on sphagnum among labrador tea.

TABLE 1. — Sandhill Crane eggs from the Kinoje Lake area and incubation data.

Egg	Nest No. 1		Nest No. 2	
	A	B	A	B
Length	95.6	93.0	88.4	88.1
Width	58.8	60.7	58.7	56.9
Laying dates	6–9 May		—	
Incubation started	10 May*		—	
Hatching date	7 June*		about 6 June	
Incubation period	27 days		—	

*In an incubator.

nest. We could see a single egg lying on a small flat island on a narrow ridge in a fen, Fig. 2. The egg was shiny and quite conspicuous. The nest was located on a reddish sphagnum substrate and consisted of a small collection of tamarack *Larix laracina* twigs which did not cover the bottom of the nest at our first visit.

On 9 May the nest was visited again and the crane flushed from the nest at extremely close range, and alighted in the muskeg about 50 meters from the nest. The helicopter landed about 10 meters from the nest, while I went to photograph and collect the eggs. The crane moved gradually closer until it was about 25 meters from me. It walked with its wings half open and drooping. The helicopter motor which remained running drowned out any calls it might have been making and did not deter its closer approach.

The second crane's nest was found on 29 May when the adult flushed from the two eggs almost under the helicopter. The nest was located in a bog under a pad of reddish yellow sphagnum in a stand of Labrador tea *Ledum groenlandicum* and Leatherleaf *Chamaedaphne calyculata*. Fig. 3. It lay about 10 meters from the edge of a sphagnum-choked shallow pond. The site had been burnt over many years earlier and the bleached skeletons of dead spruce still stood all over the area. The first nest found contained one egg at 1714 hours on 7 May, which could have been laid on 6 or 7 May. It contained a second egg at 1044 hours on 9 May. The eggs were collected and taken to the Ontario Waterfowl Research Foundation Station at Guelph for incubation. They were placed in an incubator on the evening of 10 May. They were pipping on the morning of 6 June and were hatched by 7 June, an incubation period of about 27 days. Walkinshaw (1949) records an incubation period of from 28 to 30 days for the Greater Sandhill Crane *Grus canadensis tabida*. I have been unable to find any record of the incubation period for the Lesser Sandhill Crane *Grus canadensis canadensis*. Incubation at the second nest was well underway when we found it on 29 May. The eggs were not pipped at 1242 on 4 June when they were measured but had hatched and the young had gone by 1702 on 7 June. They may have pipped on 5 June and hatched on 6 June, dates very close to those of the first nest. The measurements of these Kinoje eggs and data on their history are contained in Table 1.

Migration past and present

Records of Sandhill Cranes on migration in Ontario have been listed by Walkinshaw (1960). One very early record is not listed by him. This is probably the earliest mention of the Sandhill Crane in Ontario. The missionary Sagard in 1632 (in Champlain Society 1939) reports "In season all the fields are covered with cranes or Tochingo, which come to eat the corn at seed time and when it is ready to harvest. The wild geese and crows which they call Oraquan do the same". In a footnote to Tochingo his editor states "Great Blue Heron" but Sagard uses the French name "Grue" for crane and not "Héron" in his original French account. The fact that they concentrated in the fields to eat corn also confirms that they were cranes and not Great Blue Herons. The area to which he referred is just south of Georgian Bay and his reference to their "covering the fields" suggests abundance.

Further evidence of the early presence of cranes in this area is furnished by Savage (*in* Hurley and Heidenreich 1971). He reports 15

TABLE 2. — Measurements of Crane Specimens taken in Ontario

Locality	Date	Length in mm.				
		Wing Chord	Culmen	Bill tip to posterior of nostril	Tarsus	Bare Tibia
Kinoje Lake ♂ ad	4 May 1969	505	123	98	228	105
Moosonee ♂ ad	17 May 1962	—	111	—	215	—
Chipman Lake Road ♂ ad (northwest of Long Lac)	17 May 1962	508	116	—	228	—
Zealand Township ♂ ad (Rainy River District)	11 Sept. 1967 (probably a migrant)	490	120	93	230	76.5
Lake River (sex?)	May 1960	—	—	—	217	—
Port Arthur ♂ juv	9 Oct. 1952	454	77.6	59.6	182	73
Thunder Bay ♀ juv	24 Sept. 1966	467	106	79.6	230	95
Toronto ♂ ad	fall of 1872	439	89.7	69.5	205	70
Sandfield Township ♂ ad (Manitoulin Island) (sex?)	prior to 1935	441	96.7	72.5	176	61

crane bones from the Robitaille site and one each from the Maurice and Inverhuron sites. The first two are located on the Penetang Peninsula on Georgian Bay and are post-European-contact Huron villages. The Inverhuron site is located near the shore of Lake Huron in Bruce County, and is much older. It has been included with the Laurentian Archaic tradition (ca 5000 B.C. to 1000 B.C.). Dr. Savage (unpublished) also has crane bones from the McMurchy site near Collingwood, the Wallace site near Georgetown, and the Auger site near Coldwater. Wintemberg (undated) recorded the Sandhill Crane in the Lawson site, Middlesex County and in the Roebuck site, Grenville County (1936).

Recent migration records of the Sandhill Crane east of Lake Huron in Ontario are scarce. Godfrey (op. cit.) summarizes its current status as a rare transient in southern Ontario. There is certainly no population of the size described by Sagard moving through the area today. Nor does it appear that the population breeding in the James Bay lowlands is migrating over or east of Lake Huron. Dr. L. H. Walkinshaw recently drew my attention to a report by Coues (1883) that cranes were common in 1792 in New Hampshire and were considered one of the commonest waterfowl in Vermont in 1794. Perhaps this was Sagard's population wintering on the coast in New England. It was apparently exterminated during the nineteenth century on its wintering grounds. Since Sagard's observations there have been no reports of cranes other than rare transients in the Georgian Bay area.

Crane records in the Rainy River District

South of the Lake of the Woods close to the Minnesota border there are some very large muskegs which have a summering population of Sandhill Cranes. On 17 September 1965, while on the edge of one of these muskegs with Conservation Officers George Thompson and Robert McGillivray, we heard cranes calling. Mr. Thompson reported that he saw flocks of 9 and 13 during the summer (1965) in that area and that they were present every year. His further report for the summer of 1968 suggests that there were 20 to 22 birds on two large muskegs in the same area. If there is indeed a breeding population in the western Rainy River District it is likely that these birds are assignable to the race *G.c. tabida.*

Racial identity of cranes in Ontario

Among the 15 specimens of Sandhill Cranes from Ontario in the Royal Ontario Museum of Zoology, and one in my own collection, there are nine for which measurements are available. Three have been prepared as skeletons and, as a result, some measurements are missing. It is apparent that two races are represented. The measurements are presented in Table 2.

I have compared these measurements with the ranges given by Walkinshaw (1965) for his new race *G.c. rowani,* for *G.c. canadensis* and *G.c. tabida.*

The fifteen measurements of the first four adult males and the unsexed bird in Table 1 fall in two instances within the overlap of *G.c. canadensis* and *G.c. rowani,* in four instances within the overlap for *G.c. rowani* and *G.c. tabida,* and in seven instances fall only within the range of *G.c. rowani.* One measurement only, the bare tibia of the Kinoje Lake male falls outside the range given for *G.c. rowani* and within that of *G.c. tabida.* Two measurements of the bill tip to the posterior end of the nostril are within the gap between the ranges given for *G.c. rowani* and *G.c. tabida.*

No series of juvenile cranes is available to me and Walkinshaw did not give ranges of measurements for this age class. It is therefore not possible now to determine the identity of the two migrant juvenile specimens from the Thunder Bay area. The last two specimens in Table 2, which are adults, one a male and the other unsexed, do not conform to the pattern described above. Of the ten measurements presented, eight fall within the range of *G.c. canadensis* and only two fall within the range of overlap between *G.c. canadensis* and *G.c. rowani.* These specimens can logically be assigned to *G.c. canadensis.* This race does not breed in Ontario, the nearest breeding population being on the west side of Hudson Bay near the McConnell River.

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Mutual Grooming by Black-tailed Deer in Northwestern Oregon

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Abstract. Pairs of black-tailed deer (*Odocoileus hemionus columbianus*) on the Cedar Creek study area in northwestern Oregon were observed while occupied in mutual groomings on 28 occasions. The grooming pairs varied by sex and age and were composed of 17 different deer. The study herd was classified as to sex and age in years 3^{+}, 2, 1, and fawns. All age classes and both sexes were observed in simultaneous mutual groomings. The complete act of mutual grooming was observed on nine occasions. The duration of the nine grooming periods ranged from 1.5 min. to 8.0 min. with an average of 5.0 min. Dominant deer always initiated grooming activities in the events involving dominant and subordinate animals. Deer always groomed with other individuals that were closest to them in the intragroup hierarchies. As a result of care-soliciting (Et-epimeletic) behaviour the initiators of grooming activities between maternal does and their fawns varied. The dominance relations which existed between members of the grooming pairs of deer indicates that grooming activities serve a social purpose. I suggest that the act of mutual grooming reinforces the social bonds between members of closed groups of deer.

Introduction

Black-tailed deer (*Odocoileus hemionus columbianus*) on the Cedar Creek study area in northwestern Oregon were observed for 1,410 hours during 1964 to relate their activity and distribution patterns to measured environmental factors (Miller, 1968a, 1970). While observing these deer I watched mutual grooming by pairs of deer on 28 occasions. The grooming pairs varied by sex and age and were composed of 17 different deer.

Interspecific activities of large ungulates are very interesting to observe and allow for insight into the socialization of the species. I offer this report primarily as a possible source of reference for future studies of the comparative behaviour of cervids.

Study Area

The Cedar Creek study enclosure is approximately 29 km inland from Tillamook, on the Cedar Creek watershed in that portion of Tillamook County known as the Tillamook Burn.

The elevation within the enclosure ranges from 245 m to about 650 m, measured from mean sea level.

The study area receives a mean annual precipitation of 330 cm, based on a 25-year average at Glenora 5 km east of the study area (U.S. Weather Bureau 1936). Maritime influences result in cool, wet winters with prolonged snow cover sufficient to restrict deer travel at elevations above 600 m. The summers are usually dry and hot, but small, permanent streams occur in the study area.

Approximately 138 hectares by horizontal surface measurement (a flat land measure that does not account for surface irregularities) are enclosed by about 4.8 km of virtually "deer-proof", woven-wire fence. Because of the rough terrain the actual surface area is nearly 2.6 sq. km.

The enclosure contains the typical seral plant growth that follows fires or clear-cut logging in the Coast Range Mountains of northwestern Oregon. The plant species were nearly all present as minor components of the preburn forest (Crouch 1968). A detailed description of the study area is in Bailey and Poulton (1968), Crouch (1968), and Miller (1968a, 1970).

Animals and Methods

Black-tailed deer for introduction into the Cedar Creek enclosure were captured in surrounding areas from July 1 to November 21, 1963 (Miller, 1968b). A CO_2 Cap-Chur rifle (Palmer Chemical and Equipment Company, Inc., Douglasville, Georgia), firing a 1-cc, 50-cal syringe with a 2-cm barbed needle point, was used with succinylcholine chloride (Squibb's) in a 20 mg/cc solution as the immobilizing agent. The effective range of dosages for black-tailed deer was 0.03-0.06 mg/kg.

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TABLE 1. — Monthly herd sizes, number of deer sightings, and hours of observations during 1964, Cedar Creek Study area, Oregon.

	Month of year, 1964											
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Size of herd	30	30	30	29	26	32	33	33	31	30	29	29
Number of deer sightings per month	147	260	419	716	1,025	507	701	546	623	337	904	505
Total hours of observation	62	80	112	100	235	146	139	141	142	74	123	56

Thirty-four deer were released in the study area on their day of capture: 4 in July, 5 in August, 8 in September, 7 in October, and 10 in November, 1963. The herd numbered 30 animals by January, 1964, when periodic observations were begun. At that time the sex and age composition of the herd was 10 adult does, 5 adult bucks, 4 female yearlings, 3 male yearling, 4 female fawns, and 4 male fawns.

It is very unlikely that there was any direct blood relationship between the individual deer as they were all captured at distances of one to several kilometers from each other. Dominance regimes were established soon after introduction and were maintained by displays and aggressive-submissive interactions. The intragroup hierarchies allowed me to assign social ranks to all members of each group.

All deer except fawns were marked with collars and ear streamers of the type used by Harper and Lightfoot (1966, Figs. 1A, 2A). Fawns of the year wore ear streamers only. The colour code of the streamers and collars and painted symbols on the collars permitted positive identification of individual deer.

The deer were observed from three huts placed outside the enclosure on surrounding prominences (Table 1). Daily, nearly equal time was spent observing from each hut, but often under very different weather conditions. The hours of the day spent at a hut were rotated. For example, from 6.00-10:00 a.m. at one hut on Monday, at the second hut on Tuesday, and at the third hut on Wednesday. The entire elevational range within the enclosure could be observed from each hut. Observational equipment consisted of 10 $\times$ 50 field glasses and a 15X-60X Balscope Zoom spotting scope. Sightings of deer were placed on a gridded map derived from an aerial photograph. Each square on the map represented 0.5 horizontal hectares. All time intervals were determined with the sweep-second hand of a wristwatch and were rounded to the nearest ± 15 sec.

Results

The study herd was classified as to sex and age in years 3^+, 2, 1, and fawns. When all possible pairs of the above four age classes were combined by sex, there were 36 possible combinations for mutual grooming, but only 10 combinations were observed (Table 2). All age classes and both sexes, however, were observed in simultaneous mutual groomings. One mature female and a mature male were observed grooming each other and were constant companions. They seemingly were co-dominant, as they showed no agonistic behaviour related to rank.

On nine occasions I was able to ascertain the duration of mutual grooming, plus the initiators and terminators of the grooming activities (Table 3). The duration of the nine grooming periods ranged from 1.5 min. to 8.0 min., with an average of 5.0 min., and involved 11 different animals.

In the six cases involving dominant and subordinate animals (Table 3) the dominant animals always initiated the grooming activities.

Subordinate animals terminated five of the six grooming sessions. The one exception was caused by the dominant animal bedding down. In the three cases involving maternal does and their fawns (Table 3), does initiated two events, and a fawn started one when it moved over to the bedded doe and began grooming her. Fawns terminated two of the events, and a maternal doe stopped one by walking away and bedded down. Animals initiating grooming activities always groomed with other deer that were closest to, but below, them in the intragroup hierarchy.

For brevity and to maintain clarity in the dominant-subordinate animal relationship, dominant animals will be referred to as "D" and subordinate animals as "S". The doe-fawn bond will not be considered as part of this dominance relationship.

Mutual Grooming Between Mature Females

May 6, 1964 — Two mature does were foraging together and the D animal moved to the left side of S and began to lick her on the shoulder. S then turned to the left and began licking D on the brisket and D turned to lick S on the neck. D then began grooming S's back moving slowly toward her hind quarters, and S reciprocated. Neither animal groomed the other beyond the anterior portions of the hind quarters. S was the first to stop grooming and return to foraging while D groomed herself for about 1 min before she resumed foraging.

Mutual Grooming Between Mature Males

May 23, 1964 — Two mature males were foraging on an open area. The D male approached S and began to lick the upper portion of the latter's left foreleg and the left side of his brisket. S turned slightly to the left and began licking D's neck. D then turned to the right and placed his left side against the left side of S. Both animals then rubbed against the other with a slight back and forth motion for about 2 min. D then placed his head across the back of S's neck and rested his chin on the back of the neck in a horse-like manner. Both deer remained fixed in this position for about 3 min. They

TABLE 2. — Summary of the observations on mutual grooming by black-tailed deer, Cedar Creek study area Oregon, 1964.

Animal combinations					No. of times observed in the act of mutual grooming
Sex	Age in years	Sex	Age in years	Dates observed, 1964	
♀	3+	♀	3+	April 18, 26; May 6, Dec. 18	4
♀	3+	♀	2	May 24, Dec. 5 (3 times)	4
♀	3+	♀	1	July 4	1
♀	3+	♀	f*	June 18, July 10	2
♀	3+	♂	3+	Apr. 17, May 4	2
♀	3+	♂	2	July 14	1
♀	3+	♂	f	July 18, Aug. 22 (twice); Sept. 22 Dec. 28	5
♂	3+	♂	3+	April 16, May 3, 7, 23, 24, June 19	6
♂	2	♂	2	May 17	1
♂	1	♂	1	May 3, 22	2

*f – fawn

then began licking each other's neck and brisket S terminated the grooming activity by lowering his head and beginning to forage in front of D. D continued to groom on the top of S's head for several seconds then also turned to foraging.

Mutual Grooming between a Mature Female and a Female Fawn

July 10, 1964 — A female fawn was bedded down watching her dam foraging some 9 m away. The doe lifted her head and looked at the fawn, then walked over to her. The doe began licking the top of the fawn's head and back. The fawn stood up and began licking the doe's forelegs, first the left then the right, and then the brisket. This activity ensued for about 3 min, then the doe stepped to the left side of the fawn and began licking the fawn's rump and anal area. The fawn turned and began to lick the doe's belly. After about 30 sec the doe walked away, scraped a bed site and bedded down. Whereupon the fawn also bedded down again.

Mutual Grooming between a Mature Female and a Two-year-Old Male

July 14, 1964 — A D doe was lying down some 6 m from a bedded S 2-year-old male. S stood up, shook himself and groomed the anterior portions of his forelegs for several seconds. He then walked over to D and stood in front of her. D lifted her head and began licking S's brisket. S then began licking the top of the doe's head and neck. The doe stayed bedded down for about 1 min licking S's brisket occasionally from a bedded position, then rose and began licking S's neck and brisket. S continued licking D's neck. They continued grooming each other in this manner for about 4 min, then began foraging.

Mutual Grooming between a Mature Female and a Male Fawn

July 18, 1964 — A maternal doe was bedded down while her male fawn playfully circled a clump of vine maple (*Acer circernatum*). Soon the fawn ran to the doe and began licking the top of her head. The doe remained in a bedded position and began licking the fawn's brisket. She then rose and began licking the fawn's head and back while the fawn licked her forelegs. Suddenly the fawn turned and ran away to resume his play activity. The doe stood and watched for a few seconds then bedded down again.

December 28, 1964 — A maternal doe and her fawn were foraging together. The doe walked to the fawn and began licking his neck and shoulders. The fawn began licking the doe's brisket. This exchange continued for nearly 5 min. before the fawn stepped away and began to forage. The doe turned and continued licking the fawn's hind quarters and anal area for about 1 min then also resumed foraging.

Mutual Grooming between a Mature Female and a Two-year-Old Female

December 5, 1964 — Two mature does and and a 2-year-old doe were foraging on an open area. The D doe moved to the S 2-year-old and began licking her neck, shoulders and back and S reciprocated. D then began licking S's brisket and S began licking D's head. This activity continued for about 4 min before each turned to grooming themselves for about 1 min. They then resumed foraging. D initiated another mutual grooming session 3 hrs later by beginning to lick S's neck and S reciprocated. D then began licking S's head. They continued licking each other's neck and shoulders for about 4 min. S then turned to the right and lowered her head to nip at some vegetation. D continued grooming S's left shoulder for about 1 min then also turned to foraging. After a 3 min lapse of time they resumed their mutual grooming again for about 1.5 min. D initiated the activity by beginning to lick S's neck and S reciprocated. On this occasion, however, D was the first to stop the grooming activity by turning away and lying down while S continued to lick D's right side for several seconds, then walked away and bedded down.

Discussion

Grooming by licking starts with the newborn young as the first expression of maternal care in the mother-young relationship. Licking and nudging the neonate probably facilitates development, eliminative activity, and stimulates it to

TABLE 3. — Observations on mutual grooming by black-tailed deer for which duration, initiators, and terminators are known. Cedar Creek study area, Oregon, 1964.

Animal combinations				Date Observed 1964	Duration of Grooming Activity in Minutes*	Initiator	Terminator
Dominant		Subordinate					
Sex	Age in Years	Sex	Age in Years				
♀	3+	♀	3+	May 6	7.5	D**	S**
♂	3+	♂	3+	May 23	8.0	D	S
♀	3+	♂	2	July 14	5.0	D	S
♀	3+	♀	2	Dec. 5	4.0	D	S
♀	3+	♀	2	Dec. 5	6.0	D	S
♀	3+	♀	2	Dec. 5	1.5	D	D
♀	3+	♀	f	July 10	4.0	♀	♀
♀	3+	♂	f	July 18	3.0	f	f
♀	3+	♂	f	Dec. 28	6.0	♀	f

* Time values are accurate to nearest 15 seconds.
**D – dominant animal; S – subordinate animal; ♀ – dam; f – fawn.

get up and suck (Almann, 1963 and Hersher *et al.*, 1963). The mother's drive to lick off the young seems to be strong, she licks over the body of her young until it is dry and free of birth membranes (Hershey *et al.*, 1963 and Miller, 1965). The drying process is most vital under cold, wet and windy conditions. Perhaps the first mutual communication between mother and young is the licking by the maternal doe and reciprocal licking by the newborn young and its bonding value may serve to fortify their ties in later life.

Observations on mutual grooming by North American deer are varied but relatively meager in detail. Linsdale and Tomich (1953: 147-148) working with mule deer in California reported that it was common to see two deer groom each other simultaneously, but the activity was usually limited to the neck and shoulders. Palmer (1951: 276) also observed that mutual grooming by white-tailed deer (*O. virginianus*) was usually restricted to the the head, neck and shoulders. Graf and Nichols (1967: 700) working with introduced axis deer (*Axis axis*) in Hawaii reported that the initiator of the act gets the same corresponding part of his anatomy groomed. Only on a few occasions did I observe in black-tailed deer this mutual attention to common parts of the anatomy. My observations are most similar to those of Bailey (1960: 69) who reported that for mule deer (*O. h. hemionus*) although the licking was usually concentrated around the head and neck, the shoulders and back were also frequently groomed.

Helenette Silver (pers. comm.) observed mutual grooming among penned white-tailed deer in New Hampshire and found that the deer were actually ingesting each other's hair. Silver (1968: 102) describes an esophageal diverticulum from a white-tailed deer filled with a cud of deer hair as proof of hair eating in the wild. Palmer's (1951: 276) findings also suggest that a considerable amount of hair must be ingested by white-tailed deer during the spring. During my study it was impossible to determine if the deer were actually ingesting the hair. There was, however, a high observed incidence of mutual grooming during the spring (Table 2) when shedding hair could have been ingested incidentally as part of the process of relieving a physical irritation or satisfying a social demand.

Linsdale and Tomich (1953) reported that mutual grooming by mule deer took place between both sexes and all age classes, which is similar to my observations. Bailey. (1960) also observed mutual grooming by mule deer in all ages and in both sexes but did not observe it between adult deer of opposite sex. Browman and Hudson (1957: 250-251) observed that mutual grooming by mule deer usually took place between two does: recording 38 mutual neck groomings between does and three between the only mature male and some doe, while working with a small captive herd of Rocky Mountain mule deer. Graf and Nichols (1967) found that mutual grooming by axis deer also usually took place between two does. Palmer (1951) observed that mutual grooming by white-tailed deer involved fawns, their mothers, and some of the doe's older off-spring.

None of these authors reported the possible role of dominance in initiating or terminating the mutual grooming activity. My finding that it is usually the dominant animal of the pair who initiates mutual grooming, indicates that grooming behaviour has probably not only mechanical function by alleviating irritation of inaccessible parts of the body, but serves also a social purpose. Two or more facts support this supposition: (1) mutual grooming extends over parts of the body which are accessible to the animal itself; and, (2) Bailey (1960: 68-70) observed mutual grooming by mule deer in Montana only during February and March, with the peak in March. Mutual grooming was most common when the large winter groups were breaking up to form small "family" groups before leaving the winter range. Perhaps the mutual grooming at that time could help to re-establish strong bonds between certain deer that had been weakened by the high frequency of contact with a relatively large number of deer during the gregarious wintering period.

Mutual grooming is probably a behavioural response with ontogenetic origin expressed through two sources: the mother-young bond and comfort activity. Social organization of closed deer groups helped to extend its function into the general social context. I suggest that the act of mutual grooming reinforces the social bonds between members of a closed group by promoting the psychological well-being of the subordinate animals within the group, and thereby strengthening the unity of the group. The end results should be beneficial to the species.

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Sex Ratio and Age Structure in Two Red Squirrel Populations in Northern Saskatchewan

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Abstract. Age determination, sex and age ratios of two red squirrel (*Tamiasciurus hudsonicus*) populations were studied in northern Saskatchewan from 1960 to 1966. Thirty red squirrels born in captivity to females caught at Cree Lake, Saskatchewan furnished lenses, femora, and humeri of known-age for establishing methods of determining ages of wild specimens. This study shows that the ages of red squirrels can be predicted with reasonable accuracy from lens weights and that juveniles and young adults can be distinguished from old adults by the appearance of the epiphyseal notches of humeri and femora. Sex and age ratios at Cree and Emma Lake were determined from 810 red squirrels collected by shooting and trapping. A complete population turnover of squirrels took place at Emma Lake in six years and at Cree Lake in nine years. The reduced longevity and greater mortality of squirrels at Emma Lake as compared with those at Cree Lake was attributed to heavier hunting and trapping pressure on the Emma Lake population. The sex ratios of 36 embryos, 23 young at birth, and 33 juveniles shot and trapped during July and August at Cree Lake was 0.92 males to 1.00 females. Contrary to statements of other workers, our data show an equal sex ratio in red squirrels at birth. The only sex ratio which differed significantly from unity was that of Emma Lake yearlings; this was attributed to the fact that juvenile males are easier to shoot or trap than are females.

The red squirrel is an important fur-bearer in northern Saskatchewan. In order to manage this resource wisely an understanding of such basic variables as reproductive success and population growth is essential. To accomplish this, sex and age of indiviuals in a population sample must be determined with reasonable accuracy.

The most desirable age criteria are those which change consistently and predictably throughout the life of the animal. Krause (1934) showed that the eye lens of the domestic rabbit grows throughout life and this was demonstrated by Lord (1959) with cottontail rabbits. Subsequently other investigators have used this aging technique for foxes (Lord, 1961; Friend and Linhart, 1964), raccoons (Sanderson, 1961), deer (Lord, 1962) and other animals with considerable success. A method of age determination based on the condition of the cartilage plates between the epiphyses and diaphyses of leg bones of the cottontail rabbit was developed by Thomsen and Mortensen (1946) and was refined by Hale (1949). It has since been used by Petrides (1951) and others for aging squirrels.

Both of the above mentioned aging techniques were used to analyze the age structure of two red squirrel populations. Sex ratios of the populations were also analyzed. The red squirrel populations studied were at Cree Lake (57° 30′ N; 106° 30′ W) and Emma Lake (54° N; 106° W) Saskatchewan, Canada.

Cree Lake, located slightly west of the center of northern Saskatchewan, comprises a total of 542 square miles and contains 546 islands (Rawson, 1959). A stunted northern coniferous forest type is present. Dominant trees are jack pine, *Pinus banksiana,* black spruce, *Picea mariana,* and white birch, *Betula pendula.* Hunting and trapping pressure on red squirrels at Cree Lake was slight. Emma Lake lies approximately 260 miles southeast of Cree Lake and is near the southern boundary of the northern coniferous forest. At Emma Lake fields of wheat and pasture land are interspersed with groves of aspen and large white spruce forests. Hunting and trapping pressure on red squirrels was very high at Emma Lake.

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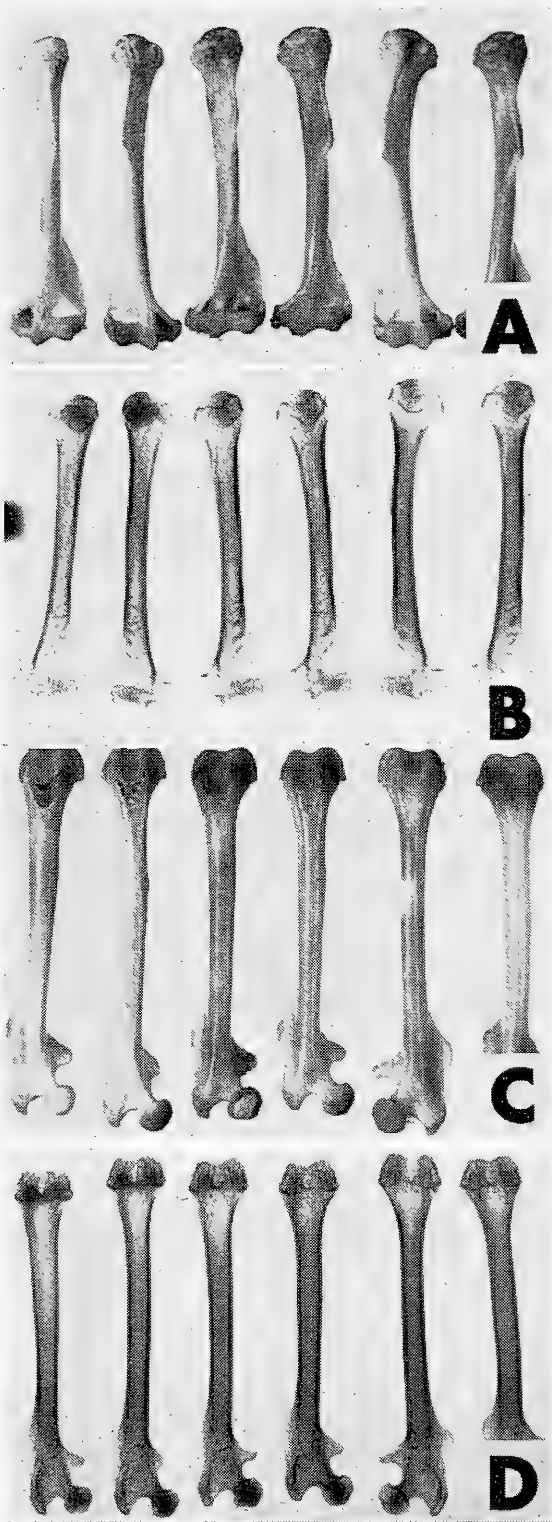

critically reading the manuscript. This study was supported by the Wildlife Branch of the Saskatchewan Department of National Resources, the University of Arkansas Graduate School, and National Science Foundation Summer Teaching Fellowships.

Methods and Materials

From June 1960 to July 1966, 810 red squirrels were collected at Cree and Emma Lakes by shooting and trapping. Winter collections were made by trappers. Thirty squirrels born to females caught at Cree Lake were killed to furnish known-aged lenses, femora and humeri. Squirrels were raised at Cree Lake for the first 2½ months and were then kept in Fayetteville, Arkansas until they were killed.

One femur and one humerus from each animal were cleaned by boiling in water, removing muscle tissue and soaking in "Clorox." The bleach dissolves soft tissue and cartilage, thus exposing the epiphyseal notch. To determine whether an epiphyseal notch was present, the bones were examined with a dissecting microscope and by radiographs. Eyes were removed immediately after death and fixed in 10% formalin for at least two weeks. After fixation the lenses were removed and oven-dried at 65° C until repeated weighings showed no additional weight loss. The mean weight of each pair of lenses was recorded as the average of the last three relatively constant weights.

Results and Discussion

Age Determination. We found the epiphyseal notch of the humerus head, viewed with a dissecting microscope, very distinct up to seven months of age (Figure I). From seven to ten months old the epiphyseal notch was closed laterally, at least externally, but was still partially open medially. Specimens older than ten months showed only a thin line at the site of the old epiphyseal notch. In some squirrels more than two years old the epiphyseal suture

FIGURE 1. Photographs and radiographs of red squirrel humeri and femora. A. Humeri of red squirrels 3, 5, 7, 9, 10, and 21 months of age (read from left to right). B. Radiograph of the same humeri shown in A. C. and D. Photograph and radiograph of femora from squirrels 3, 5, 7, 9, 10, and 21 months of age.

TABLE 1. — Mean weights of paired lenses of 30 known-aged red squirrels and predicted lens weights to year nine.

Age in Days	Mean Weight (mg)	Age in Months	Mean Weight (mg)	Age in Months	Mean Weight (mg)	Predicted Weight	
						Age in Years	Weight (mg)
0	.5	3	14.7	14	22.8	4	27.4
0	.5	4	17.5	16	23.0	5	29.0
0	.5	5	17.2	18	23.8	6	30.6
5	1.4	6	18.4	21	23.4	7	32.2
6	1.7	7	19.3	24	23.1	8	33.8
6	2.0	8	20.2	26	25.6	9	35.4
25	6.5	9	21.6	28	25.6		
48	10.5	10	22.2	30	24.6		
57	11.4	11	21.9	32	26.1		
		12	22.1	34	25.9		
				36	24.9		

was completely obliterated. A thin black line was still visible at the site of the epiphyseal plate in radiographs of proximal humeri and distal femora of 21 month old squirrels.

The epiphyseal notch at the distal end of the femur was distinct up to eight months of age. The notch was closed, except in the medial portion, in 8-18 month old squirrels. The medial line was thin but open enough to catch the end of a needle drawn across it in squirrels aged 21 to at least 34 months.

Thus, juveniles or young adults may be distinguished from old adults by the appearance of the epiphyseal notch at the proximal end of the humerus up to the age of ten months and to the age of 18 months by the condition of the epiphyseal notch of the distal end of the femur. Wood (1967) reported that the epiphyseal notch of the distal end of the femur was distinct in red squirrels from Wood Buffalo National Park at least to the age of 16 months, but his specimens were not of known age.

The lens growth curve of the red squirrel (Figure 2) suggests three distinct growth phases. Lens weight increases most rapidly from birth to four months of age; the growth rate was slower from age 4-10 months and was slowest from age 10-36 months. There were no significant differences in lens weights from the two sexes. Table 1 shows lens weights of squirrels up to nine years of age. Predicted lens weights were calculated from the 12-36 month portion of the growth curve, assuming that lens weights increased at the same rate after 36 months as between 12 and 36 months.

Possibly lenses of laboratory-reared squirrels are heavier than those of wild squirrels at the same age, because Matschke (1963) showed that lens weights in penned European wild hogs, *Sus scrofa*, were affected by nutrition. But we are assuming that the growth curve for lenses of captive squirrels (Figure 2) and the predicted lens weights (Table 1) are representative of wild squirrels. This raises the possibility that age variation in lens weights of red squirrels might occur from year to year as availability and quality of foods differ geographically, in different habitats and from one year to the next. Three Cree Lake squirrels had lens weights from 33.2 to 34.6 milligrams. The estimated ages of these squirrels would be eight years (Table 1) which is probably near the maximum for a wild squirrel.

There was 82% agreement between the epiphyseal notch and lens weight techniques in distinguishing animals under 16 months of age from older animals taken at Cree Lake. Age was overestimated 17% of the time using the epiphyseal notch technique alone. Most of the discrepancies were in the 12-16 month age group. This study agrees with previous studies on other species in showing that lens weights can be used to predict ages of red squirrels with reasonable accuracy and that juveniles

TABLE 2. — Survivorship and mortality of red squirrels in summer samples at Cree Lake and winter samples at Emma Lake. The Cree Lake sample number from 12–96 months is 412. The Emma Lake sample number from 9–69 months is 217. Proportions of young in 0–12 months and 0–9 months age groups are based on the expected number of young born.

Cree Lake: April – August sample

Age in months	0–12	12–24	24–36	36–48	48–60	60–72	72–84	84–96	96–108
Number surviving at beginning of age interval	1000	328	97	71	77	50	26	7	4
Mortality percentages	67.2	70.4	26.8	—	35.1	48.0	73.1	42.9	100.0

Emma Lake: November – March sample

Age in months	0–9	9–21	21–33	33–45	45–57	57–69	69–81
Number surviving at beginning of age interval	1000	322	107	38	17	17	2
Mortality percentages	67.8	66.8	64.5	55.3	—	88.2	100.0

and young adults can be distinguished from old adults by the condition of the epiphyses of humeri and femora. The lens weight technique is presently the only one which can be used to estimate the birth year of an individual red squirrel after two years of age.

Age Ratios. Survivorship curves and tables were constructed and mortality rates calculated from a sample of 412 squirrels collected at Cree Lake from April to August and 217

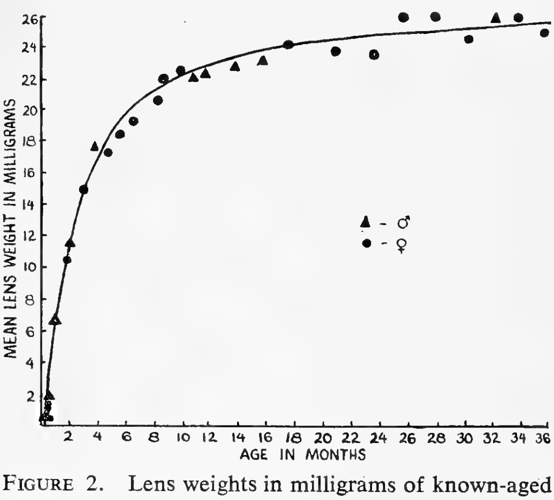

FIGURE 2. Lens weights in milligrams of known-aged red squirrels. Curve drawn by inspection.

squirrels collected at Emma Lake from November to March. The number of young at time zero (birth) was calculated from the mean litter size, the percentage of breeding females and the sex ratio (Davis, 1969) for these populations (Table 2 and Figure 3). These data were converted to a scale of 1,000.

Only five percent of the squirrels lived as long as five years at Cree Lake, and less than 4% of those at Emma Lake survived for three years (Table 2). Three squirrels from Cree Lake (0.4%) survived more than eight years, and only one from Emma Lake (0.2%) lived longer than six years.

At Cree Lake mortality was high in the first two years of life (67.2 and 70.4%) but was much lower (26.8%) in the third year (Table 2). Due to a higher reproductive rate in 1960-61 than in 1961-62, squirrels in the four year old age group outnumbered those in the three year old group. Less than half of the four and five year old age groups died in the fifth and sixth years after birth, but the mortality rate increased after the sixth year of age; no squirrel reached the age of nine.

Mortality percentages for Emma Lake squirrels were nearly identical for the first three years of life and showed a slight decrease in the fourth year. An equal number of squirrels in the five and six year age groups was accounted for by a more successful breeding year in 1960 than in 1961. Mortality was very high in the six and seven year age groups, and no squirrels older than 7 years were collected. The greater mean life expectancy (18 months *vs* 8 months) and maximum longevity (about 8 years *vs* 6 years) of Cree Lake as compared with Emma Lake squirrels was probably due to the much greater hunting and trapping pressure on the Emma Lake population.

Wood (1967) found that less than one percent of red squirrels studied in Wood Buffalo National Park survived to four years of age. His age determinations were based on tooth wear categories which he believed corresponded to age in years, but he had no known-aged material. Klugh (1927) reported a longevity of nine years in a captive red squirrel, but signs of decrepitude were apparent between five and six years of age. The present study raises some doubts concerning the reliability of Wood's aging technique and is consistent with reported maximum longevity for this species.

Sex Ratios. The embryonic sex ratio of Cree Lake red squirrels was 0.71 males to 1.00 females ($n = 36$), while the sex ratio of 23 young at birth was 1.30:1.00 (Table 3). The sex ratio of juveniles trapped and shot during July and August was 0.94:1.00 ($n = 33$). Young males were easier to trap and shoot during early winter. In November, 1965, the sex ratio of 61 juveniles collected at Emma Lake was 3.07:1.00. However, the sex ratio of 25 juveniles collected in the following month was nearly 1:1. During October and December the ratio of juvenile males to females trapped or shot at Cree Lake was 1.63:1.00.

Emma Lake males in their first year made up a significantly greater percentage of the juvenile total than females (Chi square = 8.06; $P = 0.01$; d.f. = 1). This was the only sex ratio which differed significantly from a 1:1 ratio. At Cree Lake the sex ratio of yearlings showed a preponderance of females, but the difference was not statistically significant. Sex ratios for each adult age group, except yearlings,

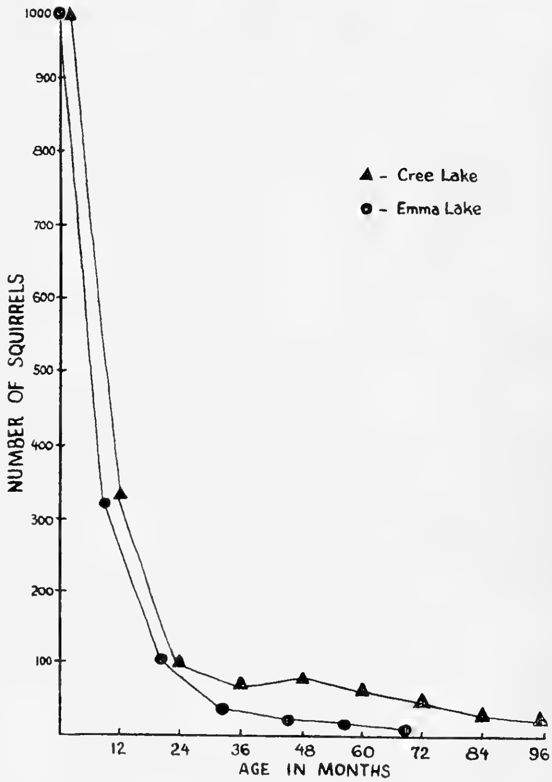

FIGURE 3. Survivorship curves of red squirrels from Cree and Emma Lakes.

TABLE 3. — Sex ratios of different age groups of red squirrels from Cree and Emma Lakes.

Age group	Males	Females	Sample Size
Cree Lake			
Embryos	0.71	1.00	36
Birth	1.30	1.00	23
Juveniles (July & August)	0.94	1.00	33
Juveniles (Oct. & December)	1.63	1.00	21
Yearlings	0.86	1.00	188
Two Years	1.04	1.00	57
Three Through Eight Years	1.07	1.00	141
Emma Lake			
Yearlings	1.65	1.00	135
Two Years	1.50	1.00	45
Three Through Six Years	1.21	1.00	31

the four year old group at Cree Lake, and the three and six year old groups at Emma Lake, showed an excess of males.

Layne (1954) and Smith (1968) reported a skewed juvenile or subadult sex ratio heavily in favor of males. Layne reported a combined sex ratio of 1.53:1.00 for 147 embryos, young in the nest, and independent juveniles. However, in the nestling and fetus group he found only 29 males to 26 females. Smith found a sex ratio of 2.40:1.00 ($n = 17$) in juvenile squirrels. He suggested that the apparently skewed sex ratio in favor of males was an evolutionary mechanism which tended to equalize the maternal energy expenditure.

The sex ratio of embryos, young at birth and nestlings reported by Layne when combined with similar data from our study yields a sex ratio of 1:1 ($n = 114$). Thus the existence of a ratio favoring males at birth seems doubtful. Since juvenile females usually are able to acquire territories more easily than juvenile males (Smith, 1968), males are apt to engage in more exploratory movements and consequently are more likely to be shot, trapped or seen. This could account for the significantly larger number of males than females collected at Emma Lake in November and for the greater proportion of males among juveniles observed in most other studies. Recently Kemp and Keith (1970) found no consistent or significant differences between trapped or shot samples of adult and juvenile red squirrels in a mixed forest type in Alberta from June until September, 1967 and 1968, but they did observe a preponderance of males during the breeding season (1.57:1.00, $n = 47$).

The reliability of the sex ratios for the Emma Lake red squirrels is not known. Sex ratios for yearlings and two year olds may not be representative of the population since males of these age groups were easier to shoot or trap than females. Sex ratios of adult red squirrels from Cree Lake, on the other hand, were probably fairly representative of the population. Pregnant females were less active and not as vocal as males. Thus, many more males than females were killed during the breeding season. After the young were born, females became very vocal, and during this period more females than males were killed.

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A Study of Introgression in *Typha* at Point Pelee Marsh, Ontario.

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Abstract. An eighteen point hybrid index was applied to leaf width and four floral characteristics of cattails of Point Pelee Marsh. The cattails were sampled randomly from twenty-two areas to determine the effect of differing marsh features on selection of putative hybrid swarms of *Typha latifolia* × *Typha angustifolia* and the parents. Marsh features were not analysed in detail. Only eleven samples of parental types were detected in the total sample of 614 individuals scored. Hybrid frequency distributions of peripheral and non-peripheral areas as well as different geographical areas of the marsh were determined. The observed differences of the hybrid frequency distributions suggested that differing ecological areas of the marsh selected individuals of different score.

Introduction

Both the common cattail (*Typha latifolia* L.) and the narrow-leafed cattail (*Typha angustifolia* L.) occur in Southern Ontario (Hotchkiss and Dozier, 1949). The third North American species *Typha domingensis* Pers. does not occur north of Virginia. Kronfeld (1889) first described the hybrid of *T. angustifolia* × *T. latifolia* in Europe. He equated the hybrid swarm with *Typha glauca* Godron. Indeed many authors in North America have considered *T. glauca* a distinct species (Hotchkiss and Dozier, 1949, Fernald, 1950, Munz, 1959). Recently in eastern North America, Fassett and Calhoun (1952) and Marsh (1962) have established the introgressant hybrid nature of the swarm intermediate between *T. latifolia* and *T. angustifolia* by both inter-specific crosses and hybrid index studies of natural populations. Smith (1967) further detailed the complexity of these hybrid swarms. The present study was undertaken to assess the status of an apparently introgressant cattail community with particular emphasis on the putative degree of hybridity in different ecological portions of a marsh. A morphological species concept has been adopted for analysis of the cattail population of Point Pelee Marsh. Smith (1967) has indicated that a high degree of fertility exists between *Typha latifolia* and *Typha angustifolia* where ever the two species occur naturally together. Therefore, *T. latifolia, T. angustifolia,* and *T. glauca* comprise one biological species.

Point Pelee.

Point Pelee National Park is the most southerly point of mainland Canada. The park is best known to naturalists who seasonally witness the bird migrations as well as the rich nesting fauna. To biologists the park is exceptional for two other features, namely the large closed fresh water marsh and the Carolinian climax forest. The marsh of 2,658 acres represents approximately 70 per cent of the park area.

Point Pelee Marsh is considered closed as there is no free exchange of marsh waters with those of Lake Erie. However, due to its size and the number of large ponds within the marsh, internally it may be regarded as possessing a gradient from closed, in central areas, to open conditions at edges of ponds and channels. Therefore, small areas or subpopulations of this flora may be comparable to many small open and closed marshes throughout southern Ontario.

Description

Both species of *Typha* are monoecious with the male flowers positioned above to the female flowers on the same floral stalk. Flowering in Point Pelee first occurs in early July and continues until the first week of August. The annual appearance of new shoots is first apparent in the fall of the preceding season. Quiescence occurs during the winter months, with apparent renewed growth in late April to early July. The shoots are produced in the

TABLE 1. — Character Evaluation

Character	Variation	Score
Leaf Width	16–20 mm. 12–16 mm. 8–12 mm. 4–8 mm. 0–4 mm.	0 1 2 3 4
Inflorescence Gap	0 mm. 0–20 mm. 20–40 mm. 40–60 mm. 60–80 mm. 80–100 mm.	0 1 2 3 4 5
Bract of female flower	Absent Present	0 3
Pappus of female inflorescence	Unclubbed Clubbed	0 3
Stigmas	Spatulate Linear	0 3

Typical *Typha augustifolia* – 14–15
Typical *Typha latifolia* – 1–2

nodes of the rhizomes. The leaves continue growth from the basal meristems until mid-August when signs of senescence first are apparent. Floral stalks are produced centrally with early growth sheathed by the leaves and the floral sheath.

Typha latifolia is easily recognizable by its broad leaves (8-23 mm) and apparent lack of floral gap between the male and female inflorescences. The female floral structure reaches a diameter in the mature spike of 17-32 mm with a distinctive dark brown to blackened colouration. The pistillate flowers lack bracteoles, possess unclubbed pappus and spatulate stigmas.

Typha augustifolia has narrow leaves (5-11 mm) and large floral gaps (10-120 mm). At maturity female floral structures reach only 10-20 mm in diameter with spike colouration of dark brown. The pistillate flowers have braceteoles, pappus and linear stigmas.

Methods

The marsh was arbitrarily divided into 22 areas each of which could be completely sampled in one half day. The areas were of equal vegetation acreage. The areas were then chosen at random for sampling to eliminate any age effects with date of sampling in any particular geographic area of the marsh. Each sample was chosen randomly on transects through the areas such that each sample was at least 100 feet from any other particular sample. To ensure that clones were not re-sampled, each sample was plotted on a grid map of the marsh. A minimum of twenty samples were collected from each area of the marsh to yield a total of 614 samples collected. Sample material included the oldest photosynthetic leaf, and the floral stalk. These were determined for leaf width, the length of the gap between the male and female portions of the cattail spike, presence or absence of a bract within the female infloresence, the nature of the pappus which surrounds the female flower, and the shape of the stigma. The characteristics studied were assigned numerical values in preparation for the assembly of a hybrid index. The values were assigned to yield a maximum index value of 18, with typical *T. angustifolia* scoring 14-15 and typical *T. latifolia* scoring 1-2. Three of the floral characteristics, the presence or absence of a bract, the nature of the pappus, and the shape of the stigma were weighted by a factor of three since floral characteristics are less environmentally modifiable than vegetative characteristics. In the present hybrid index, floral features account for a total possible score of 14 of a total possible score of 18. Table I presents the scores of the characteristics used for this hybrid index.

Results and Discussion

Total Population Distribution

Figure I shows the frequency distribution of hybrid indices for the entire marsh. The distribution is typical of a population which is introgressing, following hybridization, although the parental species are no longer represented. Of the 614 individuals scored in the study, only seven are typical of *Typha latifolia* (score 1-2) and there are only four

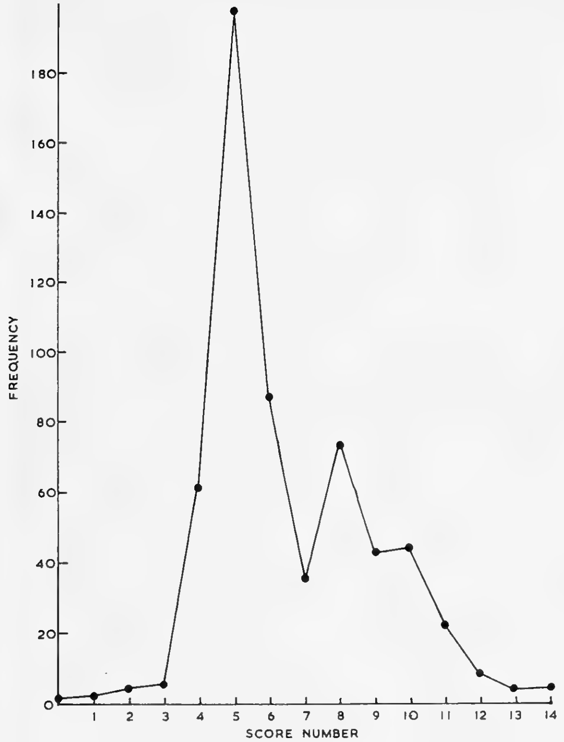

FIGURE 1. Total distribution of samples.

individuals typical of *Typha angustifolia* (14-15). The population of *Typha* in Point Pelee Marsh thus represents a strongly introgressive group, the majority of which may be placed in the category of *Typha glauca*. There appear to be two and possibly three scores in the marsh as a whole. The main one, score 5, is most common, followed by a second population with score 8 and a third with score 10. Thus the marsh appears to have few *Typha latifolia* or *Typha angustifolia,* but is instead typified by a group of individuals which show segregation of characters of two parental populations. It may be further speculated that conditions of the environment are now selecting these individuals in preference to the parental species, so that eventually distinct ecotypes may emerge.

Peripheral vs. Non-peripheral Distribution

From field observation, the authors have suspected that edge populations of cattails are more variable in composition than those of a non-peripheral nature. The determining factor may be environmental heterogeneity such as peculiar substrates, water depth, or differing light relations which vary considerably in southern Ontario marshes (unpublished data of the authors). To test whether this was evident in the sampling at Point Pelee, the data was re-grouped into peripheral and non-peripheral samples and the data replotted. The definition of peripheral samples in this discussion is that they border open water, while the non-peripheral samples are not adjacent to open water.

Distribution of segregating types in the non-peripheral graph (Figure 2) shows that distribution is limited principally to individuals with score 5 and score 7 individuals, with a very limited distribution of other types. By contrast, distribution of the peripheral samples shows two nearly equal peaks of individuals with score 5 and score 10, with a secondary peak of score 8. At least 3 scores are predominant in the peripheral distribution (Figure 3), and other scores are well represented. Since the hybrid index is largely based upon floral characteristics which are less susceptible to environ-

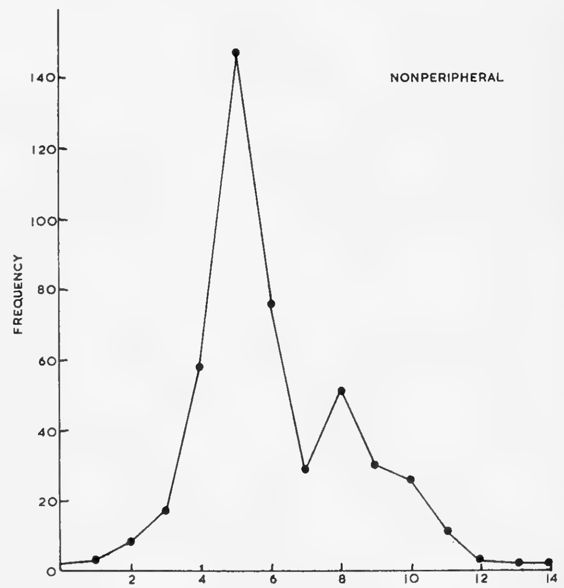

FIGURE 2. Non-peripheral sample distribution.

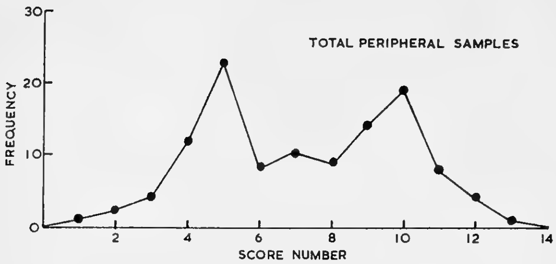

FIGURE 3. Peripheral sample distribution.

alteration of the individuals by the environment. The strong representation of many different scores probably results from the peripheral exploitation of new habitats.

Area Distribution of Peripheral Samples

The sample data for the five major bodies of open water within the marsh were separmental changes, the observed variation must be due to genetic variation rather than plastic ately plotted, to determine whether peripheral populations behaved uniformly throughout the marsh (Figure 4). Although numbers of individual samples are small, comparison of the hybrid frequency distributions of individual ponds suggest that the peripheral areas are behaving differently in the various geographic regions of the marsh.

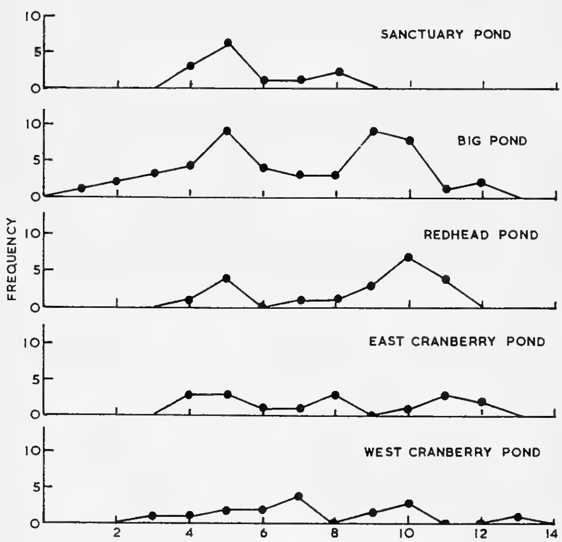

FIGURE 4. Peripheral sample distribution, by pond areas.

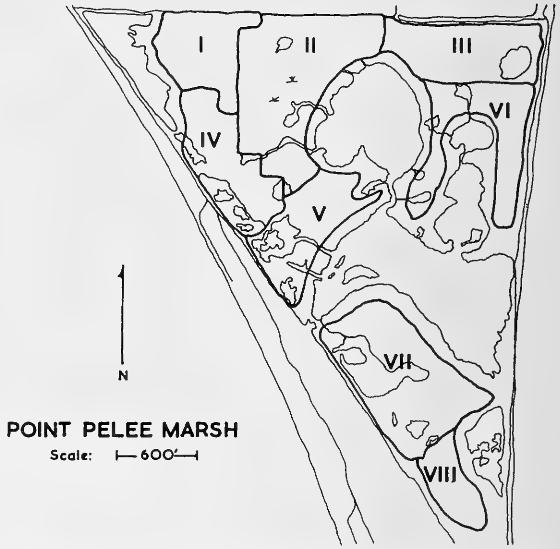

FIGURE 5. Map of Point Pelee marsh, showing non-peripheral areas.

Most areas of the marsh have shown a lessening of the cattail populations due to the high water levels of Lake Erie in the summer of 1968 and 1969. In particular, the high water levels of the summer of 1969 have caused die-back of the cattails in the deeper areas of the marsh. However, the shallow rapidly prograding ponds such as East and West Cranberry Ponds have supported continual rapid growth of the cattail populations. Here all segregants are equally represented as the population moves out into open water habitats. The other ponds, particularly Sanctuary and Redhead Ponds, have widened so that the peripheral populations of previous years are missing, and the now peripheral samples are in essence the more stable non-peripheral communities of previous years. Big Pond, which has gone through some regression because of high water, and which shows distinctly two segregants, is again beginning to prograde, so that the two trends, one of stabilization, [the hybrid frequency distributions with two predominant scores,] and of progression, [the hybrid frequency distributions with a wide representation of other scores], are superimposed on each other.

Area Distribution of Non-peripheral Samples

When all the 22 areas were plotted, similarities of data have condensed the non-peripheral areas into 8 geographic regions of the marsh. In each, behaviour of the scores serves as an indicator of the environmental pressures acting upon them (Figures 5, 6, 6a). Area I, with its two main scores and a reasonably strong representation of others, indicates an area of rapid aggression, which has only recently become non-peripheral. Area II has similarities to Area I, but is of more recent origin, and competition among the scores is still strong. In Area III competition has been strong in the past, but the population is now stabilizing with individuals of score 5. Area IV is more or less stabilized with individuals of score 5, and it is an area where succession to *Decodon verticillatus* is taking place. Area V indicates the trend toward stabilization, although sorting is still occurring. In Area VI, stabilization with individuals of score 5-6 is occurring, and other scores are reduced in numbers. Area VII is still under considerable growth pressure, but unlike most of the other areas, is becoming stabilized with individuals of score 3, which more closely resemble *Typha latifolia*. *T. latifolia* tends to occupy the shallower, more transitional marshy areas, and indeed Area VII is in this state of transition to swamp-forest. Area VIII, though shallow, still continues to show the entire range of scores, suggesting that for *Typha* it is one of the more recent habitats.

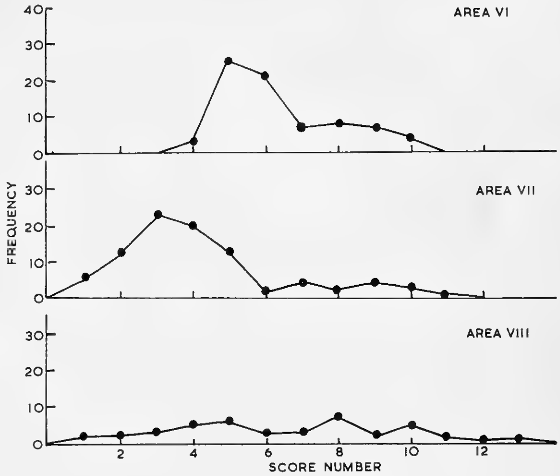

FIGURE 6a. Non-peripheral area sample distribution.

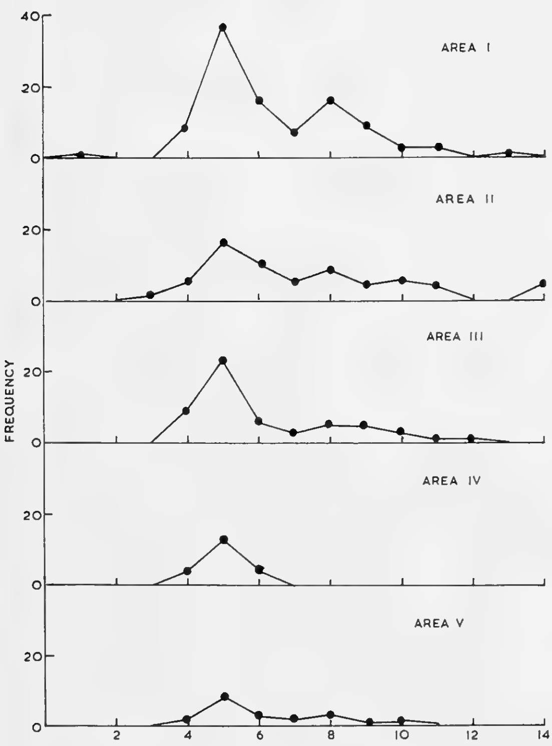

FIGURE 6. Non-peripheral area sample distribution.

From the general data, it would appear that the entire 2,658 acres of Point Pelee Marsh is one extensive hybrid swarm of *Typha*, but that environmental selection has stabilized some areas so that particular segregants predominate. The major type at present is the individuals of score 5, which closely conforms to the taxonomic description of *Typha glauca* Godr. Individuals of score 3 which closely resemble *Typha latifolia* are present in only one area of the marsh, a swamp-forest transition, while individuals of score 10, which more closely resemble *Typha angustifolia*, are consolidating their position around Redhead Pond, a pond of low ionic content.

Although other large marshes bordering the northern shore of Lake Erie and Lake St.

Clair have been visited, they have not been scored. Collections and sampling in these marshes, particularly the large one at Long Point, suggest that *T. glauca* is the most common morphological species. All the work on *Typha* sampling which the authors have done in recent years in the Ottawa district suggests that here also, it is the hybrids and not the parental species which are in ascendency.

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Observations of the Great Gray Owl on Winter Range

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Abstract. A study of some aspects of the ecology and behaviour of wintering Great Gray Owls was undertaken in the Ottawa, Ontario-Hull, Quebec District, in the winters of 1966, 1967, 1969, and 1971. The vast majority of work was accomplished in 1966 and 1969.

The Great Gray Owls studied generally set up definite home ranges and tended to stay within those boundaries. One home range consisted of approximately 112 acres of suitable habitat (poor, abandoned shield farmland). Field appearance and flight are described. The wingbeats/second of three kinds of flight are given for one of the birds: 2.3 beats/second at hovering and normal flight, 2.9 beats/second when rising from the ground.

Territorial confrontation appears to be rare on the winter range, as is vocalization. Hunting behaviour is discussed in some detail. The authors agree with Law (1960) and Nero (1969) that hearing plays an important role in hunting during winter. The Great Gray Owl was primarily a crepuscular and diurnal hunter in our study area. The primary prey species of the Great Gray Owls studied appears to have been the Meadow Vole, *Microtus pennsylvanicus*. No evidence of the Great Gray Owl eating birds or, mammals larger than the Red Squirrel, *Tamiasciurus hudsonicus*, was noted.

It is speculated that the traditionally described habitat of dense coniferous forest as the preferred breeding habitat of the Great Gray Owl may need to be modified to include some open areas. Since these areas are limited, this may explain the sparse occurrence of the species in Canada.

Introduction

Observations of the Great Gray Owl, *Strix nebulosa*, on its winter range were made in 1966 and 1969 and to a lesser extent in 1967 and 1971, in the Ottawa, Ontario-Hull, Quebec District. Some aspects of the species' behaviour and ecology other than those of winter range will be discussed.

The Great Gray Owl is a very rare winter visitor into the district (Pittaway 1969), normally occurring in occasional influxes. Godfrey (1967) described the 1966 influx as, ". . . at least 15 individuals, and unverified reports of as many more. Our first definite record was at Carleton Place, Ontario . . .; the last on April 9 at Ramsayville . . . The greatest concentration was of three at Lucerne, near Hull, Quebec . . .".

In 1967 only one bird was reported, that seen by Pittaway on February 27, 1967 in Lucerne. On February 12, 1969 one bird was observed in the Aylmer-Lucerne, Quebec area. By February 21 the area held four Great Gray Owls, these being in exactly the same locality as the concentration of three mentioned by Godfrey (1967). The last observation in 1969 was made on March 2. The authors were told that at least two of these latter birds may have been shot, perhaps explaining their sudden disappearance (J. Dubois pers. comm.). At least one the of birds in the concentration in 1966 definitely was shot.

The proximity of this concentration to Pittaway's former residence in Aylmer East facilitated intensive study of those seven birds.

In 1971 a single bird, probably a male, was observed in the west end of Ottawa. Ontario on January 31. It remained only one day.

Previously this paper appeared as a more popular version (Pittaway and Brunton 1969).

Field Appearance

The bird is huge. At first glance in flight, the owl reminds one of the size of a Great Blue Heron, *Ardea herodias* — because of its enormous, rounded wings. The species has been identified with certainty by naked-eye at distances in excess of ½ mile (Pittaway and Brunton 1969). Its large head and bulging neck give it a front heavy appearance in flight.

The birds appeared typically grayish-brown in colour, though the same individuals were seen to vary from deep chocolate to lightish-gray, depending upon light conditions.

The most striking field mark in poor light is the luminous-white throat marking described by Godfrey (1966) as ". . . a narrow but surprisingly conspicuous white throat patch". This, and the surrounding black and brown areas varied considerably from bird to bird, and was used to differentiate individuals. There appears to be a sexual dimorphism in the Great Gray Owl, the female being darker in colour, larger, and having a longer throat patch than the male. Law (1960) describes sexual dimorphism for size and colour in the Great Gray Owls he observed in Saskatchewan. Godfrey (1967) states that the throat patch ". . . may well be functional."

The great amount of puffy, loose feathering is probably an adaptation for cold and may also reduce sound made by the bird in flight. Very rarely did the talons or bill project appreciably from within the plumage. The heavy plumage tends to accentuate the smallness of the eyes and concavity of the facial disc.

In all winter birds which we have examined, the bill was horn, or pale yellow in colour, not as bright and striking as generally illustrated. The well-defined dark streakings which most illustrators give the Great Gray Owl (e.g. Peterson 1947) were very seldom clearly visible in our experience, and generally took the form of an irregular pattern of patches and lines down the underside of the bird. As wind regularly tossed the loose feathering around, such features were constantly changing form. (See Figure 1).

Habitat

In our winter study the areas most frequently occupied by Great Gray Owls were open fields with scattered large elms, patches of shrubbery, weedy areas and overgrown fence-rows. This is typical of poor quality, abandoned shield farmlands. Bordering areas consisted of such features as fairly extensive mixed forests, secondary roads, a golf course, and scattered housing. Typical roosting perches were the heavy branches of these large elms. Hunting perches consisted of almost anything available, generally smaller trees or shrubbery. (See Figure 2).

Only rarely was a Great Gray Owl seen in neighbouring forested areas On the two occasions that this was observed, the birds remained only briefly, then returned to the typical open habitat described above. They were not observed to occupy areas of heavily grazed or cultivated farmlands. This probably was due to such areas supplying little suitable habitat for Great Gray Owl prey species. Nero (1969) found the winter habitat most often occupied by Great Gray Owls in southern Manitoba to be very similar to that described in this paper. This description seems also to approach closely that described in recent literature as nesting habitat (e.g. Parmelee 1968, Nero 1970).

Since the habitat as described above was occupied in two successive influx years by concentrations of Great Gray Owls (three birds in 1966 and four birds in 1969), it was concluded that this habitat is highly attractive to the species.

Flight

Flight was generally low, with two or three wingbeats and much gliding. Being very lightweight and of large proportions they seem to float leisurely through the air. Seldom were they observed to fly above tree-top level. Although a large proportion of flight was occupied by gliding, the estimate of 80% (Law 1960) seems too great in our experience. In gliding, the wings are held straight out (like those of an eagle) with only the outer primaries being uptilted. This is well illustrated in Nero 1969.

Hovering was observed to last longer than 10 seconds on some occasions. During hovering, a Great Gray Owl was calculated to be beating its wings at a rate of 2.3 beats/second. When rising from the ground, however, this frequency increased to 2.9 beats/second, returning to a rate of 2.3 beats/second when the bird attained normal height and speed. These figures were calculated from a small sample of movie sequences of one owl photographed by Pittaway in February 1969. The method used for the calculations was that described in Palmer (1962). During hovering the owls were observed to be completely stationary in the air.

When leaving a perch the Great Gray Owls would slowly tip forward, then launch straight out, with legs dangling. Landing generally consisted of an upward sweep to the intended perch. Immediately before contact the bird would extend its legs forward, and then heave itself up onto the perch. If the intended perch was a shrub or small tree, the bird would hover above, then lower gently down upon it. Landing usually was followed by a brief period of fluffing of the feathers. Occasionally some preening was observed at such times, but usually this was restricted to the resting period. (Note: Little preening was noted at all by this species. It generally consisted of the bird running its bill down the breast and at the same time, shaking its head from side to side. The 1971 bird was seen to shake itself violently on one occasion, the bird swinging from side to side rapidly).

Rather than change the course of flight to avoid obstacles (including observers) the owl would tip or twist to one side. Their flight always appeared to us as purposeful; seldom were any of the birds observed to do other than fly directly, quickly, and silently, with no deviations of its course attempted. Their flight appeared graceful and efficient. (Flight while hunting is described under Hunting Behaviour).

Voice

Only two calls were noted, both by the same bird on the same occasion (see Territory for details). One was a short, rasping "e-e-e-e-e-e-e-e-e-e" which did not carry far. The other was a quiet, drawn out "Who-oo-oo-oo-oo-oo" with the quality of a Great Horned Owl, *Bubo virginianus*.

Nero (1969) mentions only one incident of vocalization in his Manitoba winter study. The Great Gray Owl does not appear to normally be vocal on winter range, except in territorial encounters with other Great Grays.

Territory

The owls seemed to establish a definite home range and seldom strayed beyond its boundaries. In 1969, one bird stayed almost exclusively

FIGURE 1. The Great Gray Owl. Note conspicuous throat patch.

within an area of approximately 112 acres of typical habitat (as described previously) for 11 days. Two other birds were observed regularly in an adjoining area but their exact range boundaries were not determined.

Individual birds were observed to show great interest in other Great Gray Owls hunting nearby, but we observed only one case of what we feel was territorial confrontation. This encounter took place when the birds had been in the area only two or three days, and perhaps was at a time when they were setting up the boundaries of their home ranges. The incident, at 5:30 p.m. E.S.T. on February 26, 1966 went as follows: As we observed (from a distance of 100 feet) a sitting Great Grey Owl, we saw another flying directly towards it. When the flying bird was approximately 250 feet from the perched bird, the latter (which appeared to be giving the other its complete attention) gave a short, rasping call, followed by a drawn-out "Who-oo-oo-oo-oo". The rasp was given once and the "Who-oo-oo" three times, each call being separated by a pause of approximately two seconds. It seemed that the perched bird was directing these calls towards the flying bird. Immediately after the last call, the approaching bird changed its course and flew away, at right angles to the sitting bird. Throughout this episode, a third bird (appearing approximately 30 minutes before either of the other two) was perched on a telephone pole 200 yards away. It remained silent and did not fly from that perch. The other two Great Gray Owls seemed to take no notice of this bird. The bird which called had been followed by Pittaway for an hour, during which time it had been actively hunting. It took the perch only a few minutes before the above encounter ensued.

Considering the number of potential situations of conflict which we observed later, and with this observation being the only clash seen, we assume that clashes on the winter range are rare. It cannot be said if this is the way in which territorial disputes are resolved, as it was the only incident of its kind we observed.

Nero (1969), regarding the reaction of other birds to the Great Gray Owl, stated that there was ". . . nothing to indicate that birds regard this species as an enemy." He says further that ". . . the owls were otherwise ignored though there were lots of opportunities for Black-capped and Boreal chickadees, Gray and Blue jays, and other species, to come in contact with them." These observations agree in a general way with ours, except that two small predators were observed to harass a Great Gray Owl: a Sparrow Hawk, *Falco sparverius,* and a Northern Shrike, *Lanius excubitor.* In 1969 a Sparrow Hawk was observed furiously diving at one of the owls and calling loudly. These actions seemed to have no effect on the owl. It was not observed to hit the owl although it came within a few feet of it.

FIGURE 2. Typical habitat. Pittaway approaching perched Great Gray Owl (arrow). Lucerne, Quebec. February 16, 1969. Photo by D. F. Brunton.

We observed few intensive reactions to the Great Gray Owl from Common Crows, *Corvus brachyrhynchos.* Both species were observed together on about 10 occasions and only once were serious aggressive actions taken by the crows. On that occasion, March 2, 1969, Brunton photographed two crows making repeated dives (about 10) at a Great Gray Owl which was sitting in an open elm, during a period of approximately 10 to 15 minutes. The normal reactions involved crows sitting a few hundred yards away, calling (and not pursuing) only when the owl left its perch.

E. J. Moran (pers. comm.) reports finding the 1971 Great Gray Owl by the angry calling and diving of four or five crows at the bird.

Hunting Behaviour

Great Gray Owls were observed to perch well out in the open where visibility of the surrounding landscape was excellent; they could be seen constantly scanning the area. A favoured position seemed to be well out from the trunk of a large elm. A hunting owl would typically move from perch to perch until it reached a spot where it appeared that the bird sensed some indication of prey activity beneath the snow. At that time the bird would cease all scanning and would peer down at a sharp angle to the snow. At such times it appeared almost hypnotized by the spot below and was very difficult to distract. Almost invariably the owl would capture prey at that spot.

Great Gray Owls have frequently been observed by the authors to fly out over a spot which has been given particular attention, hover briefly over it (with legs dangling), and then crash into the snow and capture prey. Upon capturing prey the owl, still sitting on the snow, (with its wings held over the surface like an

FIGURE 3 Great Gray Owl attacking prepared skin of Meadow Vole, *Microtus pennsylvanicus*, being pulled on a string. Lucerne, Quebec. April 6, 1971. Photo by J. D. Lafontaine.

umbrella, if there was bright sunshine) was generally observed to scan the surrounding area briefly. Then, reaching down, it would take the prey from its talons and swallow it immediately (head-first and whole). This latter sequence took only two or three seconds — so quickly that an observer could easily miss it and conclude that the owl had not caught prey. The owls were regularly observed to spend considerable time on the snow after the prey had been eaten, (occasionally over five minutes).

Owls were observed hunting from the snow on several occasions in 1966 and 1969. This apparently was done only when a suitable perch was not available in the close vicinity of a spot in which the bird was interested.

On numerous occasions we studied carefully the spot given close attention by a Great Gray Owl. Although we were often observing from 10 to 20 feet away, very rarely did we see anything on the snow, yet the owls would almost invariably capture prey upon plunging into what appeared as bare snow. Law (1960) states that the Great Gray Owl captures prey in winter by hearing alone. Nero (1969) says that ". . . our observations of hunting behaviour support the belief . . . that this owl can find its prey solely by sound . . .". The authors can think of no other explanation for the high degree of hunting success under the conditions mentioned above, other than that Great Gray Owls had been locating their prey by hearing.

The species' ability to instantaneously and precisely locate the sound of a clicking camera shutter from a distance of 100 feet or more, while looking in a totally different direction, was demonstrated to us several times in 1969, and is further evidence of the Great Gray Owl's hearing ability.

In February 1969, we were studying a bird that apparently was transfixed by some object a great distance away. Suddenly the bird leapt from its perch and flew approximately 200 yards directly across the field towards a small mammal (*Microtus?*) on the snow. With almost continuous flapping (up to 25 beats without a glide) the owl quickly reached the mammal (gliding the last 10 yards), snatched it up, and devoured it shortly after landing approximately 25 feet farther on. The rapid, uninterrupted flight was typical of other occasions when we observed a Great Gray Owl attacking prey. The owl had apparently seen the mammal (in broad daylight) from that distance; the Great Gray Owl can rely on eye-sight acuity as well as hearing in the capture of prey. (In 1971 Brunton observed a Great Gray Owl to follow the flight of an eagle sp. at a distance of approximately 700 yards).

On four occasions Great Gray Owls were induced to attack a prepared skin of a Meadow Vole, *Microtus pennsylvanicus,* attached to a long white string and pulled over the snow. So intent on the specimen were these owls that they would approach within an arm's length of the observers and/or fly around them to get a clear view of the specimen. It is worthy of note that the birds would pay no attention to the specimen unless it was moving. (See cover).

Diurnal Activity

The peak hunting hours of the owls were in the early morning, and from late afternoon to dusk. After bad storms (e.g. sleet) when they were undoubtedly having difficulty in obtaining food, hunting was continued throughout the daylight hours. Normally however, they would have a "rest period" abcut mid-day, about which time they became increasingly inactive, spending much time dozing with perhaps some preening. On several occasions in 1969, observing the owls from noon until dark (when activity decreased drastically) and again checking after dark (as late as midnight), we noted that the owls had rarely moved and were no longer active.

The Great Gray Owl seen January 31, 1971 was observed roosting from 9:00 AM to 5:00 PM E.S.T. It became increasingly active after 3:00 PM until its departure at 5:00 PM, approximately one hour before darkness. This bird may have been nocturnal in habits, or may have been taking a prey species available around dusk. It should be noted that the bird was seen in a residential district of Ottawa, and as such was completely out of habitat (as described previously). No other bird observed by the authors exhibited these habits or was found in this habitat.

It is concluded by the authors that the Great Gray Owls observed were primarily crepuscular and diurnal in hunting behaviour.

Prey Species

From examination of the few pellets retrieved, and primarily from field identification of prey, we concluded that the Great Gray Owls we studied were feeding almost exclusively on Meadow Voles. The occasional Short-tailed Shrew, *Blarina brevicauda,* was identified in pellets. Nero (1969) reports the Meadow Vole as being the major food item found in eight stomachs and one pellet of the Great Gray Owl in Manitoba (61% of total prey individuals). 94% of prey items in the extensive food study in Fenno-Scandia proved to be voles (*Microtidae*) (Mikkola and Sulkava 1970).

The authors have not observed the Great Gray Owl to feed on birds. We observed as one of the owls landed in a shrub under which a covey of Gray Partridge, *Perdix perdix,* was sheltered. Although the partridge fled immediately upon the owl's arrival, the Great Gray showed no interest in them. In literature however, a wide variety of birds are listed as food for this species, e.g. Common Crow, *Corvus* *brachyrhynchos,* (Allen 1904), Redpoll, *Acanthis,* (Fisher 1893), Hazel Hen, *Tetrastes bonasia,* (Mikkola and Sulkava 1970), etc. The taking and/or eating of birds must be assumed to be uncommon. Of 4,026 prey items examined in their pellet study, Mikkola and Sulkava (1970) found only 44 items (1.1%) representing birds, ". . . ranging from finches (*Fringillidae*) and five adults and young gamebirds (*Tetraonidae*) to Jays *Garrulus glandarius* and a Tengmaln's Owl *Aegolius funereus*."

We have not observed the Great Gray Owl to attack and/or feed on any mammal larger than the Red squirrel, *Tamiasciurus hudsonicus.* We observed an owl attempting to capture a Red Squirrel which was on the ground, in February 1969. A furious struggle ensued, in which the squirrel finally escaped from the owl, after almost knocking the bird down. The squirrel however, was injured and bleeding. The owl remained at the site and a few minutes later again managed to seize the squirrel which had temporarily hidden in a tunnel in the snow. Again the mammal escaped though seriously injured and bleeding profusely. Approximately five minutes after the second attack, the Great Grey Owl left the site. The squirrel was apparently too large a prey, at least for this particular bird. Nero (1969) notes that using this mammal as bait for live-trapping Great Gray Owls met with only limited success.

Large mammalian prey is regularly reported in literature. Bent (1938) includes young rabbits and hares. In 1966 in the Ottawa District, Dalton Muir (pers. comm.) observed a Great Gray Owl flying with a Snow-shoe Hare, *Lepus americanus,* in its claws. The owl was first observed perched (on the hare) in a tree, 8 to 9 feet above the ground. When flushed, it flew (with great effort) over 200 yards, though steadily losing height, until finally landing with the hare on the snow. Muir has documentary photographs of the event. Peterson (1966) gives the weight of a Snow-shoe Hare as being between 3 and 5 pounds (1362 and 2270 grams). As the Great Gray Owl typically weighs between 790 grams (a small male) and 1454 grams (a large female) (Earhart and Johnson 1970), this observation is truly an amazing one.

Feeding on grouse, rabbits, hares, etc. is certainly uncommon. One might wonder if these records constitute kills, or if perhaps they represent (at least in part) feeding on carrion by the Great Gray Owl.

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Notes

Parasitism of Mallard Nests by Common Goldeneyes

Abstract. Goldeneye eggs were found in 11 nests incubated by mallard hens at the Delta Waterfowl Research Station in Manitoba. These were all located in wooden nest boxes. Goldeneye eggs pipped in four nests, and three ducklings hatched in one nest.

Some ducks lay eggs in the nests of other species. The Black-headed Duck (*Heteronetta atricapilla*) is the only known obligate nest parasite in the family Anatidae (Weller, 1968). The Redhead (*Aythya americana*) and the Ruddy Duck (*Oxyura jamaicensis*), which nest over water, are recognized for their non-obligate nest parasitism (Bent, 1902; Weller, 1959). In New Brunswick, hole nesting species, the Hooded Merganser (*Lophodytes cucullatus*), the Wood Duck (*Aix sponsa*), and the Common Goldeneye (*Bucephala clangula americana*), were found to lay their eggs in each other's nests (Prince, 1965). The least nest parasitism has been noted among ground nesting waterfowl. The data reported herein describe nest parasitism by a typically hole nesting duck, the Common Goldeneye, of a ground nesting species, the Mallard (*Anas platyrhynchos*), in an area where the Mallard makes use of man-made nest boxes.

As part of a study of the breeding behaviour of a dense population of free-winged, semi-domestic Mallards at the Delta Waterfowl Research Station in Manitoba during 1966, 1967, and 1968, regular checks were made of 90 elevated wooden nest boxes in the 7.6 acre study area. Mallards used 69 of these boxes in 1966, 66 in 1967, and 51 in 1968. At least three female goldeneyes in 1966, two in 1967, and three in 1968 laid eggs in the nest boxes. These hens eventually incubated their own nests.

During the three years 11 Mallard nests contained goldeneye eggs (Table 1). The eggs of these two species were easily distinguishable according to characteristic colour, shape, and shell thickness. In seven nests goldeneye eggs did not hatch, but in four, goldeneye eggs were pipped when the Mallard young left the nests. In these four nests Mallard hens left before all of their eggs had hatched. One can only speculate that the goldeneye eggs might have been properly hatched had the Mallard hens been more attentive to their own clutches.

One parasitized Mallard nest was notable. It contained six Mallard and eight goldeneye eggs, all of which were incubated by a Mallard hen. On the evening of June 25, 1966, four Mallard and one goldeneye eggs were pipped. On the morning of June 27, the hen had left the nest with five Mallard ducklings, abandoning three goldeneye ducklings and five pipped eggs, four of which were goldeneye. The fifth unhatched goldeneye egg was addled. Perhaps the goldeneye ducklings stayed in the nest box because they were unresponsive to the behaviour of the Mallard hen calling her young from the nest. The three goldeneye ducklings and five pipped eggs were removed to the Delta hatchery where they were hand reared.

Table 1. — Mallard nests in which Common Goldeneye eggs were recorded at Delta, Manitoba

Year	Nest Box #	Total Eggs	Goldeneye Eggs	Eggs Pipped Only		Eggs Hatched	
				Mallard	Goldeneye	Mallard	Goldeneye
1966	50	7	1	1	1	3	0
	13	8	1	2	1	1	0
	15	13	2	—	—	8	0
	34	11	4	—	—	0	0
	35	14	8	1	4	5	3
1967	40	10	1	—	—	3	0
	15	16	2	—	—	5	0
1968	23	10	1	—	—	0	0
	25	11	1	—	—	10	0
	50	12	2	—	1	8	0
	11	15	2	—	—	0	0

From these observations several conclusions are suggested about the association between hole nesting Mallards and Common Goldeneyes. The Delta Mallard makes use of nest sites that this species does not normally use. Goldeneyes readily accept a nest box (Delacour, 1959; Johnson, 1967). Thus it is not unexpected that the hole nesting goldeneye, with incipient parasitic tendencies, should capitalize on the situation. In eight nests the goldeneye eggs were not completely incubated. Some may have been laid after Mallard hens had been incubating. Possibly the goldeneye hens, confronted by the large choice of suitable nest sites, dumped eggs in boxes other than the one finally selected for nesting. Alternatively, it is possible that the Mallard and the goldeneye competed for nest sites, and that the goldeneye deserted in the presence of the Mallard. This appears to have occurred where the eight goldeneye eggs were found in one nest. Despite the similarity in incubation periods of the Mallard and the goldeneye, it seems improbable that the association of the two species as noted at Delta could lead to a productive semi-parasitic condition.

Acknowledgments

These observations were made during a study of the effects of crowding on the breeding biology of a population of Mallards supported by grants from the National Research Council of Canada, the National Audubon Society, and the North American Wildlife Foundation through the Delta Waterfowl Research Station. Facilities for research were provided by the Delta Waterfowl Research Station in Manitoba. Thanks are due to H. Albert Hochbaum at Delta for his suggestions and criticisms during the preparation of this manuscript, and to Nelson Watson of McGill University, and Tim G. Dilworth and Joseph A. McKenzie of the University of New Brunswick for their comments on the manuscript. Harold H. Prince of Michigan State University gave permission to quote from his unpublished material.

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Rate of Loafing Raft Use by Ducks

Abstract. Use of loafing rafts by ducks was measured on five parkland and six grassland lakes. Rafts were placed at the rate of one per 100 yards of shoreline. Significant differences in the proportion of ducks using rafts were found among the 13 species in both areas. Highest use was observed in Lesser Scaup, Blue-winged Teal, and Gadwall. Ruddy Ducks and White-winged Scoters were never seen on rafts. The proportion of ducks seen on rafts was significantly higher for most species on parkland lakes, apparently because those lakes had fewer natural resting sites.

Loafing rafts for attracting breeding ducks have been evaluated (Uhlig 1963, Shearer and Uhlig 1965, Sill 1966, Sugden and Benson 1970), but the relative use by different species is not indicated. This paper compares raft use by different species on two Alberta study areas.

Wooden rafts, approximately 9 feet long, were anchored 20 yards from shore at an average rate of one raft per 100 yards of shoreline on five parkland and six grassland lakes. The lakes ranged in size from 12 to 60 acres and had little or no emergent vegetation. Parkland rafts were made of two telephone poles (5-8 in. dia.) wired together and grassland rafts of one, 8×18 inch flat bridge timber. Eight to 12 duck counts were made on each lake during May and June of 1964 in the parkland area and of 1963 and 1964 in

TABLE 1. — Percentage of ducks using rafts on parkland and grassland lakes.

Species	Parkland		Grassland	
	Number of ducks	% on rafts	Number of ducks	% on rafts
Mallard (*Anas platyrhynchos*)	385	10	431	6
Gadwall (*A. strepera*)	63	14	1,437	9
Pintail (*A. acuta*)	3	0	858	6
Green-winged Teal (*A. carolinensis*)	33	9	73	4
Blue-winged Teal (*A. discors*)	150	13	261	10
American Widgeon (*Mareca americana*)	106	16	543	4
Shoveler (*Spatula clypeata*)	35	11	545	4
Redhead (*Aythya americana*)	146	25	99	6
Canvasback (*A. valisineria*)	85	19	363	3
Lesser Scaup (*A. affinis*)	662	17	2,034	12
Bufflehead (*Bucephala albeola*)	91	25	44	5
White-winged Scoter (*Melanitta deglandi*)	10	0	25	0
Ruddy Duck (*Oxyura jamaicensis*)	56	0	467	0

the grassland area. All counts for each area are pooled for this analysis.

There was considerable variation in the degree to which different species used the rafts (Table 1). Chi-square tests show significant ($P < 0.01$) differences among species in both areas. In the grassland area, for which most samples are larger, Lesser Scaup (*Aythya affinis*), Blue-winged Teal (*Anas discors*), and Gadwall (*A. strepera*) were seen on rafts with highest relative frequency. These were also among the highest for the parkland. At the other extreme, Ruddy Ducks (*Oxyura jamaicensis*) and White-winged Scoters (*Melanitta deglandi*) were never seen on rafts. Ideally, raft use also should be compared with use of natural loafing sites; however, I was unable to obtain a reliable measure of that. During counts, ducks on nearby shores tended to move into the water before they could be tallied, whereas those on rafts seldom moved.

Excluding pintails (*Anas acuta*), which were scarce in the parkland area, and Ruddy Ducks and White-winged Scoters which apparently did not use rafts, the relative number of the remaining 10 species seen on rafts was significantly ($P < 0.01$) higher for the parkland area. Because of fewer ducks on those lakes, the actual number observed on parkland rafts was no greater. The average proportion of rafts in use on a lake at one time was similar in both areas: 21% (range 0-60%), and 26% (range 0-58%) for parkland and grassland lakes, respectively. The average number of ducks per occupied raft was also similar in both areas; 1.86 ± 0.06 (*se*) in parkland and 1.85 ± 0.05 in grassland. Five was the largest number of ducks seen on a raft at one time in either area. I believe that proportionately more ducks used rafts on parkland lakes because there were fewer natural loafing sites. Generally, parkland lakes lacked open, gently sloping shores prevalent on grassland lakes and commonly used by loafing ducks.

Although rafts did not increase breeding pairs in this study (Sugden and Benson 1970), they have done so on man-made ponds such as dugouts which lack natural resting sites (Shearer and Uhlig 1965). Data in the present paper indicate the species that are likely to respond best to the technique because of their higher rate of raft use.

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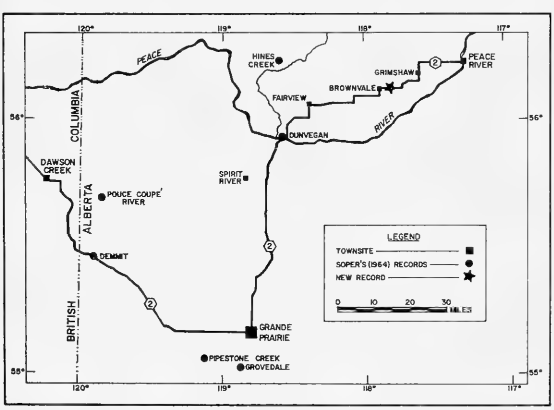
A Range Extension for the Bushy-tailed Wood Rat

In Alberta, the range of the bushy-tailed wood rat, *Neotoma cinerea drummondii* (Richardson), has been defined by Soper (1948 and 1964), and by Hall and Kelson (1959) whose nomenclature is followed here. The northern-most six records given by Soper (1964) are shown on the accompanying map. Records from Hines Creek and Dunvegan are both based on verbal reports. The other four records [and a fifth (unpublished) near Spirit River, Alberta] are dependent on observations by biologists, rather than on specimens (Soper, pers. comm.).

In July, 1970, J. D. Love noticed nest-building activity, that could only be credited to a wood rat, in a weather proof poultry shelter and adjacent garage, at a long-abandoned homestead 2 miles east of Brownvale on No. 2 highway. I saw two nests there on August 25, both made from stems of grass, herbs and twigs; and both containing pebbles, bits of paper and other debris. The characteristic wood rat odour was noticeable. Mr. Love had trapped a single adult male wood rat about two weeks earlier and had discarded it. No other rats seemed to be present. He was able to recover the carcass and the skull is now lodged in the National Museum of Canada, and has catalogue number NMC 37353. My identification was confirmed by Mr. P. Youngman, Curator of Mammals at the Museum.

The position of this new record is 32 miles northeast of Soper's verbal report at Dunvegan and about 31 miles southeast of the record at Hines Creek. It is over 130 miles northeast of the nearest record supported by specimens known to Soper. Unlike other northeastern records, the present wood rat was 10 miles north of the Peace River in cultivated agricultural country with frequent patches of aspen forest rather than in a river valley.



I would like to thank Mr. J. D. Love of Brownvale, Alberta for drawing this matter to my attention, and Dr. J. D. Soper of Edmonton, Alberta who kindly read the manuscript and provided information. The map was made by Mr. Clint Jorgenson, Canadian Wildlife Service.

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An Erythristic *Plethodon cinereus cinereus* from Ste. Foy, Portneuf County, Québec

To date, the erythristic phase of the red-backed salamander has been collected in three localities in Canada, all in the Maritimes. Two individuals were taken by J. S. Bleakney and F. R. Cook in Annapolis County, Nova Scotia (Bleakney and Cook, 1957), seven were taken by the same workers in Fundy National Park, New Brunswick (Cook and Bleakney, 1961), and eight were taken by J. Gilhen in Cumberland County, Nova Scotia (Gilhen, 1968).

On August 26, 1967, an erythristic individual was caught along with nineteen of the common striped phase on the campus of Laval University at Ste. Foy Québec. This is the first time that this phase of the redback has been identified in the province of Québec. Three of the specimens that were collected at this time were found underneath rotting logs, and the remaining seventeen were found underneath a layered pile of tar paper measuring about two by three feet in length and width and about six inches in height. The erythristic specimen was one of those individuals from the tar paper pile.

The woodlot in which the salamanders were caught was entirely on low ground. Second growth was virtually absent and rotting logs were few and far between. By far the majority of trees were deciduous hardwoods. There were no streams or ponds at the time, but it did appear as if some temporary pools had existed earlier.

The erythristic individual measured 76 mm in total length and 38 mm in snout-vent length. It had some dark flank pigmentation, characteristic of the common striped phase, but the bright dorsal colouration invaded it at numerous points giving it a faded, somewhat mottled appearance, especially anteriorly. In addition, it was noted at the time of capture that the dorsal colouration was somewhat brighter than that of the other nineteen individuals, being bright pinkish-orange. This specimen was subsequently donated to the National Museum of Canada (NMC 12940).

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Long-eared Owl at Churchill, Manitoba

On September 1, 1966, I collected a male Long eared Owl (*Asio otus*) near the Aurora Borealis Observatory, about 4 miles east of Fort Churchill, Manitoba. I had been trying for some time to obtain a much-needed specimen of the Short-eared Owl (*Asio flammeus*) since the species was abundant in the region. In early evening a small owl flew close to me in open sedge marsh, about 25 metres from the nearest trees. Its size, shape, and manner of flight suggested Short-eared Owl and since I could see only the silhouette, I shot the bird.

The species had not been observed before in Churchill (Jehl and Smith, 1970) and is in fact uncommon at The Pas, Manitoba (Godfrey, 1966). The specimen is in the collection of the Department of Zoology, University of Western Ontario (U.W.O. 3999).

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First Canadian Specimen of Bell's Vireo

Abstract. A Bell's Vireo, *Vireo bellii bellii,* was collected at Point Pelee National Park, Essex County, Ontario, on June 23, 1970, to establish the first occurrence of the species in Canada. Previous sight records are summarized.

In The Birds of Canada, Godfrey (1966) lists Bell's Vireo as hypothetical and states, "There are several sight records allegedly of this species for extreme southern Ontario, but no specimen has been taken in Canada". The first Ontario sight identification of Bell's Vireo was at Toronto on May 18, 1940 and sporadic identifications were made throughout southern Ontario in subsequent years (Baillie 1964). Since 1952, the bird has been a rare but regular migrant at Point Pelee and on May 19, 1963, a bird was photographed there by T. R. Scovell (Baillie 1964).

C. Goodwin (1968) reported a sight record of the species at Point Pelee on May 10, 1968 and R. Simpson sighted a Bell's Vireo at Rondeau on May 8, 1970 (Goodwin 1970).

On June 22, 1970, at Point Pelee National Park, Essex County, Ontario, I observed a Bell's Vireo singing from a clump of willows (*Salix* spp.) at the edge of an open grassy field. The following day, June 23, I collected the bird and W. Earl Godfrey, Head, Vertebrate Zoologist Section, National Museum of Natural Sciences, confirmed identification. The bird was a male, was moderately fat, and weighed 19.5 grams. The skin is No. 57428 in the National Museum collection.

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A Mew Gull Specimen from New Brunswick

On May 4, 1969, I saw an adult Mew Gull *Larus canus* at McGowan's Corner (45° 53′ N, 66° 18′ W), New Brunswick. It was resting by the edge of a slough in a field. Nearby was a mixed flock of Great Black-backed, Herring, and Ring-billed Gulls. During two hours of observation I noted its apparent reluctance to associate with the other gulls when they began to move about and to approach it. Permission to collect the bird was sought and obtained from the property owner. In the company of N. R. Brown I returned to the area early the next morning when we found two Mew Gulls, about 100 yards apart. One had an all-white head, the other some light-brown head feathering. The latter bird was collected. I am grateful to Brown for preparing the specimen and to W. E. Godfrey who examined it, confirmed the identification, and referred it to the New World subspecies *L. c. brachyrhynchus*. This was the first New Brunswick record of a Mew Gull. The only other Atlantic Province record of which I am aware refers to a specimen of the European race *L. c. canus* which was taken in Newfoundland in April 1956 and reported by L. M. Tuck (The Auk, 85: 307, 1968).

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Visual Releaser for Aposematic Behavior in *Ambystoma tigrinum diaboli*

Carpenter (1955) described apparent defense behavior in *Ambystoma tigrinum melanostictum.* During the morning of August 29, 1970, I observed several displays of *Ambystoma tigrinum* which were apparently stimulated visually.

As I was driving westward on U.S. rte. 2 from 20 mi. E Devils Lake to Minot, North Dakota, I encountered several *Ambystoma tigrinum* crossing the highway. Salamanders were observed on the road from 4:30 to 11:00 a.m. (CST). Rain had fallen during the night; there was water on the highway until 7:00. Air temperatures increased from predawn 14.5°C o 23.3°C at 10:00 a.m. (YSI telethermometer).

Nine salamanders collected during the darkness showed no noteworthy behavior. Occasional individuals attempted to escape when approached in the light from the car headlights. The sky became light at 6:15. At 6:30 I stopped to collect a salamander on the road 4.5 mi. E Leeds, and was attracted to the animal's activity, behavior which had not been observed in any of the salamanders approached during the predawn darkness. As I approached to within 10 feet, the salamander slowly raised up on stiffened hind limbs, raised its tail in a broad arch, and tilted

FIGURE 1. Defensive attitude of *Ambystoma tigrinum* (from color transparency).

its head, nose downward (Fig. 1). It then slowly brought the tail and head around to the side, its body and tail forming a circle. This type of behavior was observed each time a salamander was approached during the remainder of the morning (20 collected, numerous others seen). Adults and recently-transformed individuals (gills and gill stubs present) alike acted in this manner. The head and tail were consistently directed away from the observer. White secretion was seen along the dorsal ridge of the tail on some salamanders.

If no further stimulus was given, the position was maintained for less than ½ minute. The salamander then relaxed the posture, and would begin to crawl away. The behavior could be induced a second and even a third time, but each time with less intense reaction. Touching the animal would cause it to react more strongly. No animal was induced to respond in this manner more than a half-dozen times.

This apparent aposematic behavior thus seems to have a visual as well as a tactile releaser under certain conditions. The reaction was never noticed during darkness, but was seen consistently during daylight hours; other conditions were essentially the same.

Cloacal temperatures (Schultheis small-bulb thermometer) of 5 *Ambystoma tigrinum* averaged 14.1°C (13.8°-14.6°). Other species noted on the road were *Rana pipiens* (small and adult), *Bufo cognatus* (small), *B. hemiophrys,* (small), and *Thamnophis radix.* All but *Thamnophis* were common.

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First Canadian Specimen of New Zealand Shearwater

Along the Pacific Coast of North America the New Zealand Shearwater (*Puffinus bulleri*) has been recorded off Monterey, California; the mouth of the Columbia River in Oregon; and Gray's Harbour in Washington (A.O.U., 1957). Peterson (1953) mentions that the shearwater is "a regular fall visitant off California (October) and casual in Oregon and Washington". In British Columbia there is only one published record for this species, namely two birds seen off the northern coast (50° 21′ N, 130° 15′ W) on August 7, 1926 (Nichols, 1927). There is no specimen record for the Province (hence Canada). Consequently the New Zealand Shearwater has been considered hypothetical here (Munro & Cowan, 1947; Godfrey, 1966). This paper reports several recent sight records and one specimen record.

On September 13, 1969, off the central west coast of Vancouver Island, three New Zealand Shearwaters were sighted 14 miles at sea associating with a flock of about 50 Sooty Shearwaters (*Puffinus griseus*) and three Pink-footed Shearwaters (*Puffinus creatopus*). Observers included R. H. Drent, D. Stirling, W. C. Weber, and myself.

The following year, on September 12, at least 10 New Zealand Shearwaters were observed by T. Stevens, K. Summers, and W. C. Weber about 28 miles at sea. They were associating with 75 Sooty and 10 Pink-footed Shearwaters. Another single New Zealand Shearwater was later seen beyond 30 miles along with 40 Sooty and one Pink-footed Shearwater.

On September 26, 1970, a single New Zealand Shearwater was collected from a small flock of Sooty Shearwaters about 25 miles offshore. The specimen has been catalogued as No. 13571 in the Vertebrate Museum at the University of British Columbia in Vancouver. The sex was undetermined. Measurements taken are: tail, 131.0 mm; exposed culmen, 43.0 mm; tarsus, 52.1 mm; middle toe and claw, 65.0 mm; and weight, 427.9 gms. All measurements are within the ranges given by Murphy (1936).

On the same day a very tight flock of about 25 "gray-backed" shearwaters was watched feeding along a convergence-line about 40 miles at sea. These birds were later identified as New Zealand Shearwaters by M. Shepard and myself.

The New Zealand Shearwater is strictly a fall migrant off the British Columbia coast, and likely Pacific Coast of North America. No birds were sighted off-shore from Vancouver Island during spring (1970) though trips were made on May 2, 10, and 17. Also there have been no spring or summer records for any of these coastal areas. In a recent paper by Martin and Myres (1969) there is no mention of New Zealand Shearwaters having seen from a period May 1 through August (1946-1948) while those authors were fishing commercially at sea. It seems likely that the New Zealand Shearwaters seen off the Pacific Coast of Canada in fall are non-breeding birds. First, the timing of the movement precludes arrival at the breeding sites off northern New Zealand in time for nesting since Murphy (1936) states that the birds return there between late August and the end of September. Secondly, it will be noted that the gonads of the specimen collected on September 26 were minute.

The fall migration period for this shearwater off the British Columbia coast still requires clarification. So far the bird has been recorded from early August (Aug. 7, 1926) through September 26, 1970. It appears that the New Zealand Shearwater is casual in occurrence in early August, becoming more common in September, and many still occur in small numbers in October. Gabrielson and Warburton (1933) collected a bird off Westport, Washington, on October 30, 1932. T. Wahl (in litt.) also mentions seeing 10 New Zealand Shearwaters 46 miles off Westport on October 11, 1970.

Judging from recent observations the New Zealand Shearwater can be regarded as a regular fall migrant off the British Columbia coast.

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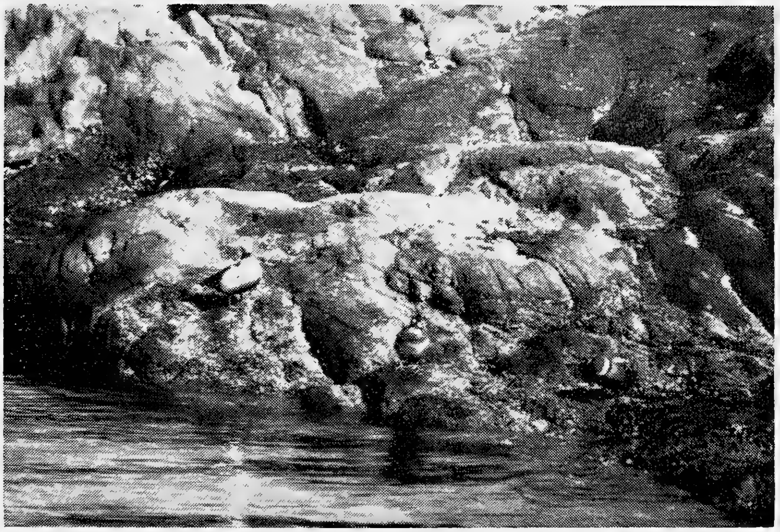
Steller's Eider Photographed near Campbell River, British Columbia

On June 17, 1970 William A. Verbruggue of Port Alberni, British Columbia, photographed an adult male Steller's Eider (*Polysticta stelleri*) on Mitlenatch Island Nature Park, B.C. This small rocky island is situated at the northern end of the Strait of Georgia about 11 miles southeast of Campbell River, Vancouver Island. The Eider was roosting with approximately 110 Harlequin Ducks (*Histrionicus histrionicus*) which pass the summer molt period on the lower rocks around the island. Gradually, as the morning progressed, the Harlequins left for their feeding grounds and about 0930 hours the Eider departed with the few remaining Harlequins.

Two color 35 mm slides were taken. Both original transparencies were kindly donated to the



photoduplicate file (catalogue number 7) in the Vertebrate Museum at the University of B.C. in Vancouver.

Steller's Eiders are of casual or accidental occurrence in Canada. This record appears to be the second occurrence of this Eider in British Columbia. Godfrey (Birds of Canada, Nat. Mus. Canada Bull. 203: 75, 1966) provides the other record, a specimen collected at Masset, Queen Charlotte Islands on 15 October 1948.

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News and Comment

Canadian Naturalists Elected to Honorary Membership in the Ottawa Field-Naturalists' Club

On the recommendation of the Membership Committee, the Club's Council, at its meeting of October 13, 1971, unanimously approved conferring Honorary Memberships on the following Club Members:

Reverend Father F. E. Banim, Ottawa
Mr. A. F. Coventry, Toronto
Mr. Rowley Frith, Ottawa
Dr. A. E. Porsild, Ottawa
Dr. M. Y. Williams, Vancouver
Dr. C. M. Sternberg, Ottawa

These Members have made outstanding contributions either to the successful working of the Club, or to Canadian natural history; indeed, several have done both to a marked degree. All have, through membership, supported the Club for periods ranging from 31 to 52 years.

1. Father F. E. Banim

A keenly interested member since 1936, Father Banim was also a member of Council for many years. He was President and filled many other roles; was extremely active in reviving the Club following the Second World War; was largely responsible for revising the Constitution which preceded the current one; provided Council with meeting quarters for a long period. A teacher of science at St. Patrick's College, he spent some of his later years teaching in Africa and brought back to St. Patrick's a wealth of knowledge — particularly anthropology — which has made his classes highly esteemed and sought after, thereby interesting young people in natural history.

2. Mr. A. F. Coventry

A member since 1913, Mr. Conventry was for many years a Professor of Zoology at University of Toronto. He is now retired. One of the most stimulating naturalists in Canada, he was eagerly sought as a lecturer, and had a tremendous impact on students and others. Unmarried, his life has been devoted to natural history promotion. One of the founders of the Federation of Ontario Naturalists, he started the F.O.N. Nature Camp, was one of the earliest and most influential champions of conservation, and was one of the founders of the Guelph Conference on Conservation, he was an Honorary President of the F.O.N. for many years. His influence in the field of natural history is immeasurable.

3. Mr. Rowley Frith

A member since 1940, a retired florist, and a knowledgeable amateur with a very keen interest in natural history, Mr. Frith was a most active Council member for years. He had a pronounced influence on the Club's growth and success. He filled the posts of President, Chairman of FON Affairs and Finance Committee, and was a member at one time or another of most committees. He introduced Audubon Screen Tours as a Club activity, thus developing considerable revenue which was used for promotion of the Macoun Club, to provide the Tours free to school children, and for other Club purposes. He was also an active member of the F.O.N. and produced for it a natural history of the Ottawa region. Virtually no requests for his assistance were refused, and his retirement from Council was due to indifferent health.

4. Dr. A. E. Porsild

Dr. Porsild, with the National Museum until recent retirement, has been a Club member since 1929, is a Greenland-born arctic botanist, and a naturalist of international reputation. For years he was a member of Council, and was particularly active in recruitment of new members, and in promotion of the Macoun Club.

Dr. Porsild spent 30 months (1926-28) surveying and mapping the route of a reindeer herd from the Bering Sea to Northwest Territories; did botanical surveys from the mouth of the Mackenzie to Great Bear Lake and of the Keewatin District. Based on these, he recommended that the Canadian Government establish a Reindeer Grazing Preserve.

He wrote "Illustrated Flora of the Canadian Arctic Archipelago" and many other botanical papers, as well as papers on birds and mammals. He has received a number of awards (e.g., the Lawson Medal from the Canadian Botanical Association).

Although retired from the Museum and from Council, Dr. Porsild is still interested in natural history and in the Club.

5. MR. M. Y. WILLIAMS

A Club member since 1919, Mr. Williams was an early President (1920) and active in its affairs, particularly in changing the format of the Ottawa Naturalist to the Canadian Field-Naturalist which has been familiar for many years. Moving to B.C. some years ago, he has maintained his interest in the Club and in natural history to the present.

A geologist, Mr. Williams has been with the University of British Columbia, and of recent years Honorary Curator of its Geology Museum. Last Fall he turned the sod for U.B.C.'s new Geology Building, in which the new Geology Museum will be named for him.

6. DR. C. M. STERNBERG

Dr. Sternberg, now retired from the Palaeontology Department of the National Museums, has been a Club member since 1919.

Following in the footsteps of his distinguished father, who was a pioneer in the fossil finds in Alberta, Dr. Sternberg was responsible for increasing and maintaining the dinosaur collections of the Museum; about half of the specimens are directly attributable to him. He was still active in Alberta until recent years, and at the present is working with Dr. Dale Russell, Chief of Palaeontology, on some special projects.

Dr. Sternberg is the author of many publications, among them "Discussion of the Passage of Air through the Heads of Duckbill Dinosaurs" and "Evolution of Horned Dinosaurs".

Dr. Sternberg is a Fellow of the Royal Society of Canada.

Letters

Organochlorines and Mercury in Merlin Eggs

In a recent issue of this journal, Risebrough *et al* (1970) and Fimreite *et al* (1970) indicated that the Merlin or Pigeon Hawk (*Falco columbarius*) was showing levels of contamination by organochlorines and mercury such that reproductive abnormalities could be expected.

I have recently completed a study of eggshell weight and reproductive success in this species (Fox, 1971) and such abnormalities were indeed found in both the eastern and Great Plains populations. The weight of eggshells produced during the period 1950-1969 was 23 per cent less than those of any 20 year period. This decrease in eggshell weight was accompanied by a 33-43 per cent decrease in hatching success and by increased egg disappearance.

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Protection of Raptorial Birds: Boon or Bust?

On March 10, 1971 "a bill to extend to hawks and owls the protection now accorded to Bald and Golden Eagles" was introduced in the House of Representatives of the United States Congress.

What does this mean in terms of the plight of the Peregrine in North America? First, if passed, it will pressure the Canadian government to follow suit with some form of protective legislation. Canada has within her boundaries, the bulk of breeding Peregrines and other endangered raptors. Second, the bill in its present form would make private ownership of hawks and owls illegal in 20 to 30 years, and falconry is not provided for within the bill.

What is wrong with such legislation? I recently prepared a proposal for the protection and management of birds of prey in Canada for a university course in Wildlife Management. What I proposed brought mixed reactions from classmates, conservationists, and professional biologists. Since it was written, I have read similar proposals by others (Nelson, 1970; Smith, 1970; Cade, 1971; and Smith and Halliday, 1971). Because concerned individuals and societies will have some opportunity to direct the form which protective legislation will take in Canada, I feel it is in order to outline what these proposals have said. I would hope that you will give them serious consideration.

All of us agree that raptorial birds should be protected on a national and, if possible, international basis. Protection or management — that is the key question. The bill before the U.S. Congress is an example of the "complete protection movement". The above mentioned authors and myself represent the other group — those who feel that in our chemically contaminated environment, these birds will have little chance of recovery even if given total protection. We feel that management is the key — management that provides protection, but which at the same time provides for a controlled harvest of nestlings for captive breeding stock *and* for falconry purposes.

Many will immediately see the need for maintaining captive breeding stocks and the usefulness of these birds in producing birds for reintroduction programs. But, why falconry? Falconers as a group, have and will continue, to provide more knowledge about raptorial birds than any other group and have been very active in public education programs. This is not accomplished without access to birds for such uses. A very small radical minority of falconers put the sport of falconry before the bird, and this minority too must be provided with a legal means of taking birds or they certainly will go to extremes in making their illegal harvest, and in so doing, will defeat all other management efforts.

What can falconry do for the Peregrine and other endangered raptors? First, falconers will be able to provide stock for reintroductions. Second, their trained birds will be frequently used in very effective public education programs — without which protective legislation and management efforts will be to no avail. Recently, at the Canadian National Sportsmen's Show in Toronto, some 5000 people were informed and many "converted" by such an educational display — many seeing a Peregrine for the first time. Such exposure is the only way the public will gain that respect and concern which is necessary to ensure the preservation of wildlife. Third, and probably most important, falconry can be used as a management technique for increasing the survival rate of immature falcons. If a controlled number on nestling falcons are removed from various segments of the population each year, for falconry purposes, with the provision that they *must* be released at the end of their second winter, in time for the spring migration, the wild populations would benefit from this increment to their breeding stock.

How? It has been estimated for the Peregrine and Prairie Falcon that of every 100 young fledged, only 34 survive to the end of their second year, or to breeding age. The remaining 66 might be considered as harvestable surplus which may be used for falconry. Survival in the hands of competant falconers is in the order of at least 70 per cent. Thus by holding falcons for falconry purposes during their first two years of life, we can increase survival to breeding age of any cohort to over 50 per cent, with the birds returned to the wild state with very low pollutant-loads and thus far more likely to produce offspring.

Protective legislation should have the following objectives:

1. To protect all raptorial birds in Canada, on a year-round basis, from all forms of destruction by man or his agents.
2. To conduct a nation-wide inventory of raptor populations and their productivity, and to initiate a central repository for information concerning these populations, available to all management agencies.
3. To develop and maintain captive, reproducing populations for reintroduction.
4. To legalize and control the sport of falconry recognizing it as a valuable field sport and utilizing it as a management tool.
5. To promote greater public concern for, and understanding of, the status and value of raptorial birds, and the necessity of enforcement of protective legislation and management as a resource.

As Cade (1971) so aptly put it "in any case, protection, based on reason rather than hysteria, and propogation based on scientific methods rather than trial and error, should go hand in hand as the two chief measures for promoting the survival of the Peregrine and other birds of prey."

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Re: "The Park in Perpetual Planning"

Although the establishment of Parks (plural) (and other reserves such as the proposed Arctic International Wildlife Range and ecological preserves under I.B.P.) in the Yukon is highly desirable, before becoming too single-minded in this regard, let's first consider our priorities. (See "The Park in Perpetual Planning" by Hoefs and Benjey — Canadian Field-Naturalist 85 (3): 261-264.)

To date the Yukon is in a state of environmental anarchy since we have no environmental controls to speak of.

Our only hope was the change that would be brought about by the proposed Yukon Minerals

Act (Bill C-187) and the Land Use Regulations, *if* they were to have significant environmental content and *would* do away with the scandalously privileged position of "mining" in the Yukon by giving it a more realistic position within the spectrum of land-use and management.

But the mining lobby has fought a holy war against this legislation; environmentalists would appear not to have taken a sufficiently united and nation-wide stand on this extremely important issue (that affects one third of our country) and as a result the legislation has almost been stripped of all environmentally significant provisions while whatever is left will probably not be in force until middle 1972, if then.

To fully discuss the appalling aspects of this virtual sacrifice of the Yukon's natural qualities to one industry is beyond the scope of a letter to the editor. But I submit that, at this time, expending great amounts of energy and pressure on the establishment of a park in the Yukon is like decorating a sinking ship with flags and bunting. A National Park is NOT a priority in the Yukon right now.

The overwhelming priority is for an integrated program of land-classification (which automatically includes designation of parks and other natural preserves); overall environmental management and research (— the latter especially regarding a) safe methods of mine-waste disposal b) siliviculture c) wildlife —) and establishment of a land-use "climate" where there is room for pursuits other than just "mining". Solid establishment of this sort of environmetal framework in the Yukon is absolutely necessary to go ahead of establishment of a National Park.

Let's first plug the holes in the hull of the sinking Yukon environmental ship before we fiddle with the superstructure.

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6 November 1971

Reviews

Our Precarious Habitat

Melvin A. Benarde. W. W. Norton Co. Inc., New York. 1970. 362 p. $2.95 Paper; $8.95 Cloth. Available in Canada from George J. McLeod Ltd., Toronto.

The author set out to inform readers so that they may evaluate environmental health problems from a basis of knowledge and understanding. To achieve this end, Dr. Benarde covers a wide range of topics from a discussion on the environment as a system through food, insecticides, zoonoses, waste disposal, air pollution, accidents, noise, to the 16th and final chapter entitled "The Politics of Pollution". Most chapters start out with an historic tidbit or a case history which does a great deal to set the discussion in a specific perspective. Much to his credit is the clarity of the definitions and the fact that he quite frequently explains simple things which are most often not clearly understood by the public. Two examples are the differences between epizootic and zoonoses or septic tanks and cesspools.

The most distracting facet of the book is its ***anthropocentricity***. In a discussion on pesticides for instance, the author states that . . . "the most reasonable course balances benefit against risk." To do this he claims that "By determining the amount of pollutant that a given population can be expected to contact, an estimation of the risk of injury may be calculated." Surely the term "population" only refers to man; otherwise, the statement becomes ridiculous. No one has ever calculated the value of a mosquito or black fly in terms of uphill movement of nutrients or their contribution to the stability of the biotic community, and these are at least two insects on which we have spent a great deal of research time and money simply to find out how to keep them from biting us. In advocating killing specific target species with pesticides, he never questions the possible dangers of killing a dominant component of a simple community. Although he has done a credible job of reviewing methods used for pest control, he does not mention integrated control.

Several concluding statements also fall a little short of being ecologically objective. One such statement is: "Regular, planned control of bird and mosquito populations is essential to prevent the spread of zoonoses to man."

The book is full of enjoyable short factual examples which do a great deal to broaden the often threadbare repertoire of anti-pollution arguments. Among these was the following: "Recently the New York State Supreme Court ruled that one of the inescapable hazards of living in a modern community is the sound of gunfire. It seems that the city of Cortland, New York, had tried to prevent a sportsmen's club from firing high-powered rifles because the noise disturbed many of the residents. The judge, in deciding the case, held that persons living in an organized community must suffer some damage, annoyance, and inconvenience from each other. He went on to say that for these inconveniences they are compensated by the advantages of a civilized society!" In this case the author clearly does not agree with the judgment but he makes no attempt to come to grips with the main problem. One is continually led to the inevitable conclusion that the solution is dilution, that is, stop the noise in town; let them do that kind of thing in the country where it will not create such a large health hazard to people. Little thought has been given to the possibility of mitigating these disturbances within man's self-created urban environment.

In a similar vein he anticipates only one side of the problems. For instance, he states, "The encroachment of urban areas on previous rural areas, the scarcity of land for disposal, and the characteristics of manure make for some particularly difficult problems ahead." . . . It does not seem to occur to the author that to avoid this problem in the future, the solution is to stop the human encroachment.

The bibliography contains very few non-medically oriented citations. At one extreme, there is Charles Elton's Animal Ecology (1927) the only animal or general ecology text referred to while at the other extreme, there are intriguing medical citations such as "Prebycusis Study of Relatively Noise-Free Population in Sudan" from the annals of Otolaryngology, Rhinology and Lyryngology. In between there is an extremely interesting and broad listing of reports under chapter headings most of which seem to be readable books for the non-medic or government documents which promise to be informative but boring.

The book has great merit as a general introduction to health hazards. The examples are good, the style is fluid and easy to read. The author is undoubtedly out of his depth when he moves from what we might call human ecology and health into the field of general ecology and conservation. Although conclusions are biased by a distinctly anthropocentric view, the body of the material makes the book a worthwhile and an enlightening document. The author does, therefore, achieve his aim to inform, and, if the reader does his own evaluations of environmental health problems as suggested in the foreword, the experience will be rewarding.

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The Biology of Parasitic Plants

By Job Kuijt, University of California Press, Berkeley and Los Angeles. 1969. 246 p. illus. $15.00.

Kuijt's book on parasitic flowering plants is a first in Botanical publications and the author is deserving of the Lawson Medal awarded to him by the Canadian Botanical Association — L'Association Botanique du Canada for this outstanding contribution to Botany. The author has compiled and discussed in a concise manner most of the published literature on parasitic angiosperms. This is particularly valuable to English-speaking Botanists since much of the literature has been published in languages other than English.

The book is divided into nine chapters. The introductory chapter makes fascinating reading for anyone interested in plants since Kuijt presents a short history of the discovery of parasitic genera, the uses of these parasitic plants and an intriguing account of parasitic plants in relation to medicine, religion and folklore. Chapters 2-6, which are illustrated mainly by line drawings, present clearly the known morphological and taxonomic details of the groups of parasitic angiosperms. Perhaps an outline of the families to be discussed in relation to other angiosperm families at this point in the book would have helped to orient the reader. Chapter 7 discusses the haustorium, a "physiological bridge composed at least in part of living tissue", which occurs between the two organisms in question. The author indicates in the introductory chapter that the presence of this type of "bridge" is the main criterion used to define parasitic higher plant relationships in this book. It is concluded that the "haustorium of parasitic angiosperms represents a root in function and evolutionary origin".

The next chapter, a consideration of physiological aspects of parasitism, is of special interest to those interested in seed germination, translocation, and the effects of parasitic angiosperms on host plants. It is through this chapter that one realizes how much research remains to be done to elucidate basic physiological problems related to parasitism.

The book concludes with a discussion of evolutionary aspects of parasitism based on the author's and other published work. Some of Kuijt's interpretations and conclusions are necessarily speculative since as the author admits, there is a need for thorough investigations of some genera before evolutionary sequences become clear.

This book is highly recommended both as a book of interest to biologists in general and as a source of detailed information for the student of parasitic flowering plants.

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Meteorological Aspects of Air Pollution

World Meteorological Organization Technical Note 106. 69 p. Available from UNIPUB Inc., P.O. Box 433, New York, N.Y. 10016. $4.50.

Because of the growing public concern about air pollution, there is a need for articles to define the relevant problems and possible means of dealing with them. This technical note outlines some, but by no means all, of the meteorological aspects of the problem. It treats in some detail the meteorological aspects of air pollution in the city, and it also contains descriptions of chemical analyses of air pollutants. However, the title of the report is somewhat misleading because not all the meteorological aspects of air pollution are discussed. In particular, nothing is said of large-scale transport of pollutants over distances of hundreds or thousands of kilometers, nor is there mention of the possible effects of atmospheric pollutants upon global climate.

The note consists of three separate articles

1) *Meteorological aspects of air pollution in urban and industrial districts* by R. A. McCormick.
2) *The importance of investigating global pollution* by Erik Eriksson.
3) *The réseau belge de mesure de la pollution atmosphérique par les oxydes de soufre et la fumée* (Le Belgian network for measuring air pollution by sulphur dioxide and particulates) par J. Grandjean et J. Bonquiaux.

The first paper by R. A. McCormick is a very good summary of the state of the art in urban air pollution meteorology. It is a very important aspect of the problem because of the large concentration of emittors and receptors (in the form of people) in the city. McCormick states quite clearly the role of meteorology in urban air pollution. He mentions not only the effect of meteorological conditions upon the dispersion of pollutants (wind and temperature structure of the air) but also its effect upon the emission of pollutants. For instance, space heating requirements (with resulting low level emissions) are at a maximum in winter; the formation of photochemical smog depends upon the amount of sunshine. The role of meteorology in the monitoring and the control of pollution, sampling procedures, air pollution forecasting and regional planning is also discussed.

After outlining the roles of meteorology McCormick goes into more specific aspects such as the wind and temperature around a city, mathematical models of urban air pollution, measurements of the diffusion of pollutants around a city and the forecasting of air pollution potential. With regard to the last item, when the winds are light and the vertical mixing in atmosphere is weak, the dispersion of any pollutants that may be present will be poor and pollution potential is said to be high. Forecasts of air pollution potential are now made in the United States based upon weather reports from stations in mainly rural locations spaced about 100 km apart. Unfortunately, McCormick fails to emphasize that the wind and temperature conditions at these stations are not necessarily the same as those in the city.

The second paper by Erik Eriksson describes the measurement of global background pollution and, in particular, the European measuring network. After a short history of such measurements is given, the author passes on to a brief description of some analytical techniques that are used. The few results that are given in the paper point out the fragmentary nature of our knowledge of the concentration of pollutants on a global scale and the need for cooperative effort in obtaining records over a long period. Several of the figures illustrating the results are somewhat unclear. For instance the maps in Figs. 3 and 4 would have been more useful if lines of equal concentration had been drawn in them (in addition to the plotted numbers) to show the areas of minimum and maximum concentration more clearly.

This paper does not really discuss the importance of investigating background pollution but rather some of the means of doing so. It would have been a more interesting and useful paper if the effects of certain pollutants upon living organisms had been discussed to some extent. Another very important aspect of global pollution is its effect, if any, upon the climate of the world. It is unfortunate that this topic is not covered in this or the other papers. Such a discussion would have fitted most naturally into this paper.

The last paper, by J. Grandjean and J. Bonquiaux is written in very clear and simple French that should be understood by anyone with a fair knowledge of that language. It describes an urban and regional air pollution network measuring ground level concentrations of sulphur dioxide and particulates in Belgium. The network itself, consisting of stations spaced several kilometers apart, and the methods of collection at each station is described. Air is passed by a pump through a very fine filter which collects the particulates and then it is bubbled through a solution of hydrogen peroxide to collect the sulphur dioxide. The concentration of particulates is then optically measured by the blackening of the filter and the sulphur dioxide is analysed chemically. The volume of the collected air is metered and the sampling equipment is semi-automated so that it can run unattended for a week.

The Belgian network appears to be quite well-organized as the data are stored and tabulated by computer at a central location. The authors show some interesting maps of the concentration of particulates and sulphur dioxide around the city of Liege in winter and summer. The high concentrations of these pollutants in the downtown and the industrial parts of the city are immediately apparent. In summary, this article is clearly written and the figures are well chosen with the result that it could be quite useful to someone wishing to set up a similar network.

In closing, the technical note is interesting and generally well written, although its scope is not as broad as its title would suggest. It would have been more logical if the paper by Messrs. Grandjean and Bonquiaux had come second rather than third, making a smooth sequence from local (urban aspects) through regional to the global aspects. In addition the global aspects have been treated rather lightly as nothing has been said about the long distance transport of pollutants or of the possible effects of pollutants upon the world's climate.

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A Guide to the Birds of South America

By Rodolphe Meyer de Schauensee, illustrated by E. L. Poole, J. R. Quinn, and G. M. Sutton. Livingston Publishing Company, Wynnewood, Pennsylvania. 1970. x + 470 p., 50 plates (31 color), $20.00.

A number of books on the birds of South America have appeared over the last few years but the majority deal with the avifauna of specific countries or districts of this vast continent. This guide which provides information on 2924 species of birds covers all of South America. It is a remarkable accomplishment considering the large number of species with which the author had to deal and the scanty information which was available to him for many species.

The author introduces each family with a brief ecological statement, a short general description of the taxon, a range outline, and general comments on reproduction; he occasionally adds remarks on voice, life habits, and other aspects. For most families a useful section "Aid to identification" follows immediately after. That section is organized pretty much in the same manner as a key, but one proceeds by elimination to use it efficiently. I found it helpful in most cases but its value is generally limited in cases where the characters of similar species are not too well marked. For each species, the author provides the approximate size of the bird, a brief description, the general range of the species, and the plate number where applicable.

The author must be commended for having provided English names to all the species listed in his book.

More than a page of addenda have been incorporated in the book, and an additional three-page list of addenda and corrigienda have been provided with my copy.

A brief bibliography, listed by country, is provided also. The index includes the scientific names of the birds mentioned in the text and a number of English names. The inside cover maps are clear and useful.

I have found few typographical errors. The book is well-printed on good quality paper and well bound.

The quality of the plates is very uneven, and one notices at once the better overall appearance of Dr. Poole's paintings, particularly the color plates. John Quinn's plates are generally speaking too dark and the color saturation appears to be much too rich particularly in the browns. I must also point out that the hallux of most of Quinn's perching birds sticks out, instead of grasping the object on which the bird is sitting; this is an anatomical impossibility. The black and white plates are in general acceptable although good contrast is lacking in some. The line drawings by G. M. Sutton are excellent as usual, but one would have wished to have each of them following the species account instead of being scattered throughout the text.

In spite of these shortcomings, this guide is a good book which will certainly prove to be very useful to everyone interested in South American birds. However, I wish the author had incorporated in the present guide the distribution data which he provided earlier in *The Species of Birds of South America and their Distribution* (1966, Livingston Publishing Co.). Nevertheless, I am convinced that this book constitutes an important landmark in South American ornithology and will generate a greater interest in the birds of that continent.

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The Hidden Sea

Photographs and notes by Douglas Faulkner, text by C. Lavett Smith. Viking Press, New York, 1970. 148 pp. $14.95. MacMillan Co. of Canada.

The world beneath the sea is one which most men are not privileged to see, and because of this they are only vaguely aware of its beauty. Moreover, until recently man did not appreciate the precarious nature of a marine community. This book should do much to correct these faults, for if Faulkner's magnificent photographs and Smith's text cannot impress upon us the desirability and necessity of conserving life in the sea, probably little else can.

The book is presented in ten sections, an introduction and one chapter each on Sponges, Corals, Mollusks, Crustaceans, Echinoderms, Fishes, Cleaning Symbiosis, Dangerous Marine Animals and Notes.

The introduction — The Hidden Sea — reviews the requirements and problems of marine life, discusses communities and the need for conservation and study of marine animals. With the exception of Notes, each subsequent chapter includes roughly three and one-half pages of text. Obviously one cannot treat, in depth, a major group of animals in such limited space, yet Smith has managed to give some insight into the variety of animals included. He provides up-to-date information on ecology, habits, structure and the role of the group in the community. The concept of interspecific interaction is masterfully dealt with in Cleaning Symbiosis, a phenomenon thought to be a biological curiosity until the exploration of the marine habitat began in detail. Dangerous marine animals stresses the forms which are toxic e.g., cone shells, bristleworms, rather than those which cause mechanical damage. The language is simple yet, for the most part, accuracy has not been sacrificed for simplicity. Scientific names are avoided except where absolutely necessary.

The text accompanies 70 outstanding colour photographs; typically seven or eight are devoted to each section. Generally the photographs are life size or larger so that the specimens can be clearly seen. Unfortunately, several colour plates are off register, at least in my copy, and this detracts greatly from the book. There are eight pictures which cover two pages; to my mind the increase in size does not counter the effect of a fold in the picture. However, these criticisms do not detract from the quality of the photographs — it is readily apparent why Faulkner has achieved the reputation of being one of the world's foremost underwater photographers. His subjects are portrayed artistically and present an exquisite amount of detail. Notes, the final chapter, is devoted to captions and explanation for each colour plate. Each explanatory caption lists the name and size of the animal shown and the location, depth, and date of each photograph. Scientific names are included if they could be determined from the photograph. Additional text vignettes either the animal depicted, or the group it represents. Notes are correlated to the plates by a moderate sized black and white photograph as well as by page number. However, with few exceptions, the colour plates have margins, and page numbers, thankfully, are omitted on the plates.

The colours in this European printed book are somewhat muted when compared to the same photographs reproduced in North America, but in my opinion this adds to the quality of the plates. There are sufficient photographs of animals from temperate waters to point out that marine beauty is not restricted to the tropics.

This is not the sort of book that one should leave on the coffee-table — guests will ignore the owner until it has been thoroughly pored over, and it will probably stimulate an entire evening of discussion on marine life. I recommend it highly to every naturalist.

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Above and Below, a Journey through our National Underwater Parks

By Helga Sandburg and George Crile, Jr., McGraw-Hill Book Company, New York, St. Louis, San Francisco, Toronto. 1969. 302 pp. $7.95.

This book tells about visits to half a dozen of the underwater parks in the United States. It is a kind of bouillabaisse, with the aquatic parks providing the central comestible, and varied items of history, biology, and childhood thrown into the soup stock providing seasoning. As such the book is seldom dull. But it is hardly a source book on underwater parks.

The book is written mainly by Helga Sandburg, daughter of the poet-folk song collector, with some sections evidently contributed by her husband, George Crile, skilled skin diver, in his field of expertise. The authors visited the John Pennekamp Coral Reef Park, in Florida. This, the world's first park to be completely underwater, was established in 1960 to protect the coral formations, fishes, and ship wrecks. The Fort Jefferson National Monument is then explored in greater detail or perhaps I should say depth. The fort, begun in 1847, and surrounding waters became a national park in 1936. The reader is presented with historical gems such as the past use of sharks in the moat to prevent the escape of civil war prisoners and some non-historical gems such as fogging with insecticides within the park precincts. Samplings of the park include a bird sanctuary where Sooty Terns banded 29 years have been recaptured, a giant jew fish sighted while snorkeling, and the mating of nurse sharks. This style of reporting sets the pattern for the other parks visited.

Underlying the travelogue one finds a deep concern with the environment. The underwater world is equally if not more susceptible to deterioration. While indiscriminate fishing or collecting of underwater fauna have the same consequences as on land, wastes disposed of by municipalities, industries, and boats are often less evident with the result that there is less concern and less control. But gradually we are coming to learn that the world is a continuum and that continued input into one part of the environment may result in unplanned output elsewhere, often undesirable. This and the pure pleasure of being able to taste nature untrammeled below or above certainly favours the creation of underwater as well as terrestrial parks. What better heritage to leave future generations. One may thank the authors for expressing in a pleasant style their journey through their national underwater parks. One hopes that we shall soon have some of our own.

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Biology of Plants

By P. H. Raven, and H. Curtis. Worth Publishing Inc., New York, U.S.A. 1970. 706 pages. $11.95.

It is not often that one picks up a new introductory botany textbook and reads it from cover to cover simply out of interest. However, I did this with this book before being asked to review it.

The first thing about this book which catches the eye is the uniformly high quality of the illustrations. The authors have obviously made a big effort to search out the leading research workers in each of the areas touched on in the text to get good illustrations from them. In many cases these illustrations are previously unpublished. Furthermore, as for example the scanning electron micrographs, and of course the photographs taken from space crafts, the illustrations include those made by means of the latest technical "know-how". This is a pleasant change from the usual situation where authors and publishers of elementary texts seem to get illustrations from the easiest sources available, apparently getting most of their ideas from those already published in other textbooks.

In addition to the superb illustrations, the authors have selected the material of the text with a great deal of care and have used an interesting blend of the historical with the very modern.

The book covers a lot of territory ranging from ideas on the origin of life to a discussion of the place of man in the ecosystem. It does not try to be encyclopedic but the basic concepts of plant biology and the role of plants in the energy relations of the world have been covered, and the examples chosen are interesting and useful and include the results of recently published research.

Unlike the case in many introductory texts, the authors have tried hard to keep the reader oriented so that different levels of organization are presented in logical sequence and frequently are illustrated in the same figure.

Reader orientation is also aided by the constant use of magnification scales on photomicrographs, an important detail often omitted from textbook figures. The text is knowledgeable and very readable, and includes a minimum of unnecessary terminology. Enough good references are included so that the interested student can use this book as a spring-board to a vast amount of information about plants.

This book is an excellent text for an introductory survey course on plants. In cases where students have had an introductory biology course in which plants have had short shrift, the material covered in this book would serve as a good framework on which to hang a modern course in plant structure and function. I also recommend the book to any general reader who is looking for a well written accurate, and up-to-date account of the biology of plants.

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An Introduction to Mathematical Ecology

By E. C. Pielou. John Wiley and Sons, New York. 1969. viii + 283 p. $16.50.

Not infrequently, books entitled with the ubiquitous "An Introduction To . . ." are not what they claim to be. This is one such example. It is most certainly not an introduction in the usual senses, being neither a broad survey of fundamentals nor a source of painless initiation for the rank tyro. In fairness however, I must admit that the potential purchaser careful enough to read the prefatory sections is warned of this much.

The book makes two demands of the reader: a modicum of mathematical competence and, not quite so obviously, sufficient familiarity with modern ecological thought to cope with occasional lapses in connecting mathematics to ecology. On both counts, it follows that comparatively few biology students in Canadian universities could use the book unassisted as an introductory text, although the shortcomings in this regard devolve from current biology curricula rather than Dr. Pielou's efforts.

Having said that, it is a pleasure to report that the text is genuinely introductory in the sense that the author has aimed at, and achieved to an unusual degree, completeness and clarity in developing her selected topics. But how saddening it would be if these laudable attributes of all good writing were to be restricted solely to criteria for introductory texts.

Naturally enough, the topics chosen for treatment closely reflect the author's interests, including several areas to which the author has herself made substantial contributions. The book comprises three relatively independent sections, all of which benefit considerably from a spare, lucid style.

The first six chapters provide useful developments of the fundamental elements of population dynamics. Ordinarily one might lightly dismiss yet another presentation of the classical deterministic models as something inescapably *de rigueur,* were it not so remarkable to encounter them developed in parallel with their stochastic counterparts. This section alone is worth the price of admission, which is high praise indeed in view of the going rate. But the best is yet to come.

The following 10 chapters deal with various aspects of the problem of spatial pattern in nature. This is the real strength of the book, and it is safe to predict that these pages, particularly the initial larger portion dealing with single species patterns, will be well-thumbed by the majority of readers. Perhaps I found this section the most rewarding because of my own bias, for I admit to feeling that this is where the real potential for development of ecological theory lies at present. As the author implys in attempting to bridge the gap from population dynamics to spatial models, the challenge is to couple conventional population models that vary with time to the stabilizing heterogeneity of properties that vary in space. While I would not care to suggest that "simple" population models such as those described in the text will provide an adequate basis for such synthesis, preferring to place my faith in "complicated" models based on biological mechanisms rather than events, the point is nevertheless timely, and well taken.

The final five chapters are rather more varied, but primarily given over to descriptive treatments of many-species systems. These include rigorous discussions of species-abundance and diversity analysis, a short chapter on community classification, and two rather terse chapters introducing principle component and canonical variate analysis as methods for compaction and simplification of survey data.

Occasionally, there are some unnecessary lapses to cause difficulties for the uninitiate. Thus the notion of "grain" is applied in chapter 9, but not explained until chapter 10, and, as another example, I expect that the reader who is not familiar with the recent furor over the MacArthur "broken-stick" model may be left rather puzzled as to the nature of the controversy.

But these are minor lapses indeed, granted the likely audience for the book. There is much to commend, not least of which is the tough, very clear treatment accorded such concepts as "pattern" and "distribution", so frequently confounded by ecologists. And the elaborate care with which the practical difficulties of field sampling are treated, a clear indication of the author's first-hand knowledge of the problems, obviates the conventional criticism by the non-mathematical ecologist that the subject is too detached from reality.

Which brings me to a point of some interest. Dr. Pielou is certain to raise some eyebrows with the prefatory reminder that "ecology is essentially a mathematical subject". She is quite right of course, although some of us might find her bluntness unnerving. In large part, ecology is concerned with the dynamic interaction of multi-species systems, a study that is indeed mathematical. Mere contemplation of *natura naturans* is an insufficient basis for ecology's existence as a distinct discipline. But to many of us who entered the field via the route from natural history, organisms are the currency of ecology and we are inclined to be suspicious of transactions conducted in anything but hard cash. However, perhaps the fact that the author does not feel it necessary to explain herself is a measure of the rapid development of ecology as a coherent discipline in recent years. Certainly it is a measure of the author's style, from which has emerged a book that will be widely used, and deservedly so.

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Rocky Mountain Trees

By Richard J. Preston, Jr. Dover Publications, Inc. New York and General Publishing Co. Ltd., Don Mills, 1968. 3rd edition. i-lxxx + 285 pp. illus. $3.25.

In this edition the nomenclature has been revised to conform with the USDA Handbook No. 41, Check List of Native and Naturalized Trees of the United States, 1953 and some of the distribution maps for the Genus *Pinus* have been somewhat changed; otherwise it appears to be an exact photo-offset of the original 1940 edition.

The text and illustrations have been slightly enlarged photographically. This makes the book more legible. The line drawings and maps are somewhat darker than the original, but this does not detract.

This book which treats the Rocky Mountain region from Texas north into southern Canada contains much information which would be useful to both professional botanists and foresters as well as the amateur interested in trees of the region. It is well worth while reprinting in this new format.

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Our Northern Shrubs and How to Identify Them

By Harriet L. Keeler. Dover Publications, Inc. New York and General Publishing Co., Ltd., Don Mills 1969. 539 pp. illus. $4.35.

This is a photo-offset reproduction of a book which was first published by Charles Scribner's Son in 1903. The text has been copied well, but the illustrations which are on a much less glossy paper than the original, have lost much in the process. A soft but waterproof cover which is bright and showy in comparison to the earlier rather drab hard cover will catch the eye when the book is displayed.

The book treats the native and more commonly introduced shrubs found in the northern United States from the Mississippi River to the Atlantic Coast.

An effort has been made to up-date the volume by the addition of an appendix prepared by Edward G. Voss entitled "Nomenclature Changes". Here the reasons for changes in the scientific names are given and a 9-pages list of "new" names together with their old counterparts is provided; no effort was made however to index these new names. Dr. Voss has pointed out that "During the past 65 years botanists have learned a great deal about the distribution and distinguishing characters of these shrubs, but obsolete statements on these matters are not altered. The alert reader will detect occasional statements which would be inadmissible in the light of modern scientific knowledge . . ." I think that it would have been much better if the book had been completely rewritten, rather than issuing a patched-up version.

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Bryozoans

By J. S. Ryland. Hutchinson University Library, London. 1970. 175 p. illustrated. Hardcover £1.65 (U.K.).

Bryozoans are colonial, predominantly marine animals whose colonies may be noted by a casual stroller along a Bay of Fundy beach or by a person scraping fouling organisms from the bottom of his boat. They are otherwise seldom noticed by laymen, and the situation is not much better among professional zoologists. Bryozoans are generally considered a specialist group whose species are difficult to identify. This is, however, no truer of bryozoans than of any other group, but this, coupled with the unattractive appearance of most species, has not attracted many workers. This is unfortunate for a phylum of some 4000 living species (and about 15,000 extinct species), but Dr. Ryland's stimulating book should ameliorate the situation. It bridges the gap between the detailed treatise accounts and the somewhat cursory accounts of many university texts and is the only general account of bryozoans in a single volume which synthesises the work of both zoologists and geologists.

Among the eight chapters are broad-based discussions of anatomy and physiology, ecology and fossil history. Due emphasis is placed upon certain current research topics and accordingly there are thorough treatments of colony growth and body wall development. The segregation of the living bryozoan order Cyclostomata and the fossil orders as a class Stenolaemata is not a new concept among bryozoologists but Dr. Ryland's account is the first available to non-specialists in which the Stenolaemata are so recognised. It is the chapter devoted to this class, in which Dr. Ryland skillfully blends paleontological and zoological research findings, that makes this book unique, and invaluable to students of paleontology who plan to have any dealings with Palaeozoic bryozoans. The chapter on gymnolaemate ecology also reflects this synthesis from two disciplines. There are slight modifications to the usual bryozoan classification, viz., the names of the cheilostome divisions are given superfamilial endings and Silen's 'Gymnocystidea' is substituted for Harmer's 'Ascophora Imperfecta', both of which are useful improvements.

Like others in the Hutchinson University Library series this book is well written and well illustrated. I personally found it very readable. It is unquestionably the best general source of information available about bryozoans for advanced university courses on invertebrate zoology and paleontology and I trust it will find the place on library shelves it deserves.

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Ecology of the Subarctic Regions

Proceedings of the Helsinki symposium. UNESCO. Place de Fontenay, 75 Paris-7e. 1970. 365 p. $19.00. Available from UNIPUB, Box 433, New York, N.Y. 10016, U.S.A.

This book of 364 pages presents the results of a symposium on the circumpolar subarctic environment. The meeting was held near Helsinki in 1966, and was attended by scientists from northern Europe, U.S.S.R., Canada, U.S.A., the U.K. and southern South America. The papers are technical and, with few exceptions, will mostly interest technical people.

The headings of the nine sections of the symposium indicate the kind of material presented:— Definition of the subarctic, meteorology of subarctic regions, snow cover as an ecological factor, weathering and geomorphological processes, permafrost as an ecological factor, soil-forming processes, ecology of vegetation, ecology of important species of fauna, conservation, and rational use of resources. According to the introductory statement, it was hoped that the papers and discussions (also printed) would lead to a better understanding of the physical conditions of the subarctic, and that new perspectives for research would be opened.

What is the Subarctic? There was no general agreement on a definition of the region, which partly explains the geographically wide range of topics. A minority concensus defined the subarctic as the forest-tundra transition, bounded on the south by the close-crowned boreal forest and on the north by the treeless tundra. This seems reasonable; it would coincide with the "open lichen woodland" of northern Canada. It is interesting that because a concept and a word ("subarctic") exists, some think it must have objective reality! Several contributors spoke of the need for more study so that the region could be defined *objectively,* as if any geographical area were not exactly what someone decides or some group agrees to make it.

With interest in northwestern North America at an all-time high, the Symposium volume provides much relevant information on terrain ecology. For example, the problems of intermittent ground frost are touched on in many articles. One of the interesting phenomena discussed by a number of authors is the genesis of ice-cored peat mounds or palsas, and similar attention is given to patterned organic terrain (string bogs, aapa fens), so familiar to those who have flown over the boreal and subarctic forests. Papers of broader than average interest include W. O. Pruitt's "Some ecological aspects of snow", R. J. E. Brown's "Permafrost as an ecological factor in the subarctic", J. C. F. Tedrow's "Soils of the subarctic regions", and P. Mikola's "Forests and forestry in subarctic regions."

In several papers and numerous discussions the problems of conservation are highlighted. It is pointed out that within the subarctic there are few national parks or natural area reserves. The necessity of protecting vegetation, habitat and native animals in advance of man's full-scale invasion is emphasized. Adding urgency to this thinking are papers treating the conventional theme of "resource-development"; exploring the means by which one of the last frontiers may be redesigned and made more productive for man's narrow needs. As in all gatherings of research people, the need for more research is reiterated. This can be interpreted as an expression of the scientists' wish "to go back north"; it is perhaps the closest most can come to calling for a more thoughtful appreciation of a lovely land.

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Urban Forestry in Canada

By E. Jorgensen. 1970.

and

Urban Forestry. Some Problems and Proposals

By E. Jorgensen. 1968. The Shade Tree Research Laboratory Faculty of Forestry, University of Toronto, Toronto, Ontario.

These two short papers point up a relatively new field of forestry interest in Canada, viz. the amelioration of the harsh, straight-lined city environment through the selection, planting and care of shade trees. With over 70% of Canada's population living in the urban environment, interest in trees as objects of beauty — screening out dust, noises and objectionable views — will undoubtedly increase. Appreciation of "trees as environment" rather than "trees as pulp and lumber" is appearing also in the hinterland where clear-cutting over large areas is being questioned, to the discomfiture of the wood-using industries. Awareness of beauty and ugliness in the landscape both in city and country will powerfully aid the conservation of environment, and Dr. Jorgensen's program in the Faculty of Forestry at the University of Toronto is an encouraging development.

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Nature of Life: Earth, Plants, Animals, Man and their Effect

By Lorus J. and Margery Milne; 316 p. + 208 illustrations. Crown Publishers, Inc., New York. 1971. Available in Canada from General Publishers Co., Don Mills. $21.95.

The title of this book could well suggest that the reader will be led into a philosophical and scientific discussion on the nature of life. Or, because of the large format and the profusion of black and white and colour photographs, one may think that this is another good "picture book".

Perhaps, then, the title is somewhat misleading; the subject of this publication is essentially the distribution of life on earth, and it consists in much more than the mere presentation of good photographs.

After a brief chapter on "The Long Evolution of the World and its Life", where they deal with continental drift and the evolution of life through the geological timetable, the authors begin to present information on the major biomes of the world, including isolated islands, the seas, the sea floors, brackish and fresh waters. Distribution by radiation and adaptation is the theme, based on the theory of continental drift and the formation (and disappearance) of land bridges. Seen in that light, the book is an interesting account of how species have spread in the world, being assisted or hindered in their progress by topography and climate.

The reader gets the impression that the Milnes have wanted to pack into their book all the observations they made and recorded as they travelled. This is an account of what they saw, not of what they did and little of what they think. So much so that reading is generally arduous; the reader would appreciate an anecdote here and there, as a rest!

The outlines of evolutionary studies and the descriptions of biomes, added to the originality of many of the observations, make this an interesting book. The illustrations are good and well reproduced and the print is of good quality. The zoogeographer will want to have "Nature of Life" in his library.

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Environment, Power, and Society

Howard T. Odum. Wiley-Interscience, New York and Toronto. 331 p. 1971. $9.95 cloth; $6.50 paper.

A less eye-catching but equally descriptive title might be "energy flow through the biosphere". The author defines power in terms of the rate of flow of useful energy, e.g. calories per day.

> "In recent years studies of the energetics of ecological systems have suggested general means for applying basic laws of energy and of matter to the complex systems of nature and man. In this book, energy language is used to consider the pressing problem of survival in our time — the partnership of man in nature. An effort is made to show that energy analysis can help answer many of the questions of economics, law, and religion, already stated in other languages. Models for the analysis of a system are made by recognizing major divisions whose causal relationships are indicated by the pathways of inter-change of energy and work. Then simulation allows the model's performance to be tested against the performance of the real system".

Some books grip the reader from moment to moment. They are usually categorized as the kind you cannot lay down. Odum is not that kind of writer. It is not the style and magic of the word flow that grips you; it is the succession and variety of ideas and examples he presents. Each point raised receives a heading and is disposed of with an economy of works that produced, in me at least, a habit of reading a section, pausing to absorb it, and then turning to study the accompanying diagrams. Mathematics are avoided but figures are scattered profusely throughout the text and form an essential part of it. The reader with a high visual component in his memory structure will be particularly appreciative: "Energy diagramming helps us consider the great problems of pollution, power, population, food and war free from our fetters of indoctrination".

The combination of text and diagrams projects a series of mental pictures: the earth as a globe receiving solar radiation and emitting waste heat; energy driving the inanimate transportation and temperature control systems we call weather, climate and the water cycle; and the one-way passage of energy through the biosphere driving the ever cycling and recycling flow of the material elements that constitute life.

Man learned to garner energy surplus to his immediate metabolic needs and to employ it as a multiplier. The spear he manufactured returned to him more energy than he expended on it, as did his first crude agricultural tools. He had an energy feed-back system permitting him to draw from the flow of solar energy more than he expended on subsistence. The surplus created primitive civilizations.

While the only source of energy was dilute solar radiation, man's technique was no different in kind than that of squirrels storing nuts, ants milking aphids, or beavers building dams and houses. However, when man learned to apply relatively small amounts of dilute solar energy to release the concentrated potential of fossil fuels he became a new phenomenon — an organism that could supplement solar energy and direct that supplement into the biosphere, which, by that time in history, he was using as *his* life-support system and exploiting as though unaware of his continuing dependence on the living systems he was altering and overloading so drastically. Modern civilization developed.

What the use of fossil fuels has done to the society of man and what it may do in the future to him and his environment is the theme of the book. By offering an analysis in terms of energy flow, the author has provided a clear, uncluttered picture of the physical causes, the generating mechanisms and perhaps the future of modern civilization, the affuent society, and man himself. It is no more than a wide-ranging review of first principles for a student aspiring to the field of computer simulation of energy systems; but for the general reader and the student of ecology, to whom it is addressed, it provides a valuable point of vantage from which to assess the problems of our times, both global and local. If we wish to influence solutions, we should understand the problems. This book helps.

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OTHER NEW TITLES

Agricultural Practices and Water Quality. T. L. Wilrich, and G. E. Smith. Iowa State University Press, Ames, Iowa. 1970. 415 p. $7.95.

Air Pollution and its Control. W. T. Sproull. Exposition Press, New York. 1970. 106 p. $4.06.

Alaska: The Embattled Frontier. G. Laycock. Houghton Mifflin, Boston. 1971. 224 p. $7.95. Based on a first-hand study, including the Aleutian Islands and the route to Prudhoe Bay, the author presents a broad outline of the struggle between development and spectacular wildlife and resources of Alaska.

Alive in the Wild. V. H. Cahalane (Ed.) and drawings by R. Candy. Prentice-Hall, Englewood Cliffs, N.J. 1970. 244 p. $9.95. Thirty-five zoologists each relate the natural history of a well known North American vertebrate. The Great Horned Owl, Golden Eagle, sea turtle, alligator rattlesnake, bear, raccoon, red fox, skunk, cats, deer, elk, seals and the grey whale are presented.

Animal Populations in Relation to Their Food Sources. A. Watson (Ed.) British Ecological Society Symposium No. 10. Blackwell Scientific Publications, Oxford, England; F. A. Davis Co., Philadelphia, Pa. 1970. 477 p. 51 figs., $17.50. The 22 papers cover selective feeding, behaviour mechanisms, population processes in relation to the influence of the quality, quantity and availability of food.

Animal Traps and Trapping. J. Bateman. Stackpole Books, New York. 1971. 286 p. $8.50. Includes a historical study of trap development, the traps of nature, man-made traps for insects, birds, fish and mammals, and discusses the ethics of trapping.

Aquatic Oligochaeta of the World. R. O. Brinkhurst and B. G. M. Jamieson. Oliver and Boyd, Edinburgh. 1971. 860 p. £12.00.

The Arachnids: An Introduction. K. R. Snow. Columbia University Press, New York. 1970. 84 p. $5.00. Descriptions, anatomy, physiology and life histories of mites, ticks, spiders, scorpions and other arachnids. A glossary of terms, selected reading lists and an index are included.

The Arctic Ocean and its Coast During the Cenozic Era (in Russian). A. I. Tolmachev. Geographical Society of the USSR and the All-Union Botanical Society. The Hydrometeorolgical Publishing House, Leningrad. 1970. 562 p. $3.00 (2 rubles, 75 kopeks).

Atlas of Energy Budgets of Plant Leaves. D. M. Gates, and E. P. LaVerne, Academic Press, New York. 1971. 278 p. $14.50.

Birds in Our Lives. A Stefferud, and A. L. Nelson (Eds.) Arco Publishing Co., New York. 447 p. $5.95 paper, $9.90 cloth. Forty-five wildlife biologists treat the popular aspects of birds in relation to man. Subjects include birds in literature art and recreation, falconry, attracting birds, bird habits, and conservation.

Biochemical Evolution and the Origin of Life. E. Schoffeniels (Ed.) Proceedings of a Conference. North-Holland, Amsterdam; American Elsevier, New York. 1971. 398 p. $$23.00. Molecular Evolution Vol. 2.

Bioethics: Bridge to the Future. Van Resselaer Potter. Prentice-Hall, Englewood Cliffs, N.J. 1971. 224 p. $5.95 cloth, $3.95 paper.

Biological Control. C. B. Huffaker (Ed.) Plenum Pub. Corp., London. 1971. 470 p. £9.10. Also discusses biological control in Canada.

Biological Principles and Processes. C. A. Villee, and V. G. Dethier. W. B. Saunders Co., Philadelphia and Toronto. 1971. 1010 p. $11.25.

The Biology of Brackish Water. A. Remane, and C. Schheper. Wiley-Interscience, Rexdale, Ont. 1971. 350 p. $21.95.

The Biology of Flowering. F. B. Salisbury. Published for the American Museum of Natural History by the Natural History Press, Garden City, N.Y. 1971. 176 p. $5.95.

Biology of the Reptilia. C. Gans (Ed.) Academic Press, New York. 1970. Vol. 1, Morphology A 373 p. $13.00. Vol. 2, Morphology B. 374 p. $16.50. These, the first two parts of a proposed multi-volumed work, summarize the present knowledge of the reptilian skeleton (vol. 1) and sense organs (vol. 2). Taxonomy and origin of reptiles are also discussed. Vol. 3, Morphology. 1970. 385 p. $21.00.

Biomathematics. Vol 1: Mathematical Topics in Population Genetics. K. Kojima. Springer-Verlag, New York. 19700. 408 p. $18.70.

Brother Earth: Nature, God, and Ecology in the Time of Crisis. Thomas Nelson Inc., New York. 1970. 236 p. $4.95.

Cadmium in the Environment. A Toxicological and Epidemiological Approach. L. Friberg, M. Piscator, and G. Nordberg. Chemical Rubber Co., Cleveland, Ohio. 1971. 200 p. $25.00. The most up-to-date summary on the environmental cadmium question.

***Canadian Parks In Perspective.** J. G. Nelson. Harvest House, Montreal. 1970. 343 p. $3.50 paper, $5.95 cloth.

The Challenge of Genetics. E. H. Simon, and J. Grossfield. Addison-Wesley, Reading, Mass. 1971. 218 p. $3.50.

Change In Alaska: People, Politics, and Petroleum. G. Rogers (Ed.) Univ. Washington Press, Seattle, Wash. 1970. 213 p. $7.95.

Chemical Biology of Fishes. M. Love. Academic Press, New York. 1970. 548 p. $21.00.

***Chemical Mutagens: Principles and Methods for their Detection.** A. Hollaender (Ed.) Plenum Press, New York and London. Vol. 1, 310 p. $19.60; Vol. 2, 299 p. $19.60.

The Chemicals We Eat. M. A. Benarde. American Heritage Press, New York. 1971. 208 p. $6.95. Explains in layman's terms why certain chemicals are added to food, what these chemicals are, and how they function as preservatives, flavouring and colouring and thickening agents. Outlines testing programs for safety and research for new protein-rich foods.

Competition for Wetlands in the Midwest: An Economic Analysis. J. H. Goldstein. Johns Hopkins Press, Baltimore, Md., for Resources for the Future Inc., Washington, D.C. 1971. 106 p. $3.50.

The Compleat Naturalist: A Life of Linnaeus. W. Blunt, and W. T. Stearn. Collins Pub. Co., London. 1971. 256 p. £3.50.

Conference on Beneficial Uses of Thermal Discharges. S. P. Mathur, and R. Stewart (Eds.) New York State Department of Environmental Conservation, Albany, N.Y. 1970. 228 p. $10.00.

Controlling the Weather. H. J. Taubenfeld (Ed.) Dunellen Pub. Co., New York. 275 p. $10.00.

The Cuticle of Plants. J. T. Martin, and B. E. Juniper. St. Martin's Press, New York. 1970. 347 p. $27.00.

Defending the Environment: A Strategy for Citizen Action. J. L. Sax. Alfred Knopf Inc., New York. 1971. 252 p. $6.95.

Dirty Water. Urban Systems Inc., 1033 Mass. Ave., Cambridge, Mass. $10.00. A game that teaches people of all ages about ecology and water pollution, and the complexities with which an administrator must deal in controlling water pollution.

An Eagle to the Sky. Frances Hamerstrom. Iowa State University Press, Ames, Iowa. 1970. 144 p. $4.95. An interesting account of personal relationships and some experiments with captive eagles.

The Earth and Its Oceans. A. C. Duxbury. Addison-Wesley, Reading, Mass. 1971. 382 p. $10.95.

Ecological Genetics. E. B. Ford. Chapman and Hall Inc., London. 1971. 430 p. £4.50. 3rd edition.

The Ecology of Man: An Ecosystem Approach. R. L. Smith. Harper and Row, New York. 1971. 448 p. $5.95.

Ecological Studies of the Timber Wolf in Northeastern Minnesota. L. D. Mech, and L. D. Franzel, Jr. North Central Forest Experiment Station (Research Paper NC-52; 62 p.) 1971. Forest Service, Dept. Agriculture, Folwell Ave., St. Paul, Minn. 55101.

Economics and the Environment. A. V. Kneese, R. U. Ayres, and R. C. d'Arge. Johns Hopkins Press, Baltimore, Md., for Resources for the Future Inc., Washington, D.C. 1970. 120 p. $2.50.

Eleventh Hour: A Hard Look at Conservation. A. B. Adams. G. P. Putnam and Sons, New York. 1970. 378 p. $7.95.

Energy Transformations in Mammals: Regulatory Mechanisms. F. L. Hoch. W. B. Saunders, Philadelphia, Pa. 1971. 218 p. $10.00.

Entropy for Biologists: An Introduction to Thermodynamics. H. J. Morowitz. Academic Press, New York. 1970. 196 p. $6.95.

***Environment and Good Sense: An Introduction to Environmental Damage and Control in Canada.** M. J. Dunbar. McGill-Queens University Press, Montreal and London. 1971. 92 p. $2.25 paper, $4.50 cloth. The introductory volume in the series Environmental Damage and Control in Canada, sponsored by the Canadian Society of Zoologists.
National Educational Association Publications, Sales

Environmental Crisis: What the Individual Can Do. Section, 1201 Sixteenth St., N.W., Washington, D.C. 20036. $15.00. Specific solutions for getting rid of traffic, water pollution and nondegradable litter are presented in this colour and sound filmstrip with 33⅓ rpm record. The philosophy of ecology is given in a message to students from the upper-elementary to college-level viewer.

Environmental Quality: The Second Annual Report of the CounCil On Environmental Quality. 1971. 360 p. $2.00 from the Public Documents Distribution Center, 5801 Tabor Ave., Philadelphia, Pa. 19120.

Environmental Radioactivity Symposium. J. C. Clopyon (Ed.) The Johns Hopkins University, Dept. Geography and Environmental Engineering, Baltimore, Md. 21218. 1970. $5.00.

Equipment for Incineration of Municipal Waste. F. D. Friedrich. Canadian Combustion Research Laboratory, Fuels Research Centre Technical Bulletin TB134. Dept. Energy, Mines and Resources, Ottawa. 1971. 64 p. $1.00 from Information Canada, catalogue no. M34-20/134.

Experiments Using Marine Animals. F. A. Diehl, J. B. Feeley, D. G. Gibson III, and J. M. King (Eds.) Aquarium Systems, Eastlake, Ohio. 1971. 92 p. $4.50.

Explorations in the Life of Fishes. N. B. Marshall. Harvard University Press, Cambridge, Mass. 1971. 192 p. $6.50.

Facets of Genetics. A. Srb, R. D. Owen, and R. S. Edgar. Readings from Scientific American. W. H. Freeman and Co., San Francisco. 1970. 354 p. $10.00.

Field Guide to the Insects of America North of Mexico. D. J. Borror, and R. E. White. Houghton Mifflin Co., Boston, Mass. 1970. 404 p. 16 colour plates, line drawings. $5.95. A new edition to the Peterson Field Guide Series. Has introductory chapters on the collection, preservation and study of insects. 579 families are identified, as well as many common arthropods.

Flora of the Galapagos Islands. I. L. Wiggins and D. M. Porter. Stanford University Press, Stanford, Calif. 1971. 998 p. $37.50.

Florida Marine Shells: A Guide for Collectors of Shells of the Southeastern Atlantic Coast and Gulf Coast. C. N. Vilas, and N. R. Vilas. Charles E. Tuttle Co., Rutland, Vt. 1970. 170 p. $6.00. Shells from North Carolina to the Florida Keyes and west to Texas may identified with this book. Most species are pictured in colour.

Forests of Lilliput: The Realm of Mosses and Lichens. J. H. Bland. Prentice-Hall, Englewood Cliffs, N. J. 1971. 210 p. $7.95. An introduction that should enable the reader to recognize these plants without botanical training or microscope.

Fossils and Flies. Elizabeth Noble Shor. University of Oklahoma Press, Norman, Okla. 1971. 286 p. $8.95. The life of a compleat scientist, Samuel Wendell Williston (1851-1918).

Glacial and Quaternary Geology. R. F. Flint. John Wiley and Sons, New York and Toronto. 1971. 892 p. $24.95. Third revision.

Global Ecology: Readings Toward a Rational Strategy for Man. J. P. Holdren, and P. R. Ehrlich (Eds.) Harcourt Brace Jovanovich, New York. 1971. 296 p. $4.50.

The Great Land. B. Herndon. David McKay, New York. 1971. 256 p. $6.95.

***Group Selection.** G. C. Williams (Ed.) Aldine: Atherton, Chicago and New York. 1971. 210 p. $2.95.

A Guide to the Birds of Ceylon. G. M. Henry. Oxford University Press, New York and London. 1971. 457 p. $9.00. 2nd edition. General information and detailed identification guide to the 400 species seen on the island, which includes many of the common birds of India.

Guide to Identification of Marine and Estuarine Invertebrates: Cape Hatteras to the Bay of Fundy. Wiley-Interscience, Don Mills, Ont. 1971. 693 p. $29.95. Complete identification manual for invertebrate species inhabiting the shore and shallow sea bordering the northeastern U.S.

Halic: The Story of a Gray Seal. E. Clarkson. E. P. Dutton, New York. 1970. 158 p. $4.95.

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An Illustrated Catalog of the Neotropic Arctiinae Types in the United States National Museum (Lepidoptera: Arctiidae). Part 1. Smithsonian Institution Press, Washington, D.C. Smithsonian Contributions to Zoology No. 50. 1971. 362 p. $4.00. Available from Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

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An Indexed Bibliography of North American Stizostedion (Pisces, Percidae) species. W. D. Addison, and R. A. Ryder. Ontario Department of Lands and Forests, Research Information Paper (Fisheries) No. 39. 1970. 318 p. Ont. Dept. Lands and Forests, Maple, Ont.

Infectious Diseases of Wild Animals. J. W. Davis, L. H. Karstad, and D. O. Trainer. Iowa State University Press, Ames, Iowa. 1971. 421 p. $18.00.

Insect Hormones. V. B. Wigglesworth. W. H. Freeman and Co., San Francisco. 1970. $6.50. University Reviews in Biology series.

Insect Natural History. A. D. Imms. Collins Press, London. 1971. 317 p. £2.50. 3rd edition.

The International System of Units (SI). C. H. Page, and P. Vigoureux. National Bureau of Standards (U.S.) Special Publication No. 330. 1971. 41 p. $.50 from Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Approved translation of the French edition published by the International Bureau of Weights and Measures. An authoritative description of the modernized metric system.

An Introduction to the Study of Insects. D. J. Borror, and D. M. DeLong. Holt, Rinehart and Winston, New York. 1971. 812 p. $17.50. 3rd edition.

Inventories of National and Individual Air Pollution. E. R. Mitchell. Canadian Combustion Research Laboratory, Fuels Research Centre Information Circular IC 269. Dept. Energy, Mines and Resources, Ottawa. 1971. 17 p. $.50 from Information Canada, catalogue no. M38-3/269. An explanation of trends of fuels use on a national and individual basis. Complements Information Circular 268 *Only People Pollute* by the same author.

The Itasca Bison Kill Site: An Ecological Analysis. T. C. Shay. Mollusk Analysis by Samuel Tuthill. Minnesota Historical Society, St. Paul, Minn. 1971. 134 p. $5.50.

***Joseph Banks in Newfoundland and Labrador, 1766's. His Diary, Manuscripts and Collections.** A. M. Lysaght (Ed.) University of California Press, Berkely, Calif. 1971. 416 p. $40.00.

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The Last of the Loners. S. P. Young. The Macmillan Co., New York. 1970. 316 p. $9.95.

Life and Death in a Coral Sea. J. Y. Cousteau with P. Diolé translated from French by J. F. Bernard. Doubleday and Co., Garden City, N.Y. 1971. 302 p., 122 colour plates. $8.95. Undersea discoveries and diver's explorations of the web of life among coral reefs of the Indian Ocean and Red Sea.

The Life Sciences. Committee on Research in the Life Sciences. National Academy of Sciences, Washington, D.C. 1970. 525 p. $10.50.

***The Lives of Wasps and Bees.** Sir C. Andrewes. American Elsevier, New York. 1971. 204 p. $6.50.

Living With Your Land. J. Vosburgh. Scribner, New York. 1971. 192 p. $6.95.

The Lysenko Affair. D. Joravsky. Russian Research Center Studies No. 61., Harvard University Press, Cambridge, Mass. 1970. 462 p. $13.95.

Making the Most of Metrication. J. S. Vickers. Gower Press (Cahners Books), London. 1970. 163 p. $10.95. Discussion of the best national solutions for conversion to the metric system, written by the chief engineer of the British Standards Institution's Planning Group.

Man and Atom: Building a New World Through Nuclear Technology. G. T. Seaborg, and W. R. Corliss. Dutton, New York. 1971. $10.00.

Man and His Environment: Climate. D. M. Gates. Harper and Row, New York. 1971. 192 p. $5.95 cloth, $3.25 paper.

Man and His Environment: Law. E. F. Murphy. Harper and Row, New York. 1971. 168 p. $6.00 cloth, $3.25 paper.

Man and His Environment: Waste. W. Marx. Harper and Row, New York. 1971. 179 p. $6.00 cloth, $3.25 paper.

Man's Impact on the Global Environment: Assessment and Recommendations for Action. Report of the Study of Critical Environmental Problems. The MIT Press, Cambridge, Mass. 1970. 319 p. $2.95.

A Manual of Wildlife Conservation. R. D. Teague. Wildlife Society, Washington, D.C. 1971. 206 p. $5.50.

Marine Food Chains. J. H. Steele (Ed.) Oliver and Boyd, Edinburgh. 1970. 552 p. £5.00.

Mathematical Taxonomy. N. Jardine, and R. Gibson. John Wiley and Sons, Toronto. 1971.

The Medvedev Papers. A. Z. Medvedev. Macmillan Pub. Co., London. 1971. 470 p. £4.95. Translated from Russian by Vera Rich.

*__Mercury.__ K. Montagne, and P. Montagne. Sierra Club Battle Book. 1971. 158 p. $2.25. Available in Canada from Clarke, Irwin and Co. Ltd., Toronto.

Mercury in the Environment. U.S. Geological Survey Professional Paper No. 713. 1970. 67 p. $.70 from Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

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Must They Die? The Strange Case of the Prairie Dog and the Blackfooted Ferret. F. McNulty. Doubleday and Co., Garden City, N.Y. 1971. 86 p. $4.95. Describes the natural habitat of the prairie dog and the role it plays in the almost extinct ferret's last stand in South Dakota.

Natural Resource Conservation: An Ecological Approach. O. Oliver. Macmillan and Co., New York. 1971. 544 p. $9.95.

Nature Study for Conservation: A Handbook for Environmental Education. J. W. Brainerd. Macmillan and Co., New York. 1971. 352 p. $4.95.

New Worlds for Wildlife. Ann Sutton and M. Sutton. Rand MacNally and Co., Chicago. 1970. 190 p. $4.95.

The North American Buffalo. A Critical Study of the Species in its Wild State. F. G. Roe. University of Toronto Press, Toronto. 1970. 991 p. $35.00. 2nd edition.

Nuclear Power and the Environment. M. W. Carbon, and W. Houlberg. Proceedings of a Conference, Madison, Wisc. University of Wisconsin. 1970. Variously paged.

The Off-road Vehicle and Environmental Quality. M. F. Baldwin. Conservation Foundation, 1717 Massachusetts Ave., N.W., Washington, D.C. 20036. 1971. 52 p. $1.00. A report on the social and environmental effects of off-road vehicles, especially snowmobiles, with suggested policies for their control.

One Earth, Many People. L. Pringle. Macmillan and Co., New York. 1971.

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The Open Sea: Its Natural History. A. C. Hardy. Houghton Mifflin, Boston, Mass. 1971. 688 p. $20.00.

Pacific Northwest Ferns and their Allies. P. M. C. Taylor. University of Toronto Press, Toronto. 1970. 247 p. $15.00.

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The People Problem: What You Should Know About Growing Population and Vanishing Resources. D. Fraser. Indiana University Press. 1971. 248 p. $6.95. Written in layman's language; explanation of population in simple biological and mathematical laws.

Pesticides and Freshwater Fauna. R. C. Miurhead-Thompson. Academic Press, New York. 1971. 246 p. $10.00.

Plants, Chemicals and Growth. F. C. Steward, and A. D. Krikorian. Academic Press, New York. 1971. 232 p. $4.50.

Pleistocene and Recent Environments of the Central Great Plains. W. Dort Jr., and J. K. Jones Jr. University of Kansas Press, Lawrence, Kansas. 1970. 433 p. $25.00.

Poisoned Power. J. W. Gofman, and A. R. Tamplin. Rodale Press Inc., Emmaus, Pa. 18049. $6.95.

*__Population Control Through Nuclear Pollution.__ A. R. Tamplin, and J. W. Gofman. Nelson-Hall Inc., Chicago. 1970. 242 p. $6.95.

Prairie Grasses Identified and Described by Vegetative Characters. K. F. Best, J. Looman, and J. B. Campbell. Canada Department of Agriculture Publication No. 1413. 1971. $2.75 from Information Canada.

Prairie Plants and Their Environment: A Fifty Year Study in the Mid-west. J. E. Weaver. University of Nebraska Press, Lincoln, Neb. 1968. 276 p. $6.95.

Prehistoric Biological Relationships in the Great Lakes Region. R. G. Wilkinson. University of Michigan Museum of Anthropology, Ann Arbor, Mich. Anthropological Papers No. 43. 1971. 162 p. $3.50.

Principles of Animal Physiology. D. W. Wood. American Elsevier, New York, Contemporary Biology Series. 1970. 332 p. $11.00.

Principles of Comparative Anatomy of Invertebrates. W. N. Blekemishev. University of Chicago Press, Chicago. 1970. 2 vols. 490 + 529 p. $35.00 set. Translated by J. M. MacLennan, edited by Z. Kabata. The classic Russian sourcebook on invertebrate zoology. This is the third, and completely revised edition. The author has developed a new system of classification from which he compares the whole organisms and life histories of basic types throughout the system.

Problem of Threatened Species. Papers and Proceedings of the Eleventh Technical Meeting of the Survival Service Commission, New Delhi, 1969. International Union for the Conservation of Nature, Morges , Switzerland. 1970. 132 p.

Proceedings of the "Snow and Ice In Relation To Wildlife And Recreation" Symposium, Feb. 11-12. A. O. Haugen (Ed.) Iowa Co-operative Wildlife Research Unit, Science Hall, Iowa State University, Ames, Iowa 50010. 1971. 280 p. $7.00.

Proper Care and Use of Binoculars. J. Day. Arizona Game and Fish Dept., 222 W. Greenway, Phoenix, Ariz. 85023. 1971. 7 p. Good information on the choice, care and use of binoculars in surveying wildlife.

Puffin Island. A Graham, and F. Graham Jr. General Publishing Co., Don Mills, Ont. 1971. $6.25. A children's (age 10-14) book about two boys and their biology teacher who visit Puffin Island in the Bay of Fundy to see how animal and plant life survive the rugged conditions. They learn about the balance of nature and how it can be affected by man's pollution of the sea.

In Quest of Man: A Biological Approach to the Problem of Man's Place in Nature. P. Alsberg. Pergammon Press, New York. 1970. 210 p. $5.50.

Readings in Marine Ecology. J. W. Nybakken (Ed.) Harper and Row, New York. 1971. 544 p. $9.00. Thirty-three important papers primarily from 1955-1969 on plankton, interidal, benthic, tropical and deep sea ecology.

Readings in Population and Community Ecology. W. E. Hazen. W. B. Saunders and Co., Philadelphia and Toronto. 1970. 421 p. $5.75. 2nd edition.

Regional Ecology: The Study of Man's Environment. R. E. Dickinson. John Wiley and Sons, New York. 1970. 199 p. $6.95.

*__The Rust Fungi of Cereals, Grasses and Bamboos.__ G. B. Cummins. Springer-Verlag, New York. 1971. 570 p. $19.50.

Salmon and Trout: A Resource, Its Ecology, Conservation and Management. D. Mills. Oliver and Boyd, Edinburgh. 1971. 351 p. £4.00.

Science and the Future of Man. R. L. Carovillano, and J. W. Skehan (Eds.) MIT Press, Cambridge, Mass. 1971. 196 p. $10.00. Proceedings of a symposium discussing each current critical issue of science and society.

Scientists and the Sea 1650-1900: A Study of Marine Science. M. Deacon. Academic Press, New York. 1971. 446 p.

Selected References on Environmental Quality as it Relates to Health. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. 1971. $4.00. A monthly publication with 100 pertinent articles selected from 2200 of the world's biomedical journals. Among the 35 subject headings are acoustic trauma, automobile exhaust, detergents, dieldrin, industrial waste, noise, population density and radioactive fallout.

Smog. Urban Systems Inc., 1033 Mass. Ave., Cambridge, Mass. A game designed to aquaint the player with the complexities of air pollution control.

Sounds of Western North Atlantic Fishes:: A Reference File of Biological Underwater Sounds. Johns Hopkins Press, Baltimore, Md. 1970. 207 p. 321 figs., $12.50. The results of a study by the University of Rhode Island Narragansett Marine Lab. The sounds produced by species in 137 families are graphically recorded in oscillograms and sound spectra. Notes on sound production and mechanisms are included, as well as a bibliography and systematic index.

Statistical Ecology. Vol. 1: Spatial Patterns and Statistical Distributions. G. O. Patil, E. C. Pielou, and W. E. Waters (Eds.) A symposium, New Haven, Conn. Aug. 1969. Pennsylvania State University Press, University Park, Pa. 1971. 582 p. $14.50.

Statistics in Biology: Statistical Methods for Research in the Natural Sciences. Vol. 2. C. I. Bliss. McGraw-Hill, New York. 1970. 639 p. $22.00.

The Storm Petrel and the Owl of Athena. L. L. Halle. Princeton University Press, Princeton, N.J. 1970. 268 p. $7.50. A well-known ornithologist reflects on man and nature in this collection of his essays devoted to the natural history of sea birds that live apart from man, and to an examination of some philosophical questions.

Symbiosis: Organisms Living Together. T. C. Cheng. Pegasus Press, New York. 1970. 250 p. $6.95. An introduction to mutualism and especially parasitism intended for general readers, this book elucidates the physiological aspects of symbiotic relationships. Endoparasites and human health are emphasized.

Symposium on Organic Matter in Natural Waters. D. W. Hood. Institute of Marine Science Occasional Publ. No. 1. University of Alaska, College, Alaska. 1970. 625 p. $10.00 cloth, $8.00 paper.

Termites: A Study in Social Behaviour. P. E. Howse. Hutchinson University Library, London. 1970. £1.75 cloth, £.75 paper. Succinct review of current knowledge of termites, their habits, social behaviour and colonies, communication and nests.

Terrestrial Slugs. N. W. Runham, and P. J. Hunter. Hutchinson University Library, London; Hillary House, New York. 1971. 184 p. $6.00 cloth, $2.50 paper.

Trail Planning and Layout. B. L. Ashbaugh, and R. J. Kordish. National Audubon Society, Nature Center Planning Division, 1130 Fifth Ave., New York, N.Y. 10028. 1971. 76 p. $3.00. The 2nd edition of basic, practical information on trail planning, construction, maintenance, educational use and interpretive aids.

Trails of a Wilderness Wanderer. Andy Russell. Alfred Knopf, New York. 1971. 300 p. $7.95. Available in Canada from Random House, Toronto.

*__Trees: Structure and Function.__ M. H. Zimmerman, and C. L. Brown. Springer-Verlag, New York. 1971. 336 p. $19.80.

Understanding Environmental Pollution. M. A. Strobbe (Ed.) C. V. Mosby Co., St. Louis, Mo. 1971. 357 p. $5.95. Readings selected for environmental quality courses and to serve as a guide to the understanding of different species of environmental pollution, including papers on current research and development.

Understanding the Earth: A Reader in the Earth Sciences. P. Gass, J. Smith, and R. C. L. Wilson (Eds.) MIT Press, Cambridge, Mass. 1971. 355 p. $12.50 cloth, $7.95 paper. Scientists present synopses incorporating the latest findings in 22 areas from the earth's magnetic field, oxygen and evolution, to the fossil record and plate tectonics.

Vanishing Jungle: The Story of the World Wildlife Fund Expedition to Pakistan. Guy Mountfort. Houghton Mifflin, Boston Mass. 1970. 286 p. $12.50. Narrative of two expeditions made at the request of the Pakistan government to study the needs and make plans for a conservation program. The country, wild mammals, birds, reptiles and other animals are described in this beautifully illustrated account.

Water Pollution as a World Problem: The Legal, Scientific and Political Aspects. Report of a Conference held at the University College of Wales, Aberystwyth, 11-12 July, 1970. Europa Publications Ltd., 1972. 240 p. £3.50. Published for the David Davies Memorial Institute of International Studies.

Water, Pollution, Disposal and Use. J. E. Zajic. Vols. 1-4. General Publishing Co., Don Mills, Ont. 1971. $31.75 each. Explores the nature of, and suggested solutions to the analytical problems concerned with studies of environmental water systems. Dr. Zajic is Chairman, Dept. Chemical Engineering, University of Western Ontario, London, Ont.

The Way of Science: A Philosophy of Ecology for the Layman. F. E. Egler. Hafner Publishing Co., New York. 1970. 145 p. $6.95.

Where Have All the Flowers, Fishes, Birds, Trees, Water and Air Gone? What Ecology is All About. O. Segerberg Jr. David Mckay Ltd., New York. 1971. 304 p. $6.95.

Why Biology? A. N. Langford (Ed.) Biological Council of Canada. 1971. A career brochure directed at high school biology students. Available from Mr. N. S. Helm, Youth Science Foundation, 151 Slater St., Ottawa, K1P 5H3.

Wild Edible Plants of the Western United States. D. Kirk. Naturegraph Publishers, Healdsburg, Calif. 95448. 1970. 312 p. $3.95.

World Vegetation Types. S. R. Eyre (Ed.) Columbia University Press, New York. 1971. 264 p. $12.50.

Your Environment and What You Can Do About It. R. Saltonstall Jr. Walker and Co., New York. 1970. 299 p. $6.95.

Index to Volume 85

Compiled by Stanley M. Teeple

ERRATUM NOTICE

Vol. 85, No. 3, p. 216 Table 3 of Fimreite *et al.,* Mercury in fish and fish-eating birds near sites of industrial contamination in Canada.

The three asterisks beside the first-mentioned *Sterna hirundo* (Common Tern) should be moved down four lines to the second-mentioned *Sterna hirundo.*

A NOTE ON THE PRODUCTION OF THIS JOURNAL

The *Canadian Field-Naturalist* conforms to recommendations on the lay-out of periodicals issued by the International Organization for Standardization. It is set by linotype in Times Roman. The title is Times Roman. Boldface headings are Bodoni. Coverstock is Cornwall Coated Card Mayfair by Domtar Ltd. and the text paper in Provincial "thriftcoat". The journal is printed by The Runge Press Limited, 124 Queen Street, Ottawa, Canada K1P 5C8.

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Information Governing Content of The Canadian Field-Naturalist

Feature Articles

Beginning with the 1970 issues, the Canadian Field-Naturalist has been open for the consideration of major feature articles whose purpose is to make authoritative reviews of outstanding natural history and/or environment issues of our time. If possible, feature articles should be illustrated. Publication costs are open for negotiation between the author, editor and the business manager of the club.

Articles

The Canadian Field-Naturalist is a medium for publication of research papers in all fields of natural history. Reviews, compilations, symposia, controversial or theoretical papers, historical researches, etc. can also be published. Environmentally related papers are given some priority in publication sequence.

News and Comment

Informed naturalists, biologists and others are invited to present documented narratives and commentaries upon current scientific and political events that affect natural history and environment values. This section deals with activities, policies, and legislation relating to land and resource use, national and provincial parks, pollution, natural science education, conservation, natural area and species preservation activites and so on. Contributions should be as short as possible and to the point.

Notes.

Short notes on natural history and environment written by naturalists and scientists are welcome. Extensions of range, interesting behavior, pollination observations, reproductive phenomena, oil and pesticide pollution statistics and many other kinds of natural history observations may be offered. However, it is hoped 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 environment values are welcome. These should be brief, clear, pertinent and of interest to a wide audience.

Reviews

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

Special Notices and other items

The Canadian Field-Naturalist has a flexible publication policy. Hence an item not falling under any of our traditional sections can be given a special place provided that it is judged suitable.

(See Instructions to Contributors inside back cover)