RAPTOR RESEARCH

Volume 7

Number 3/4

Fall-Winter 1973

Raptor Research Foundation, Inc.

Vermillion, South Dakota, U.S.A.

RAPTOR RESEARCH **Fall-Winter 1973**
Volume 7, Number 3/4, Pages 72-120

CONTENTS

RAPTOR RESEARCH

Published by: RAPTOR RESEARCH FOUNDATION, INC.
c/o Department of Biology
University of South Dakota
Vermillion, South Dakota 57069 U.S.A.

RAPTOR RESEARCH is published quarterly in Spring, Summer, Fall, and Winter issues and occasional Supplements. The contents are usually divided into three sections. The first section is *SCIENTIFIC PAPERS* for reports of original research or theoretical analyses. These papers will be given careful editorial and referee scrutiny. A second section, *REPORTS, REVIEWS, AND OPINION*, will include secondary material, translations of material originally published elsewhere, reports of work still in progress, reports on meetings, often in some detail, book reviews, and other similar items. This material will be edited for accuracy but will not receive the critical review given the Scientific Papers. Because of the preliminary or secondary nature of the material in this section the Editors recommend that this material be cited in other papers only with great care or in a very general way and especially with specific preliminary or conference material only after consultation with the source of that information. Papers which express a personal opinion or letters to the Editor will be included in this section. *NOTES, NEWS, AND QUERIES* is used for notices of information or events, requests for information, news items either specially prepared or reprinted from other sources, and similar small items.

This journal began publication as RAPTOR RESEARCH NEWS with Volume 1 in 1967 as a quarterly in typewritten mimeographed form on an 8½" by 11" page size. Volumes 2 and 3 in 1968 and 1969 were offset printed but continued the same frequency, page size, and standard typewriter type. An analytical index for Volumes 1-3 was published. Volumes 4 and 5 in 1970 and 1971 were published six times a year in offset printing, 5½" by 8½" page size, and with IBM Composer typefaces; an analytical index for Volumes 4-5 is in preparation. In 1972, Volume 6, the name of the journal was changed to reflect the broader scope to RAPTOR RESEARCH. Currently the journal is published quarterly by offset printing with 6¾" by 9½" page size and IBM Composer typefaces and annual analytical indexes.

For membership and publication costs see inside back cover.

A FULLY AUTOMATED EGG FOR TELEMETERING ADULT ATTENTIVENESS AND INCUBATION TEMPERATURES*

by
David H. Ellis**
and
Joel R. Varney
Montana Cooperative Wildlife Research Unit
University of Montana
Missoula, Montana 59801

ABSTRACT. The construction and operation of a temperature and light telemetering egg are described. The egg was used to gather incubation temperature and nest attendance data at two Golden Eagle (*Aquila chrysaetos*) eyries. The system is low cost, has the advantages of long life and low maintenance, and is operable with a minimum of disturbance at the nest.

Incubation temperatures have been monitored by thermistors and thermocouples placed in the nest (Baldwin and Kendeigh 1927, Norton 1972), inside real eggs (Snelling 1972), and inside dummy eggs (Holstein 1942, Norton 1972). All of the above systems have disadvantages. Exposed wires interfere with egg turning activities of parent birds. Sensors in the nest itself measure ambient temperature rather than egg temperature.

Photoresistors placed in the nest floor can give an index of parental attendance (Weeden 1966), but errors are introduced when nest litter, eggs or young birds cover the sensor.

A better approach to recording both temperature and adult attendance is to install light and temperature sensors inside the egg. Small temperature recorders have been placed inside eggs (Lind 1961, Drent 1967), but short-term operation life (up to 12 hours) necessitated frequent visits to the nest and disturbance to the parents. This disadvantage was, in part, overcome by using a radio signal to relay data to nearby recording equipment (Eklund and Charlton 1959). Their system had an operating life of 100 hours so disturbances were less frequent but not eliminated.

Recent advances in electronic components have made possible the construction of an inexpensive and accurate monitoring system capable of operating during an entire nesting season. The system presented in this report relays both

*This paper was presented at the Conference on Raptor Conservation Techniques in Fort Collins, Colorado, 22-24 March 1973.

**Present address: Montana Department of Fish and Game, Helena, Montana 59601.

light (adult attendance) and incubation temperatures from a dummy egg to a loop antenna surrounding the nest cup and below the surface of the nest. A lead from the receiving antenna to receiving and recording equipment makes it possible to check equipment and replace batteries without disturbing the adults.

The need for a system that could provide a maximum amount of data on parental attentiveness and incubation temperatures (both peripheral and central) was strongly suggested at both the 1971 (Olendorff 1972) and 1972 conferences on captive breeding of raptors.

Egg Construction

The telemetering egg, designed in 1972, contains switch and timing circuits, sensors monitoring core temperature, shell temperature, and ambient light, and a blocking oscillator pulse transmitter. Schematic diagrams of the circuitry of the egg and pulse rate convertor have been published elsewhere (Varney and Ellis 1974).

The system has the advantages of low power consumption. The drain by transmitter and logic circuit is 30 μA resulting in a predicted life of two years for a 23 gram, 500 mAH mercury battery.

For eagle-egg application .size was not a problem, so four integrated circuitry packages of the inexpensive epoxy type were employed. For smaller eggs, smaller packages can be obtained at higher costs. With readily available components it is possible to fit the circuit into a 15 cm^3 egg and obtain a 60-day operating life. Typical component cost is $25 for an eagle egg and $48 for smaller eggs. If even smaller eggs are desired, component costs rise sharply, but construction is possible especially if only a one- or two-channel system is required.

Sensor components can be temperature-calibrated prior to assembly or the completed unit can be calibrated in a constant-temperature water bath. By either method an accuracy of $\pm$ 0.2 degrees Centigrade is achieved.

For studying the Golden Eagle (*Aquila chrysaetos*), we used an oversized Domestic Chicken (*Gallus gallus*) egg. The egg fell within the length-width dimention ranges reported by Bent (1937:299) for the Golden Eagle. The egg was sawed open, drained, and coated within by a thin layer of dental acrylic. The electronic guts were inserted, and the egg was filled with paraffin, which is thermally much like avian albumins. The end cap was then attached with acrylic so that an air space lay between the photoresistor and the cap. In 1972 the shell was spotted with water colors which subsequently eroded away, so in 1973 the egg was camouflaged with spray enamel.

The assembled egg was thermally much like a natural egg. Its density and specific heat were 1.10 g/ml and 0.63 cal/g deg C as compared with 1.09 g/ml and 0.77 cal/g deg C for comparable parameters of a natural egg (Romanoff and Romanoff 1949:105, 376). The instrumented egg was resultantly heated and cooled about 18% faster than a natural egg.

Receiving and Recording Equipment

The low power consumption is, in part, reflected in rapid attenuation of the signal with distance. The egg should be within two meters of a receiving antenna. The antenna, hidden in the nest surface, consisted of a 20-turn coil of number 24 AWG wire. Our antenna coil was approximately 50 cm in diameter, but smaller coils can be used where desired. An unshielded, two-conductor, cable lead (up to 40 m long) can be made between the loop antenna and the receiver. This lead connects to a standard broadcast-band receiver. Any small, battery-operated receiver with an earphone jack is suitable. The signal is converted to suitable recording form by a pulse-rate converter.

The pulse rate was displayed and recorded on a 1 mA Rustrak Model 288 chart recorder. At one inch per hour, the Rustrak can collect 25 days of continuous data on a 50-foot roll of chart paper.

A lead-acid automobile battery will operate the receiving and recording system for approximately two months. A total of 40 mA are required for receiver, recorder, and pulse rate converter.

The receiver was tuned on a quiet spot, free from night-time long-distance reception, at a low volume. Too high a volume setting will cause false triggering on background noise.

Approximate receiving system costs include the receiver ($8), pulse rate converter components ($15), and chart recorder ($140).

Installation and Field Performance

In 1972 and 1973 installations were made at one Golden Eagle eyrie each year. The recording equipment was positioned prior to flushing the incubating adult. In 1972 the time between flushing and completion of installation was 37 minutes. In 1973 only about 25 minutes were required. The recording equipment was placed out of sight of the nest at a distance of 30 m. Weekly equipment checks were possible without disturbing or even alerting the incubating adult.

In 1972 the last half of the incubation period was recorded. In 1973 the system was installed four days after laying of the second egg.

A five-hour segment of data is shown as Figure 1. The data from each channel appears as a dotted line, each segment of which represents a 32-second sampling interval for each sensor. "Random" dots between channels appear when the recorder striker-bar operates during the transition between channels. Channels are easily identified by their behavior.

Although it was not the purpose of this paper to present data gathered by the system, I include here a few values from 1972 which illustrate the ranges of the data. The core temperature high was 38 C (100.4 F). The core temperature low was 11 C (51.8 F). High and low peripheral temperatures were respectively 40 C (104.0 F) and 11 C. The greatest duration of adult absence was nine hours (recorded on approximately the 18th day of incubation). The range between extremes in temperature was 27 C (49 F).

Discussion

The telemetering egg system, described above, has been a useful device for

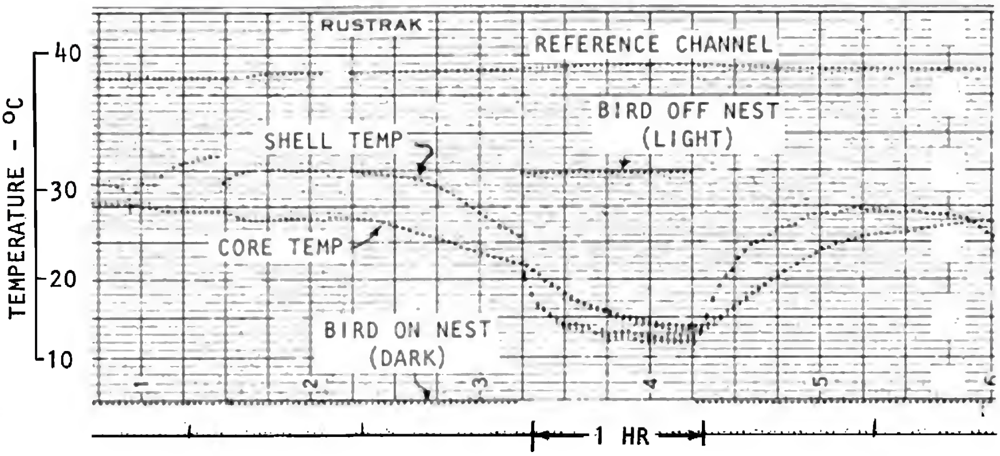


Figure 1. A five-hour data sample. The dotted lines are the recorded data from each of four channels. The upper line, which is consistently just below 40 C, is a reference channel which allows calibration of specific values on the other channels. The light channel was off until hour three (as indicated by the dotted line at the bottom of the chart) after which it jumped to full scale reading (0.6 mA) for about one hour. During the light-on time the adult is not incubating. The shell and core temperature channels are distinguished by their behavior. Shell temperature drops off more rapidly and rises more rapidly when the adult ends and begins incubation, respectively.

obtaining incubation temperatures and behavioral data with a minimum of disturbance to the adults. The system is reasonably simple to construct and operate (even without extensive electronic experience or equipment). The advantages of low maintenance, high accuracy, moderate cost, and multi-channel monitoring are all combined.

The egg circuitry can also be modified for various study objectives. Egg turning rates and additional temperature channels can be included (especially in larger eggs).

Acknowledgments

Grateful appreciation is extended to the International Foundation for Telemetering which primarily funded the development of the technique described herein.

Literature Cited

Baldwin, S. P., and S. C. Kendeigh. 1927. Attentiveness and inattentiveness in the nesting behavior of the House Wren. *Auk* 44(2):206-216.

Bent, A. C. 1937. Life Histories of North American Birds of Prey, Part 1. *U. S. Nat. Mus. Bull.* 169. Reprinted 1961. New York: Dover Publ. 409 pp.

Drent, R. H. 1967. Functional aspects of incubation in the Herring Gull (*Larus argentatus*). Pp. 1-132. *In* Baerends, G. P., and R. H. Drent (eds.) 1970. The Herring Gull and its egg. *Behaviour,* Suppl. 17. Leiden: E. F. Brill. 312 pp.

Eklund, C. R., and F. E. Charlton. 1959. Measuring the temperature of incubating penguin eggs. *Amer. Sci.* 47(1):80-86.

Holstein, V. 1942. Duehøgen, *Astur gentilis dubius* (Sparrman). Biolog. Studier over Danske Rovfugle. I (Copenhagen).

Lind, H. 1961. Studies on the behavior of the Black-tailed Godwit (*Limosa limosa* L.). *Medd. fra Naturfrednigsrådets reservatudvalg* 66:1-157.

Norton, D. W. 1972. Incubation schedules of four species of calidridine sandpipers at Barrow, Alaska. *Condor* 74(2):164-176.

Olendorff, R. R. (ed.). 1972. Special conference on captivity breeding of raptors—a report. Part B. Incubation, Natural and Artificial. *Raptor Res.* 6 (Suppl. B): B7-B35.

Romanoff, A. L., and A. J. Romanoff. 1949. *The Avian Egg.* New York: John Wiley & Sons. 918 pp.

Snelling, J. C. 1972. Artificial incubation of Sparrow Hawk eggs. *J. Wildlife Manage.* 36(4):1299-1304.

Varney, J. R., and D. H. Ellis. 1974. Telemetering egg for use in incubation and nesting studies. *J. Wildlife Manage.* 38(1):142-148.

Weeden, J. S. 1966. Diurnal rhythm of attentiveness of incubating female Tree Sparrows at a northern latitude. *Auk* 83(3):368-388.

FIELD TECHNIQUES IN A STUDY OF THE BEHAVIOR OF PEREGRINE FALCONS*

by
R. Wayne Nelson
Department of Biology
The University of Calgary
Calgary, Alberta, Canada T2N 1N4

ABSTRACT: This discussion outlines techniques and philosophies used in a behavioral study of resident coastal Peale's Peregrines on the Queen Charlotte Islands, British Columbia. The principal aim of the study was to produce a qualitative and quantitative description of Peregrine breeding behavior (February through September). Such information will be applicable to problems in falcon management, biocide contamination, and captive breeding. Naturalistic observations formed the basis of the study, i.e. no experimentation or manipulation was undertaken.

Methods included observing from a distance and from blinds. With caution, over a period of time, it is usually possible to habituate falcons to accept an observer in full view within 100 to 200 m of the nest cliff. At this distance fruitful observations are possible. Habituated falcons appear to treat the observer much like a deer, sealion, or other animal. Satisfactory blinds can be constructed of canvas and PVC, natural and beachcombed poles, wire, and staples, with camera and telescope slits, and one-way glass windows. Disturbance to the falcons has been minimal with these methods.

Data recording was largely in detailed diary form, although this method is time-consuming in the analysis phase. In the field, however, when combined with tape recorded dictation of very rapid sequences, diary notes are satisfactory. 35 mm still and 16 mm movie cameras also provide useful information by preserving fleeting behavior postures and by allowing subsequent frame-by-frame analysis. Similarly, tape recordings of calls yield useful information.

Some special equipment, techniques, and problems are described, and some results illustrated.

Introduction

Knowledge of a particular species' behavior is useful, particularly to those investigating population dynamics, ecology, movements, transplantations and reintroductions, rehabilitation, and captive breeding of birds. Most avian behavior papers deal primarily with results and describe methods only briefly. This paper: (1) outlines a recent field behavior study of Peale's Peregrine Falcons (*Falco*

*This paper was presented at the Conference on Raptor Conservation Technique in Fort Collins, Colorado, 22-24 March 1973.

peregrinus pealei), (2) describes techniques used, (3) discusses problems encountered and their solutions, and (4) shows some preliminary results of the study.

The behavior of raptors is still poorly explored. Substantive behavior studies have been conducted on the following species and others: Burrowing Owl (*Speotyto cunnicularia*) (Coulombe 1971, Thomsen 1971); Northern Goshawk (*Accipiter gentilis*) (Schnell 1958); Rough-legged Hawk (*Buteo lagopus*) (Schnell 1967, 1969); Red-tailed Hawk (*Buteo jamaicensis*) (Fitch *et al.* 1946, Grier 1971); Marsh Hawk (*Circus cyaneus*) (Hamerstrom 1969); American Kestrel (*Falco sparverius*) (Cade 1955, Willoughby and Cade 1964, Olendorff 1968, Mueller 1971); European Kestrel (*Falco tinnunculus*) (Tinbergen 1940); Hobby (*Falco subbuteo*) (Schuyl *et al.* 1936, Tinbergen 1958); Peregrine (Herbert and Herbert 1965, Nelson 1970, 1971, Fyfe 1972, Enderson *et al.* 1972), and Prairie Falcon (*Falco mexicanus*) (Fyfe 1972).

While on the study area on the Queen Charlotte Islands, British Columbia, I sought to obtain an over-all understanding of all breeding season activities of Peale's Peregrines without concentrating on any particular aspect. I have been in the field from early courtship (February) to when the last youngsters become independent of their parents (September). An M.Sc. thesis (Nelson 1970) deals with the qualitative aspects of Peregrine behavior (what the behavior patterns are); I am presently analyzing Peregrine behavior quantitatively (when, where, how often, how many).

Climate, Terrain, Travel, and Comfort

Severe limitations are placed upon equipment and observation methods by the weather and terrain. Over most of the Queen Charlotte Islands it is generally cool, wet, and windy. The coastal areas are often rather rugged with cliffs, gullys, thick brush, and downed timber. When ocean conditions are satisfactory, travel about the coastline is aided by an inflatable rubber boat and outboard motor (20 horsepower). When travelling by boat or when backpacking, the equipment is limited by weight, bulk, and delicateness. Blinds made of wood are generally out of the question. Heavy clothes and rubberized nylon rainsuits are the usual wearing apparel. Several sizes of clear plastic bags are invaluable in protecting gear from rain, yet allowing it to be at hand when needed. With the notebook inside a plastic bag one can continue notetaking through rainy periods.

Equipment for Observing

With notebooks, pens, telescope, and binoculars, basic observing and recording can be carried out. Rather large hard-backed sewn-bound notebooks of lined paper are durable and convenient. A fast-drying water-proof ink in a Rapidograph pen (or equivalent) is satisfactory, especially when writing in humid weather and/or poor light. Wide-angle "night-viewing" binoculars are helpful for observations in poor light. A 20-40X binocular telescope allows comfortable observation of birds for hours, whereas prolonged watching with a single eyepiece telescope leads to severe eye-strain.

Blinds can be constructed of PVC (polyvinyl chloride, an extremely strong fabric), canvas, natural or beachcombed poles and boards, and available trees and logs, all wired and staple-gunned together to provide a sturdy enclosure. (See Shea 1972 for comments on possible harmful effects of PVC vapors.) Use of hammer and nails is to be avoided, whenever possible, because the noise disturbs the birds. Blinds may be constructed at some distant point and slowly moved to a position overlooking an eyrie. Other blinds, because of the landscape, might be constructed at considerable distances from, but in view of, the incubating falcons. Care must be taken to carry out all activities smoothly and quietly.

If there is need to flush a bird from a nest during blind installation, it should be forewarned, if possible, by talking, breaking sticks, and hand clapping, and sometimes by imitating the Cacking protest of the falcons. This usually brings a bird slowly off its eggs or nestlings. When it moves toward the front of the ledge to investigate, it can be flushed without endangering the nest contents. Birds should be kept off their nests for the minimum time. Once a blind is in place, a retreat should be beaten so that the birds will be aware of one's departure and can resume their normal activities.

Camera and telescope slits, in some instances protected by projecting darkened tin cans, and one-way windows (10 x 20 cm; 4 x 8 in) provide adequate viewing. Windows can be supported in light wooden frames sewn into the fabric of the wall. The hole in the fabric can be covered, and the window tilted back into the blind for cleaning without disturbing the birds. A small shelf permits cameras and scope to be lashed (with insulated wire) into position and trained on the eyrie—even in the dark. A rather dark fabric is preferred when using one-way glass; the inside of the blind must be approximately twice as dark as the outside for the glass to function as a mirror when seen from outside.

It is important to enter blinds without being observed by the birds. If birds are disturbed, their natural incubation, feeding, and other rhythms probably will be disrupted for much of the remainder of the day. I located most of my blinds so that I could enter them through brush or trees. At some sites I was forced either to enter the blind by dark (sometimes even that did not work!) or by crawling through a low (60 cm; 2 ft high) canvas corridor supported by sticks and wire. Because of topography, cover, and visibility, most of my blinds have been placed at distances of 30 to 100 m (100 ft to 100 yds) from the eyries. Unfortunately, many pairs of falcons use several different ledges from year to year; very seldom is it possible to build blinds overlooking ledges at the end of one season in anticipation of the next.

During observations of flying birds from my exposed coastal positions, tiny clear plastic lean-to shelters have provided some protection from the elements, while allowing near-maximal visibility of the surrounding area.

Cameras are important for preserving postures and fleeting behavioral sequences. For still pictures I use 35 mm cameras with lenses in the 400 mm to 600 mm range and moderately high-speed color-slide films. Super-8, regular 8, and 16 mm movies permit frame-by-frame analysis. 150 or 200 mm lenses affixed to a 16 mm camera mounted on a shoulder stock allow filming of flight actions not possible with a camera mounted on a tripod. Fairly high-speed black-and-white film (ASA 250, with filters when needed) permits rapid shutter speeds and minimal blurring of images when swift action is filmed; filming is also possible in poor light. When the camera is mounted on a tripod (or otherwise immobilized) and aimed at a specific location, an electric motor for advancing the film is useful; it can be triggered with a switch at a distance and allows longer sequences to be shot than with a spring-driven camera.

Had they been available, time-lapse motion picture cameras, videotape cameras (both with long telephoto lenses), and multichannel event recorders could have provided much useful data for this study.

Tape recorders can be used to record bird vocalizations and descriptive dictation of very rapid behavioral sequences for later transcription onto paper. A sensitive directional microphone and a parabolic reflector are useful for taping vocalizations of distant birds. Some cassette recorders are adequate, though larger portable reel-to-reel types are preferred for most sound spectrograph analyses.

Philosophy for Observing

At the start of a study a student of behavior should have a clear-cut idea of what he or she wishes to learn, as well as some understanding of the analytical procedures to be used later and the form in which the results might appear. Analysis of hard-earned and valuable raw information can be frustrating unless plans are made in advance of data collection.

One's approach is also important; it will determine not only how, but also what types of data are gathered. For example, by setting out to obtain a detailed description of Peregrine behavior, I had to *see* and *record* the full variety of activities carried out by the falcons and do this at as many sites as possible in order to detect variations between individuals and eyrie locations. Specifically, my approach involved naturalistic observations—no experimentation or manipulation. This included the following: (1) detailed objective observation, (2) accurate recording, (3) non-participant observing (the observer must not influence the animals being watched), and (4) grouping and/or classifying behavioral events (Agnew and Pyke, 1969).

At times such approach necessitated observing the whole eyrie area from a distance; this imposed strict limitations on the detail of recorded data. On the other hand, when birds are "tied" to a nest ledge, observations from blinds can be very detailed, though of a different type than those data obtained when watching a large area from a distance. If the major interest is the time budget (the use of time) of the birds, all observations might be made from a distance, over a large area; in such case, rather broad categories of behavior might be required. If a person is primarily interested in rather specific subjects (e.g., the roles of the sexes in incubation), the approach, the methods of data-gathering, and the type of data obtained will be different. Regardless of the approach, the student of animal behavior must be patient. Patience over the long term is required because certain behavior patterns might be observed only once or twice in a field season. Patience over the short term is required because a lot of time is spent waiting just for something to happen, particularly early in the courtship phase.

Observing from a Distance

To observe territorial defense, courtship, hunting, caching of food, development of flying skills in fledglings, etc., it is difficult, if not impossible, to observe from blinds. The birds simply cover too much area of the sky too rapidly. Thus I have done much observing from exposed positions, usually 150-200 m (sometimes farther) away from the base of the nest cliff, and usually off to one side. This distance appears to be a reasonable compromise between rapid and slow habituation of the birds (see below), as well as observing from too near or too far. There is a difference between individual Peregrines in their reactions at this distance, and I assume the same will prove true for other species.

Several things were important in the process of habituating falcons to my presence near their eyries.

(1) Predictability of my actions seemed to aid in the birds' acceptance of me. My travels to and from observation positions followed fairly well-defined routes, rather like the travels of deer on their trails. My clothing and speed of travel were also consistent from day to day. If observations from exposed positions began early in the courtship phase, I was apparently tolerated more readily by the birds; they seemed to accept me as a usual part of the habitat.

(2) If I had to begin observations from a new coastal position later in the season, my appearance in the area was sometimes protested. To avoid this, I very gradually worked toward the prospective observation position; I looked at flowers, pebbles, and seashells, paying no attention (outwardly) to the falcons in the area. Sometimes the birds simply would not tolerate me at a certain position; I retreated to a more distant location as soon as this became obvious. By gradually working closer over a number of days, a "trust" was built up, and the key observation position was attained without (apparently) bothering the birds.

(3) While in full view of the birds, I attempted to move slowly and deliberately; this appears to be quite important, for sometimes a single accidental sudden movement—by a human being or a deer—triggers a low intensity cacking protest from a nearby falcon.

(4) By conditioning *oneself* to be extra-sensitive to the "feelings" of the falcons, one develops what amounts to almost a sixth sense that evaluates the disturbance one is causing to the birds. By treating each protest by the bird, as being a declaration of failure of the observer to condition adequately the bird and himself, one very quickly begins to think first of the bird and its peace of mind, and only secondarily of himself and his search for information; this is as it should be. In the courtship phase and after the nestlings have flown, vocal protests are seldom directed toward human intruders. One has to rely on other indicators of fear or annoyance, such as a bird's perching posture, the lay of its

feathers, the manner of its flight, and its silent avoidance of the area where the observer is sitting.

(5) I have avoided, as far as possible, causing disturbance to the birds for purposes such as banding. I feel that that interferes with habituating them to accept me near their nests. Such disturbances may indirectly limit not only the distance to which I can approach the birds, but also type of information I might obtain from the exposed observation positions.

(6) One serious problem is that of desertion of a nest. By visiting the top of a cliff on which a pair of birds appeared about to nest, I have caused the birds to shift as much as half a mile to another cliff to lay their eggs. As pointed out by Herbert and Herbert (1965:81), if the birds are disturbed part way through laying of the clutch, they sometimes will desert the ledge and finish laying the clutch at another ledge.

(7) There is considerable variation in the attitudes of the birds towards the observer; this must be taken into consideration. The observer must also be careful to habituate both birds of a pair to his presence.

The success of the habituation process should be evaluated continually by using the birds' reactions. When birds will voluntarily and regularly carry out certain activities within 100-200 m of the observer (e.g., Food-transferring, Copulating, Ledge Displaying, feeding nestlings, perching, and dozing), then they are probably adequately conditioned. By also observing them from much greater distances, one can get an impression of whether or not the data obtained from 100-200 m are in any way abnormal.

When watching, one soon realizes that there is some pattern to the life of birds. Usually there is a series of favored perches, perhaps used in relation to the direction of the sun or wind. There is a roughly predictable series of events during the day, particularly near dawn and dusk, perhaps with more variability to the pattern during the remainder of the day. Certain actions will be recognized as forerunners of other actions. These patterns can be used to advantage; they warn an observer to be ready to record or to photograph certain other actions. Other activities will tell the observer that he can take a moment to relax.

The regularity of certain actions allows one to locate the birds more readily at the beginning of an observation period or after a bird suddenly disappears. Aside from learning the usual actions of the birds being observed, it is also helpful to scan the area at intervals to detect other raptors, prey, or changes in weather. It is also helpful to practice estimating distances over known terrain, so that it becomes second nature to recognize how far away and how high a bird is when it does something of interest.

Observing from Blinds

While blinds allow intensive observations at nests, they also can be versatile enough to permit following of adults when they come and go. It may be possible to locate perches in this way, thereby allowing records of not only the activities at the nest, but other behavior as well. For this reason, several windows should be provided in each blind.

At one site I used a portable blind consisting of a single piece of light-weight green canvas measuring about 2 x 3 m (6 x 9 ft), provided with a single 15 cm slit in the middle, one-third of the way along its length. The pair of falcons was courting at a new ledge on the side of a narrow gorge. Without a blind of some sort I would have been unable to observe courtship activities at or near the ledge; yet, building a blind only 30 m away would almost certainly have caused them to desert the ledge. The ledge was not visible from any greater distance. The portable blind was used on several days in the following manner: I crawled (unseen) to near the edge of the gorge on the side opposite the ledge; by covering myself with the canvas and then very slowly rising to a kneeling position, I peered through the slit in the canvas, down and across the gorge onto the ledge; and I trained a camera (on a tripod) on the ledge from within the canvas. The birds hardly glanced at the apparition on the opposite rim of the gorge. I can conclude only that they must have considered it to be some kind of animated bush. In any event, the technique permitted detailed observations of Ledge Displays which, until that point, had been only poorly observed from great distances. The birds produced a clutch at that ledge, and later I was able to construct a blind and move it into position.

I suspect that there is much to be learned in the way of camouflage and disguises that will permit close approach to certain raptors. When I receive a protest at 100 m from a Prairie Falcon eyrie, yet a group of cattle wander about 5 m below the eyrie and apparently cause no upset to the falcons, I seriously consider the possibility of using the Indian technique of draping oneself with a buffalo (or cow) hide and attempting to move closer.

Recording Information

The method of recording information will depend to a considerable degree on the purposes of the study, the manner in which the data are to be used, and personal preferences. Both from blinds and from exposed observation positions, it is immensely helpful to have a number of photographs taken of the view, the eyrie, landmarks, and surrounding features, to refresh one's memory and to aid in the analysis of the written information later.

Because many behavior patterns occurred so rapidly and so seldom, I attempted to record everything that I considered to be of any possible significance. I recorded events as they occurred, by hand, almost in a diary form. I abbreviated the names of behavior patterns (once they were adequately described), the species of birds, landmarks in the area, etc., for the sake of brevity. When some activities occurred too rapidly to be written down, they were dictated into a tape recorder and transcribed later, usually within a few days.

From such copious field notes it *is* possible (but not necessarily easy) to extract a great deal of useful information, both qualitative and quantitative. By using this method I have discovered in the notes some stereotyped behavior patterns that I was not aware of in the field simply because they occurred so very seldom—and so swiftly. When read several hours or several days apart in the notes (instead of several weeks apart in the field), certain patterns became specific displays. Further, the diary method, if adequate data are recorded, allows one to answer a number of entirely new questions posed years after the data are gathered.

Prepared data sheets for recording behavior patterns and other aspects of the birds' lives are useful at a later stage once one knows what the various units to be recorded are and has decided which to record.

In the notes I attempted to describe exactly when and where the birds went, what they did, how long it took, and just how they did it. By doing so I was later able to plot on photographs and maps the routes used and the areas covered. Similarly, it was possible to plot their perches, food cache sites, and ledges. A perched bird can be described in the notes as being exposed to sun, wind, or rain, or in view of its mate. The direction the bird's body faces can be easily noted, as can the direction in which the bird is looking. When watching a bird on a ledge, I mentally superimposed the image of a clock face down upon the bird (with 6 o'clock towards me), and was able to read off the position of the bird on the scrape—for example, "incubating at low position, facing 10:30, looking often towards 9:00." This sort of data, coupled with a sketch or photograph taken from the observation position and knowledge of the direction that the ledge or cliff faces, can provide useful information on the preferred incubation positions relative to the exposure of the ledge, cliff, and other factors.

I regularly inserted into the notes brief synopses of the weather—wind speed and direction, cloud cover fraction, sunshine, precipitation, and condition of the ocean. Changes were noted as they occurred. These synopses allowed me to relate behavior to local weather. Weather influences the lives of the birds considerably.

The time of day was frequently stated at some obvious place in the notes (e.g. in the left margin), especially at the start, during, and at the end of behavior sequences. Often even the seconds were recorded.

The description of vocalizations is always difficult. Initially, I attempt to describe at some length, in writing, a new vocalization or a variant of a recognized one. This consists of constructing a word that attempts to duplicate the sounds. Additional words describe variations of pitch, syllabication, accent, and loudness. Of equal importance is a detailed description of the circumstances in which the call was given. Without all of these aspects of vocalizations we may never understand what the various calls actually mean. For example, Richard Fyfe and I are experiencing difficulty in sorting out and recognizing the number of variants in the "Eechip-complex" of calls (as we term them) given by the Peregrine, particularly since these calls are given in widely varied circumstances. We may have to resort to sound spectrograph analysis in order to *see* the differences.

Tape recordings of vocalizations, augmented by written or dictated notes about the sex and age of the bird and the circumstances in which the call was given are very valuable. Such recordings and descriptions of the same call taken at intervals as the season progresses may show gradual changes through the season—changes not recognizable in the field. One obvious change is in the begging calls of the nestlings.

The use of a tape recorder as a convenient means of note-taking has definite drawbacks. Once something is written, one can quickly check it for accuracy and correct it, if necessary; with tape recorded notes this is difficult. Furthermore, it is easy to omit important items when talking into the recorder, whereas omissions can be detected and filled in if notes are written. The worse problem with tape-recorded notes is transcribing them. One hour of tape equals two to three hours of transcribing. With a secretary to do the initial transcription, much time and energy might be saved, though almost certainly the tape will have to be compared with the written account afterwards to fill in omitted material (if it still can be remembered). If a sequence is taped, the time and date should be placed onto the tape also; a large space must be left in the notes for the transcription, with a brief note indicating what occurred and the fact that it is on tape. This facilitates transcribing the tape into the proper section of the overall notes.

In short, for important sequences where the observer must keep very close watch on rapidly-occurring activities, tape-recorded notes are invaluable; for routine note-taking, pen and paper suffice.

The time and subject of still and motion pictures should also be written down in some convenient shorthand so that later they may be labelled accurately. And photographs should be taken not only to illustrate unusual and interesting aspects of the birds' lives, but also to depict the usual and mundane aspects, in order to present a reasonably well-rounded description. I find, for example, that I have no photographs of an adult falcon muting or rousing!

Partly because of weather conditions and partly because of the ease with which birds are lost to view when flying at some distance, I have avoided tracing flight paths directly onto maps, aerial photos, or plastic overlays while in the field. I simply describe the bird's path in writing and draw it onto maps or photos later.

Sketches of many things can also add immensely to the usefulness of one's notes: positions of eggs, postures or flight patterns of the birds, the outline of a ledge, perch or cliff.

The timing of observation periods bears some planning. By making observations at roughly the same time of the day and for the same duration of time, the data will more readily provide comparisons between days with differing weather or at different stages in the season. While regularity of observing has definite advantages, watches scattered through the day will provide suggestions as to daily cycles of activities. For certain aspects of behavior, observation periods of ½, 3, 5 hours, etc., might suffice. For other types of activities, e.g. the number of feedings per day or the number of incubation shifts per day, dawn to dusk vigils are necessary; however, with daylengths of 16 hours or more, it is almost impossible for one person to make meaningful observations of this sort for two days in a row.

Thus I have found it useful to designate certain one-hour periods as "intensive observation periods" in which all major and minor activities are recorded with no distractions (e.g. for photography). Such observations are most productive when interspersed within regular observation periods when only more major activities are recorded.

Analysis

The challenges of analysis of data collected as described above come in asking the right questions and then seeking the answers in the amassed data. I find this more exciting and useful (though more time consuming, perhaps) than asking all questions before I go into the field and seeking only data to support or refute preconceived ideas. The relative merit of these two research philosophies is a moot issue. The first step in analysis of the types of data I collected is devising a means of cataloguing and categorizing the facts. In the field I write only on the right-hand pages of my notebooks. I leave the left-hand pages for short remarks on photographs or tape recordings, for sketches, and, most important, for a form of succinct indexing (in pencil) of what is on the right-hand pages. Depending on one's preferences and how the data are to be handled, a wide variety of further means of indexing, summarizing, and extracting can be worked out.

Innumerable forms of data presentation are possible. Drawings and photographs are useful ways of supplementing qualitative description of behavior patterns. Data plotted onto maps or presented in graphs or tables add to quantitative descriptions.

Figure 1 illustrates how a photograph or a drawing (in this case, traced from four overlapping photographs) might be used to show the positions of perches used near the eyrie. Similar illustrations might show how perch use varies during the courtship, incubation, nestling, and fledgling phases. Small histograms or pie-charts might show the preferences for particular perches. (All figures are reproduced from Nelson 1970.)

From a description in the field notes, Figure 2 plots a flight path onto a drawing of the cliff-front. With a series of plastic overlays, many such flights can be superimposed onto one drawing, photograph, or map, to illustrate what areas are used for various purposes.

Each drawing in Figure 3 was traced from projected images on 35 mm slides. Despite the fact that the images of the birds on the slides were very small (due to an inadequate telephoto lens), useful pictorial material *was* obtained to show the changes in feeding and begging behavior at intervals through the whole nestling phase. 35 mm photographs are also useful in stopping action in a very rapid sequence which might be only a blur to the human eye. Figure 4 is a cropped photograph of a fleeting event that usually leaves the mind and eye puzzling as to what really happened. In raptors, there are many such activities which lend themselves to photographic analysis.

Figure 1. Drawing of nest cliff at Area B indicating important ledges and trees used by the falcons in the 1969 season. (a) The 1968 eyrie location. (b) The "new ledge." (c) The "grass strip" ledge at which the falcons raised their young in 1969. (d) Favored site for Food-transfers on the conspicuous branches of the tall tree in front of the cliff. (e) Usual food cache area in grassy area on cliff (partly hidden behind tree in this view). (p) Favored perches. (wg) Location of the West Gorge.

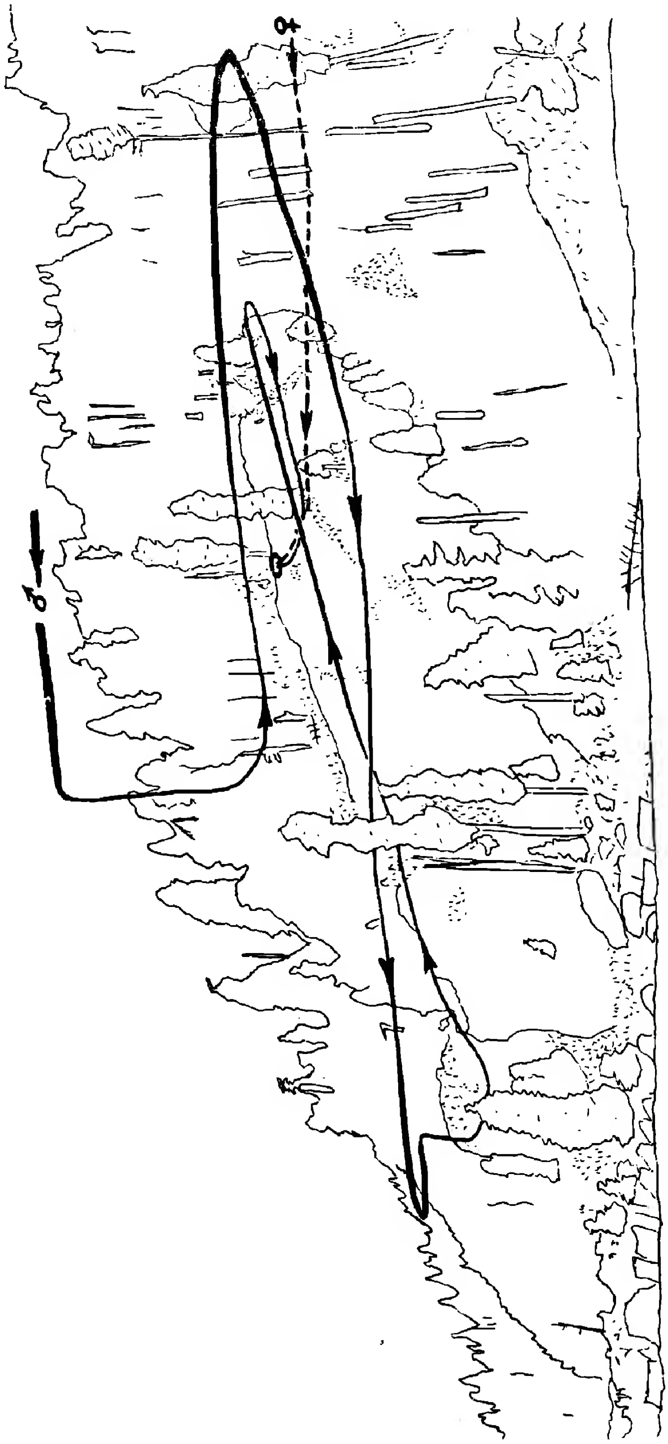


Figure 2. Path taken by adult male Peregrine Falcon in the Power-diving, Cliff-racing, and Male-ledge Displays; 13:29 hrs, 12 March 1969. Thinner line indicates more rapid flight. The two vertical portions indicate Power-diving; the thin horizontal portions in front of the cliff indicate Cliff-racing. Male-ledge Displays occurred as soon as he landed. 15 seconds later the female (broken line) sailed in from the east (right) and joined him at the preferred ledge.

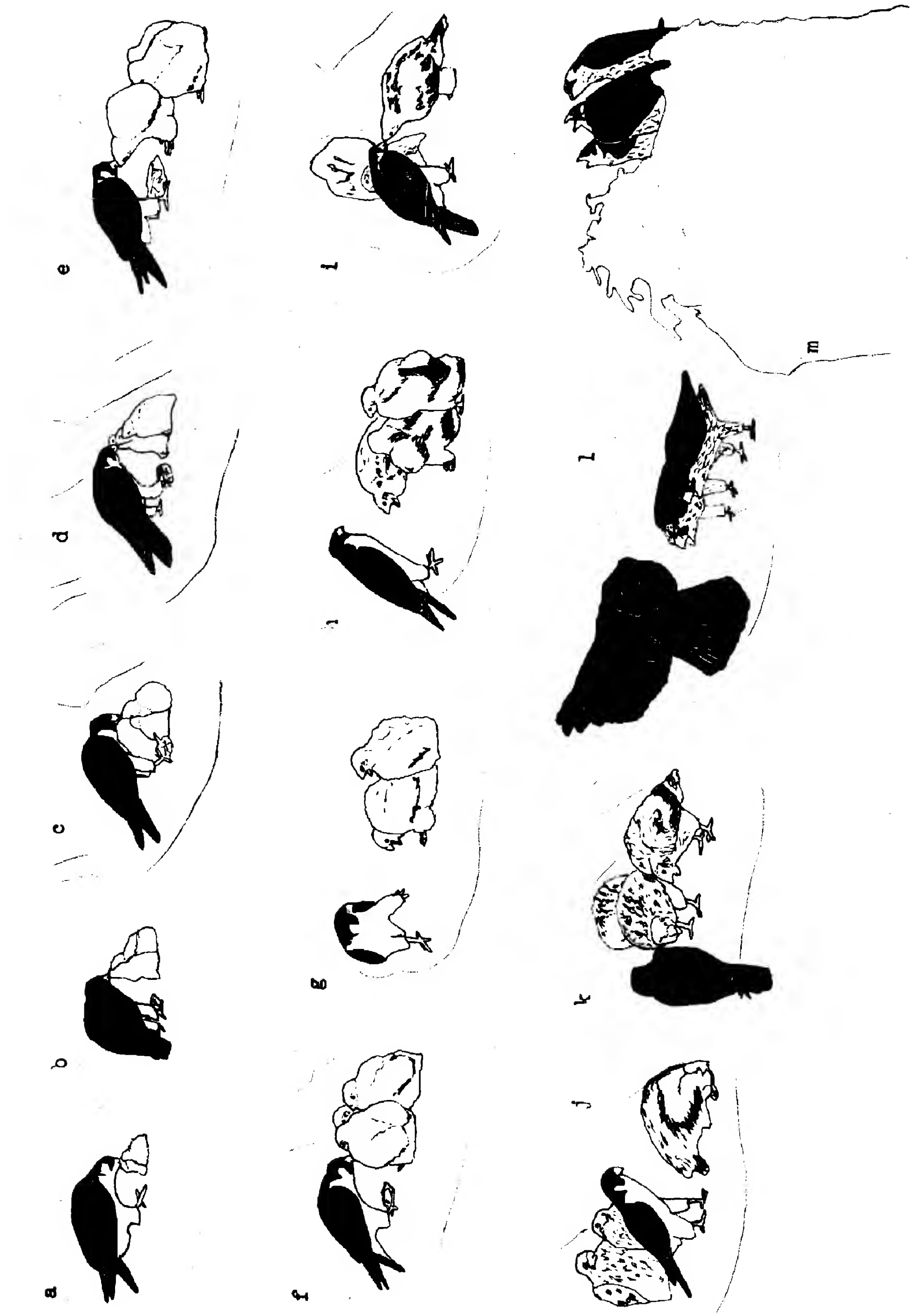


Figure 3. Development of feeding and begging behaviour in nestling Peregrine Falcons.
(a) Age 1 day. (b) Age 8 days. (c) Age 10 days. (d) Age 14 days. (e) Age 22 days.
(f) Age 22 days. (g) Age 23 days. (h) Age 29 days. (i) Age 29 days.
(j) Age 31 days. (k) Age 31 days. (l) Age 36 days. (m) Age 50 days; 7th day of flying.

The nestlings orient nearly vertically until about two and one-half weeks of age, but even then they reach towards the adult's beak rather than towards the food held in the adult's feet.

Until they are two weeks old, the nestlings remain mostly in the vicinity of the scrape.

At 22 days of age (e), the nestlings, though quite capable of doing so, do not always move to the adult as soon as it arrives on the ledge with food. The adult usually takes the food to the nearest nestling and proceeds to feed it, but the other nestlings may call from a distance. Usually, after some time, they will move to the adult to receive some food, but their feeding is usually seen to be not highly motivated in such instances (e and f).

By 23 days of age (g), they call strongly at the adult if it arrives without food or leaves before all are satiated.

By 29 days (h) they beg vigorously at an adult whether it carries food or not. From this time on, more and more frequently they seize the food from the parent (j), but they will sometimes still accept the food as the parent presents it to them individually (i).

In (j) one nestling which has ripped the food from the adult may be seen mantling over the food and facing away from the adult and other nestlings. In such situations the adult usually is harassed to such an extent by the unfed nestlings that it leaves the ledge.

The Horizontal Posture (h) is usual by 36 days of age (1). If an adult is flying over, however, the young falcons face toward the adult and do not show the Horizontal Posture. In (m) one of the fledglings can be seen to be turning its head on its side while looking upwards at an adult flying over the fledglings' stump-top resting location.

(Traced from 35 mm colour transparencies taken at Area A, 1968.)

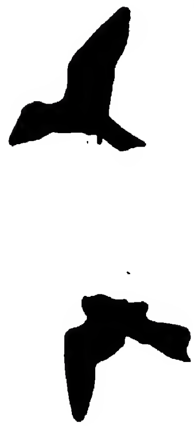


Figure 4. Two fledgling males "playing tag." The "attacker" has pulled out of its swoop and is lowering its feet as it passes over its brother. The "attacked" fledgling has rolled completely over and is presenting its feet towards the "attacker." From a 35 mm color transparency.

Frame-by-frame analysis of motion picture sequences can be presented by means of photographs or tracings made from the film. Figure 5 is an example: a Bald Eagle's complete roll-over in full flight is seen in its various stages–the roll-over occurring in about one-half second, the over-all sequence lasting almost one and one-half seconds. With a projector that will stop on individual frames, each image can be traced from the screen at almost any size imaginable. By tracing onto acetate plastic, it is possible to arrange a number of tracings on a page, and then to photocopy the whole set. One can also produce a single final tracing, on paper, with the assistance of a light-table. The result is often a pleasing and instructive illustration, demonstrating something that the eye normally is incapable of registering.

In addition to cataloguing one's notes, a detailed cataloguing system for photographs, movie sequences, and tape recordings is highly desirable. This permits these data to be extracted quickly for analysis. At a minimum, each picture or sequence should be labelled with a date, time, location, and summary of subject matter.

Numerical data concerning how often or how many events occurred can be treated strictly as numbers in tables, with appropriate statistical tests when required. Such data may also be presented in graphical form. Figure 6 demonstrates a means of showing the observed occurrence of selected behavior patterns through time, in this instance through the season rather than the day.

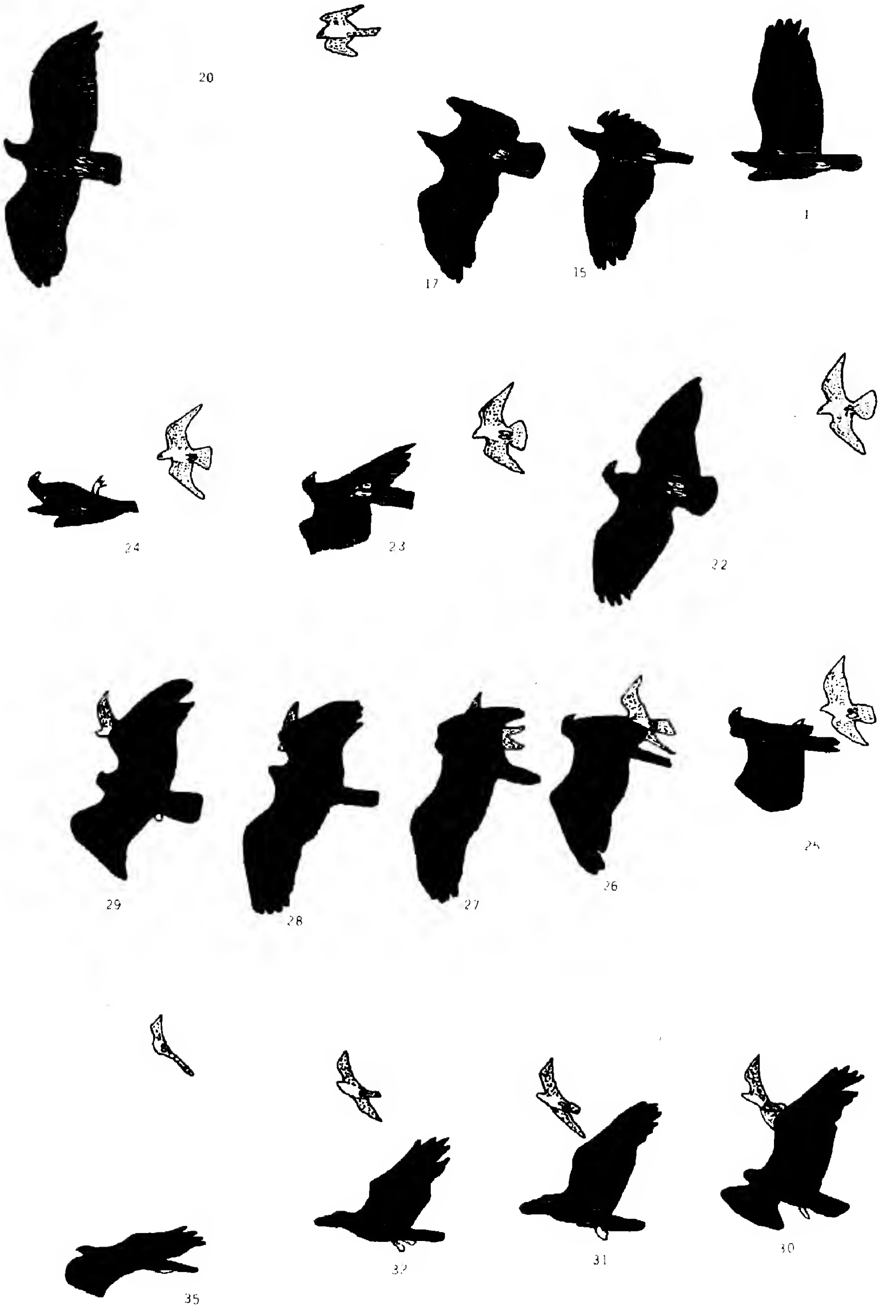
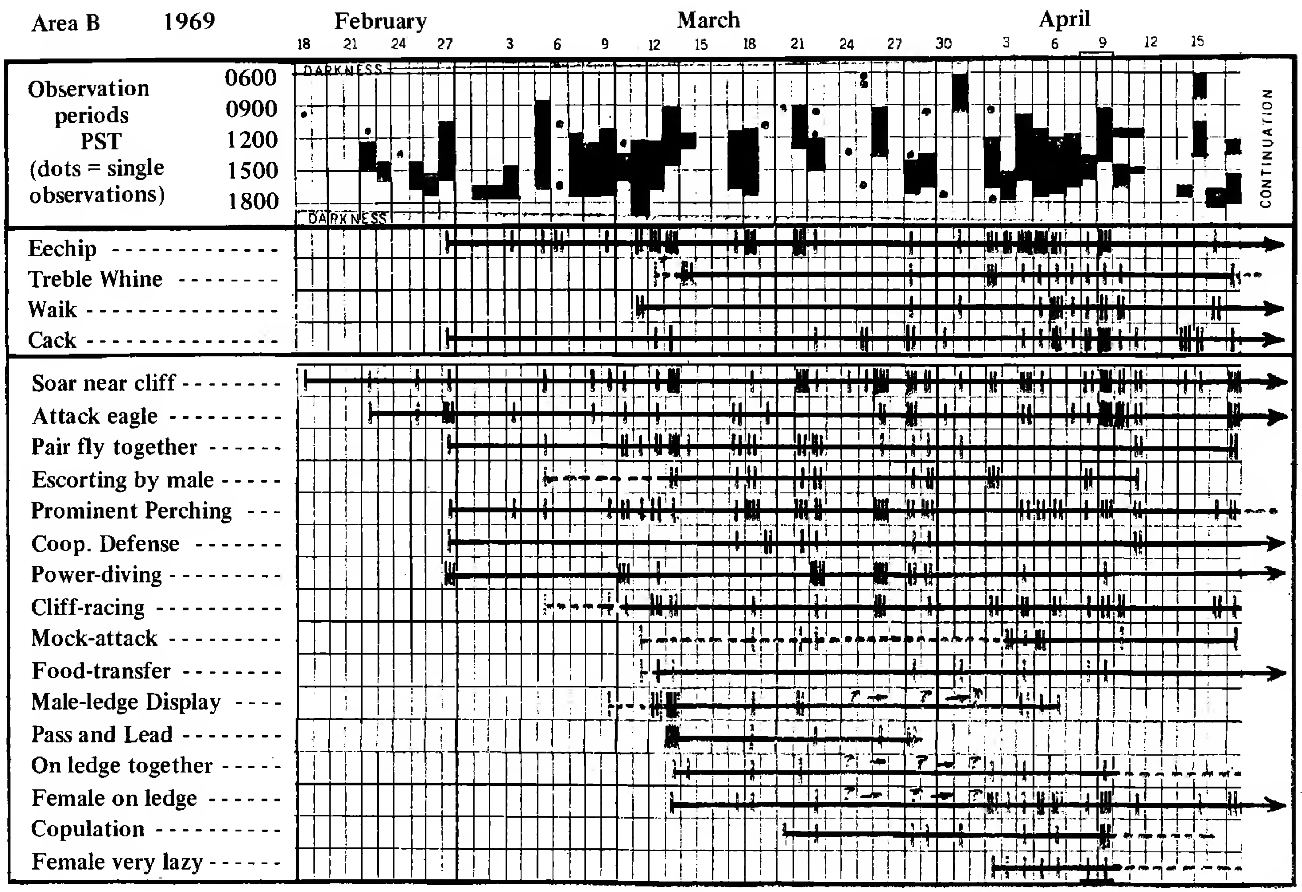


Figure 5. An example of the use of frame-by-frame analysis. A falcon attack upon an immature Bald Eagle. Read right-to-left, top-to-bottom. Traced from 16 mm motion picture film exposed at 24 frames per second. Numbers indicate frames in the sequence.

Figure 6. Important preincubation behaviour patterns. Solid lines = observed occurrences; dotted lines = uncertain observations. ? = pair relocated; ledge actions not observable. First egg laid April 8-9.



Acknowledgments

Many agencies and individuals have lent support to the study of which this work is a part. The British Columbia Fish and Wildlife Branch, the Canadian Wildlife Service (Toxic Chemicals Section), and the Ministry of Transport (Marine Division, Prince Rupert, B.C.) have assisted in a great many ways. Financial support has come from the Department of Biology of the University of Calgary, the Canadian Wildlife Service, the National Research Council of Canada (grants to M. T. Myres), and the Frank M. Chapman Memorial Fund of the American Museum of Natural History.

Bruce Jones assisted with some equipment, Colin Brookes assisted in the field for a month, the Prince Rupert Fishermen's Cooperative Association helped in many ways, and Richard Fyfe has provided comments and encouragement throughout. Dr. M. T. Myres has supervised the study. My wife, Alora, has assisted in all phases of the project.

References Cited

Agnew, N. McK., and S. W. Pyke. 1969. *The Science Game: an Introduction to Research in the Behavioral Sciences.* Englewood Cliffs, N.J.: Prentice-Hall. 188 pp.

Cade, T. J. 1955. Experiments on winter territoriality of the American Kestrel, *Falco sparverius. Wilson Bull.* 67(1):5-17.

Coulombe, H. N. 1971. Behavior and population ecology of the Burrowing Owl, *Speotyto cunicularia,* in the Imperial Valley of California. *Condor* 73(2): 162-176.

Enderson, J. H., S. A. Temple, and L. G. Swartz. 1972. Time-lapse photographic records of nesting Peregrine Falcons. *Living Bird* 11:113-128.

Fitch, H. S., F. Swenson, and D. F. Tillotson. 1946. Behavior and food habits of the Red-tailed Hawk. *Condor* 48:205-237.

Fyfe, R. 1972. Breeding behavior of captive and wild Prairie and Peregrine Falcons. *Raptor Res.* 6(Suppl. C):C43-C52.

Grier, J. W. 1971. Pre-attack posture of the Red-tailed Hawk. *Wilson Bull.* 83 (2):115-123.

Hamerstrom, F. 1969. A Harrier population study. In: J. J. Hickey (Ed.). *Peregrine Falcon Populations: Their Biology and Decline.* Madison: University of Wisconsin Press. pp. 367-383.

Herbert, R. A., and K. G. S. Herbert. 1965. Behavior of Peregrine Falcons in the New York City region. *Auk* 82(1):62-94.

Mueller, H. C. 1971. Displays and vocalizations of the Sparrow Hawk. *Wilson Bull.* 83(3):249-254.

Nelson, R. W. 1970. Some aspects of the breeding behaviour of Peregrine Falcons on Langara Island, B.C. M.Sc. thesis. The University of Calgary, Calgary, Alberta, Canada. 306 pp.

Nelson, R. W. 1971. Captive breeding of Peregrines: suggestions from their behaviour in the wild. *Raptor Res. News* 5(2):54-82.

Olendorff, R. R. 1968. A contribution to the breeding behavior of the American Kestrel in captivity. *Raptor Res. News* 2(4):77-92.

Schnell, G. D. 1967. Environmental influence on the incidence of flight in the Rough-legged Hawk. *Auk* 84(2):173-182.

Schnell, G. D. 1969. Communal roosts of wintering Rough-legged Hawks (*Buteo lagopus*). *Auk* 86(4):682-690.

Schnell, J. H. 1958. Nesting behavior and food habits of Goshawks in the Sierra Nevada of California. *Condor* 60:377-403.

Shea, K. P. 1972. Plastics in the air. *Environment* 14(9):10-11.

Schuyl, G., L. Tinbergen, and N. Tinbergen. 1936. Ethologische Beobachtungen am Baumfalken (*Falco s. subbuteo* L.). *J. Ornithol.* 84:387-434.

Thomsen, L. 1971. Behavior and ecology of Burrowing Owls on the Oakland Municipal Airport. *Condor* 73(2):177-192.

Tinbergen, L. 1940. Beobachtungen über die Arbeitsteilung des Turmfalken (*Falco tinnunculus* L.) während der Fortpflanzungszeit. *Ardea* 29:63-98.

Tinbergen, N. 1958. *Curious Naturalists.* London: Country Life.

Willoughby, E. J., and T. J. Cade. 1964. Breeding behavior of the American Kestrel (Sparrow Hawk). *Living Bird* 3:75-96.

ADVANTAGES AND DISADVANTAGES OF THE USE OF ROTOR-WINGED AIRCRAFT IN RAPTOR SURVEYS*

by
Clayton M. White
and
Steve K. Sherrod
Department of Zoology
Brigham Young University
Provo, Utah 84601

ABSTRACT. We believe that the advantages of aerial survey with helicopters far outweigh the disadvantages. Disturbance may be less than that caused by entering on foot. Statistical validity is greatly increased as is understanding of the *gestalt* of the population.

Although other raptors may react in a different manner to helicopter observations, our impressions are that little damage is done by aerial vehicles used in the manner we have described for collecting data from the raptor species we have mentioned.

Additionally one should be aware that although the cost, on a per hour basis, for helicopters may be considered expensive, it may prove no more expensive than the cost of outfitting and supporting a field party when the differential of time and efficiency are compared.

Introduction

Fixed-winged aircraft and rotary-winged aircraft (helicopters) are available today for use in censusing raptor populations. Indeed the latter type has been used rather extensively with the opening up of northern regions in the course of mineral and oil explorations. Along with their use, however, has come considerable criticism sometimes justified, but more often than not from people who have never used one for such work. Due to our limited experience with fixed-wing aircraft, the following remarks are primarily confined to both advantages and disadvantages of using rotary-winged aircraft for observations of raptor populations. We have tried to be unbiased in our observations and to present the data as we see it. Our impressions are based upon a total of 888 hours of helicopter usage in Interior Alaska, on the North Slope, and in the Aleutian Islands from 1969 to the present, and an additional 50 hours in 1964 on the North Slope. Species that have been observed are the Bald Eagle (*Haliaeetus leucocephalus*), Golden Eagle (*Aquila chrysaëtos*), Peregrine Falcon (*Falco peregrinus*), Gyrfalcon (*Falco rusticolus*), and Rough-legged Hawk (*Buteo lagopus*).

*This paper was presented at the Conference on Raptor Conservation Techniques in Fort Collins, Colorado, 22-24, 1973.

Our experience is also limited to work with raptors nesting off cliffs or hillsides in open terrain and not with tree nesting species. We hope that such people as D. Roseneau, T. Ray, E. Boeker, L. Crowley, J. McGowan and J. Gerrard will also record their observations for they have worked with either fixed-wing aircraft or tree-nesting species. Once this is done, we might then come up with a more realistic evaluation of the impact the use of aircraft seemingly has on raptors. We recognize that different groups of birds react in different manners. For example, Snow Geese (*Chen caerulescens*) are particularly sensitive to aircraft, especially fixed-winged, and we must stress that our remarks should not be taken as applying to birds in general.

Types of Aircraft

Helicopters are preferable over fixed-wing craft in many cases. They allow more time for observing habitat therefore spotting birds. Many times it is necessary to hover in mid-air while making an accurate census count or while searching a cliff for a nest ledge.

Helicopters are primarily divided into two kinds: jet engine powered, and piston engine powered. The high frequency whine made by some of the jet engine helicopters seems to be much less disturbing to nesting raptors than the low frequency noise of the piston-powered craft.

We have experience with the following aircraft: Sikorsky S-56, Hiller 12-E4, and two Bell helicopters of unknown models, all piston driven; Aloutte II, Aloutte III, Hiller FH 1100 and Bell Ranger, all jet engine-powered. Of these we prefer Hiller FH 1100 since noise levels seem least disturbing to raptors and there is sufficient power to maneuver in and out of wind drafts around cliffs.

Flight Patterns

We have noted that certain patterns of approach are much less disturbing to raptors than others. Allowing the birds to see the vehicle approaching is of primary importance. We have found that by flying parallel to a cliff at an initial distance of about a half mile out with gradual approach toward the nest, the birds are least disturbed and, indeed often continue to feed the young or loaf on a cliff when approached in this manner. To have the helicopter on the same level as the birds or slightly below while making the observations seems to be important.

Birds which are surprised suddenly by the presence of a helicopter appearing from over the top of a cliff usually panic and exhibit frantic escape behavior. This may even result in the dumping of eggs or young from the nest by the adult (Richard Fyfe, pers. comm. and pers. observ.).

Approach from above is not nearly as alarming to the bird especially when they can see the approach from a considerable distance as in the case of tree nests or those on sea stacks.

Timing of Flights

The time that nesting census data are gathered from aerial observations are important. We believe the most deleterious times are just before egg laying, during egg laying, and during incubation depending on the species. Disturbance during these periods may cause desertion or even breakage or dumping of eggs as we have previously mentioned.

If it is imperative that counts be made during these periods, interference may be reduced to a minimum by following the flight pattern suggested above.

Once the young have hatched, if the suggested flight pattern is followed, we believe that minimal damage will result.

Weather conditions are of prime consideration. Forcing birds from the nest during inclement weather may result in chilled eggs or young. Fair-weather days are both desirable for this reason and for the fact that they allow clearer observation.

Aerial observations too late in the season can be just as harmful as observations at earlier critical periods. The presence of helicopters too close to a nest may force young birds into premature fledging. However, young birds almost ready to fledge which have been surveyed several times previously at younger stages show little fear of the helicopter. In the same fashion Mr. James Brooks, Commissioner of the Alaska Department of Fish and Game, has mentioned to us that young mountain goats and Dall sheep are forced off cliffs, especially by photographers in helicopters anxious to obtain the ideal picture.

Other Suggestions

Experienced pilots are indispensable. After they have flown surveys for a while, they obtain an intuitive feeling as to "how" to fly for raptor work. Experienced pilots are most essential where weather is particularly turbulent. He must be able to maneuver away from the adult birds and should be familiar with wind drafts. He should be somewhat familiar with the behavior of the species of concern. Hopefully, he would be exposed to the material presented in this paper before attempting a raptor census of any kind.

In addition to the pilot, there should be two observers: one that is observing to the front and side and one that is observing to the side and back. Some falcons, particularly, leave their perch after the aircraft has passed.

From our previous experience, we realize that certain unexpected reactions may occur. We have had Peregrines, and Bald Eagles, and even on one occasion a Gyrfalcon, try to attack a helicopter. Once birds obtain position directly above the aircraft, it is possible for them to be sucked into the rotor, killing both the bird and the observer. Attacks, however, appear to be more frequent against fixed-winged aircraft especially by Gyrfalcons (D. Roseneau, pers. comm.).

Birds that are inadvertently flushed into the wind may wing back into the helicopter. Approach from upwind is advisable.

Advantages

The advantages afforded by aerial observation from helicopters are numerous and of significant importance. This is especially true in the management aspects of raptors.

The ability to cover large areas of habitat is particularly of interest. Whether conducting population census or obtaining nesting data, one is able to increase the sample size and therefore, the statistical validity, of such information. Surveillance on foot or by boat in such instances may prove next to impossible and certainly much less thorough. During the non-breeding season when birds are not "attached to nests," it is extremely difficult to make density observations. The over-all *gestalt* of some populations such as eagles on Amchitka, becomes much clearer through aerial surveillance. We now have an excellent idea of the age class structure of that population. One may easily observe old as well as new nests.

Of primary importance is the opportunity to obtain large blocks of data within a short period. For population census data, this may allow counting of an entire population at one time and therefore, much more accurate results; and we can better evaluate, for example, the effects of weather on nestlings. Collection of such data by other means is impossible. For production data obtained from nest counts, aerial observations are essential. They allow synchronous counts during one part of the nesting period and repetition of such counts throughout the season. A series of complete counts for Amchitka Bald Eagle nesting data in 1972 exemplifies the differences in data that can be collected according to how far along the nesting season is when such data are collected. The observer who collects data by one observation at each nest in a population which takes an entire summer to check is in fact collecting data from a continuously changing set of facts. By this we mean, for example, that the number of young per nest is quite different at the completion of hatching than at the period of fledging. Aerial observations over a great area in a short period of time eliminate such error.

Disadvantages

There are many disadvantages to be weighed against the advantages.

First of all is the fact that the birds are obviously disturbed during nesting season. However, in order to obtain many kinds of nesting data first hand, it is necessary to disturb the birds whether on foot or via helicopter (excepting by spotting scope in which case erroneous data may often be concluded). The time spent at a nest observing from a helicopter is usually much shorter (10 sec.-2 min.) than on foot.

Aerial observation can result in biased information in several ways. On many occasions, birds (especially Peregrine Falcons) will not flush from a cliff when approached in a jet helicopter. Such pairs of birds may be missed on initial survey. At other times birds conditioned to the approach of a helicopter may not flush even though they have flushed previously. Such pairs may be counted as having abandoned a previously occupied nest. Alternatively, Peregrines often flush from the cliff after the helicopter has passed and the falcons go in the opposite direction the helicopter is traveling.

Although the Hiller FH 1100 is an excellent aircraft because it appears not to frighten birds, the possibility of missing birds, simply because they are not flushed, is a real problem.

Young which crawl off behind grass mounds or rocks may also be missed in an aerial count. Even young eagles nesting on hillsides on Amchitka have "disappeared" only to reappear again on the next survey.

The presence of high winds greatly limits use of helicopter as updrafts and downdrafts can be extremely hazardous especially around cliffs. Lack of wind can have less severe but similar deleterious effects.

Small helicopters are limited as to loading capacity and the number of people (and size or weight of people). The distance that can be traveled is directly proportional to the number of people (and size) as well as wind speed. The weight loading capacity is determined by these values plus the quantity of gasoline that can be carried for any given helicopter.

Conclusions

At present we do not feel that the data support the allegation that helicopters are a source of reduced productivity in certain raptors at the population level. Some data are as follows.

On Amchitka Island helicopters have been used for five years to census raptors. On average, 66% of nesting attempts by Peregrines are successful in fledging young. A sample of 63 nesting attempts in 1939-1940 in New York and on the British Coast had 60% of the attempts to produce young (Hickey and Anderson, 1969). Other information is also available. Data for Bald Eagles are as enlightening. Egg production for Amchitka is 1.91 egg per nest and in Southeast Alaska and parts of British Columbia, Canada, where helicopters were not used in the studies, production was 1.97 per nest (F. Robards and J. King, mimeo. report U.S.F.W.S. for 1966; D. Hancock, pers. comm.). Percent of territories with young were about 55% in Ontario (J. Grier, pers. comm., 1971), about 64% in Saskatchewan (D. Whitfield, J. Gerrard and W. Davis, Mimeo. report, 1969), about 58% on Kodiak Alaska (Hensel and Troyer, 1964), and for Amchitka in 1972, about 60%. Helicopters were not used in the first three studies. Fledging success for active nest shows a similar conformity when comparing yearly variation. For Ontario between 0.73 and 0.89 young fledged per active nest (Grier, pers. comm.), between 0.62-0.93 for Kodiak (Hensel and Troyer, 1964), and for Amchitka 0.85 for 1972. These values are all in the same ball park for both those studies in which helicopters were not used and used.

Perhaps the best over-all helicopter, at least the one that appears to be least frightening to raptors, is the Hiller FH 1100. As we have shown (Figs. 1, 2, 3, 4), pictures have been taken from the Hiller of adult Peregrines, Golden Eagles, Gyrfalcons and Rough-legged Hawks while feeding large downy young, and the adults have not flushed even though approached to within 60 feet (18 m) at the same level as the nest.

Acknowledgments

Some of the work on which this report is based was performed under AEC

Figure 1. Adult Bald Eagle in the Aleutian Islands returning from a perch to alight in a sea stack nest containing small young. Helicopter is hovering about 80 feet (24 m) away and was in that same position when the bird left the perch to return to the nest. Helicopter bubble struts can be seen in bottom of picture. Photo taken with a standard 50 mm lens.

Figure 2. Adult female Peregrine Falcon feeding week old young in an eyrie on the North Slope of Alaska. Photo taken from a helicopter that hovered about 45 feet (14 m) away throughout the entire feeding sequence. Note shadow of the helicopter's main rotor blade (marked by arrow) on cliff. Photo with standard 50 mm lens.

Figure 3. Adult female Rough-legged Hawk brooding young on the North Slope of Alaska. Photo taken at about 85 feet (26 m) with standard 50 mm lens from a hovering helicopter.

Figure 4. Adult female Peregrine Falcon brooding two week old young in nest on the North Slope of Alaska. In order to flush the adult to obtain an accurate count of the young the helicopter had to be landed and the nest had to be approached on foot. Photo taken from hovering helicopter at about 45 feet (14 m) with a standard 50 mm lens.

Contract AT(26-1)-171 for Battelle Columbus Laboratories and on funds from the Bureau of Sport Fisheries and Wildlife, Special Studies, through LeRoy W. Sowl. Thomas D. Ray worked with us on some of our flights, and we appreciate his input. We thank W. "Scotty" Matthews, who is one of the best "raptor pilots" we know, and Mervin Weatherly for their excellent helicopter flying, and we have learned much from the many other helicopter pilots with whom we have flown.

Literature Cited

Hickey, J. J. and D. W. Anderson. 1969. The Peregrine Falcon: life history and population literature. *In:* J. J. Hickey (Ed.) *Peregrine Falcon Populations: Their Biology and Decline.* Madison: Univ. of Wisconsin Press. pp. 3-42.

Hensel, R. J. and W. J. Troyer. 1964. Nesting studies of the Bald Eagle (*Haliaeetus leucocephalus*) in Alaska. *Condor* 66:282-286.

AN AUTOMATIC RADIO TRACKING SYSTEM FOR BIOTELEMETRY*

by
Mark R. Fuller
and
John R. Tester
Department of Ecology and Behavioral Biology
University of Minnesota
St. Paul, Minnesota 55101

One of the keys to understanding certain aspects of raptor behavior is knowledge of the location of the birds under investigation at all times. Past experiences with portable radio-tracking receivers showed that several persons could not continuously monitor the position of more than one animal. This report briefly describes an automatic radio-tracking system designed to provide quantitative data on animal behavior under natural conditions. A more complete technical description is given in Cochran *et al.* (1965).

The site of this system is the Cedar Creek Natural History Area located approximately 30 miles (48 km) north of Minneapolis, Minnesota. This area of 6000 acres (2420 ha) is owned and administered by the University of Minnesota in cooperation with the Minnesota Academy of Sciences. It has a variety of habitats which make it ideal for tracking several different species of raptors.

Rotating antennas on two towers, 0.5 miles (0.8 km) apart, receive radio signals from raptors carrying transmitters. The receiving and recording system has the capacity of continually recording the location and activity of 52 animals on 16 mm film. Locations may be obtained from the film record by using a microfilm reader, or they may be determined instantaneously in the laboratory by use of electro-mechanical counters. The mechanical accuracy of the system is ± 0.5 degrees. Movement of an animal causes slight displacement of the antenna of the transmitter. This is manifested by an uneven light in the indicator-tube, which can be detected on the film. In this way periods of activity and of rest can also be tabulated. Under ideal conditions, the system has a potential of obtaining 1,920 locations per animal per day. Animals which go beyond the range of the system can be found by mobile or portable receiving units which can be carried into the field or mounted on vehicles.

Information on location and activity may be transferred to machine punch cards and analyzed by several computer programs developed specifically for data from this system (Siniff and Tester, 1965). Results from the University of Minnesota's CDC 6600 computer give movement and location parameters, and activity patterns. Maps of movements may also be obtained with the use of an X-Y plotter.

*This paper was presented at the Conference on Raptor Conservation Techniques at Fort Collins, Colorado, 22-24 March 1973.

Great Horned Owls, Barred Owls, Saw-whet Owls, Red-tailed Hawks, Broad-winged Hawks, Red-shouldered Hawks, Cooper's Hawks, Goshawks and Kestrels have all been radio-tagged at Cedar Creek. Tail-mounted transmitters developed exclusively for use on raptors have been used on all but the Saw-whet Owl. Attachment involves taping a transmitter, weighing less than 2% of the bird's body weight, on a central rectrix. This technique seems to minimize behavioral responses of the bird to the transmitter package and, at the same time, to protect the package, avoid aerodynamic problems, and reduce the possibility of entanglement in vegetation. When the life of the transmitter, or molting period, or interference with feather growth precludes use of this design, a modified harness transmitter has been used. On very young, relatively sedentary brancher owls, a jess package fastened to the leg allows radio contact to be maintained with the bird until further development permits use of one of the other two more desirable packages.

Analyses of radio tracking data on these raptors is leading to a better understanding of such behavioral and ecological aspects as habitat use, home range size, territoriality, movement patterns, spacing, activity rhythms and predator-prey interaction. The advantages of this system over conventional radio tracking techniques involving hand held or vehicle mounted receivers include: increased qualitative and quantitative data returns, simultaneous monitoring of several animals while the animals are left undisturbed, and reduction of the time required to obtain these data.

The authors wish to acknowledge support from NIH Training Grant No. 2 TO1 GM01779 and the U. S. Atomic Energy Commission (COO-1332-89).

Literature Cited

Cochran, W. W., D. W. Warner, J. R. Tester and V. B. Kuechle. 1965. Automatic radio-tracking system for monitoring animal movements. *BioScience* 15 (2):98-100.

Siniff, D. B. and J. R. Tester. 1965. Computer analysis of animal movement data obtained by telemetry. *BioScience* 15(2):104-108.

AN INVASION OF GOSHAWKS[1]

by
P. B. Hofslund
Biology Department
University of Minnesota, Duluth
Duluth, Minnesota 55812

The 1972 fall flight of raptors over the Duluth, Minnesota flyway was unusual in the magnitude of the Goshawk (*Accipiter gentilis*) migration. By the end of November, 5352 had been tallied, a total that dwarfs any other Goshawk count in the 23-year history of hawk migration censuses taken on the Duluth flyway. Previously the high counts for this species were 333 in 1962 and 715 in 1963. One can appreciate the magnitude of the 1972 invasion when one notes that these totals were surpassed in a single day several times.

The flight started early with five Goshawks seen during the first week of September. Between the years of 1951 to 1972 only nine of this species had ever been censused this early. By the end of September, Hawk Ridge observers had seen 88 Goshawks, and on October 1 it was exciting to count 99. It almost was with awe, however, that we finished October 8 with a day's count of 618. We tallied on that day almost as many as in the entire 1963 season, the year of our previous highest count.

A count of 333 on October 11 ushered in a fantastic week: 740 on the 12th, topped by 777 on the 13th, and then an all-time high of 984 on the 14th. Although we saw only 99 on October 15, on the 16th we had a count of 757 and on the 17th, 218. The 18th showed a drop to 64, and after that date along with deteriorating weather the daily totals showed a steady decline. The seven-day total (October 11-17) of 3908 Goshawks, probably was as high a Goshawk count as has ever been made in the United States.

We are without the evidence necessary to validate our conclusions as to the cause of this migratory eruption, because none of the 382 Goshawks trapped were wearing bands and so their place of origin could only be guessed. However, circumstantial evidence was such that we felt quite confident that the flight was initiated by a poor food supply rather than high reproduction.

Only about 15% of the Goshawks trapped at the station (bander David Evans) were immatures. While most of these had empty crops, few were excessively thin and it was more their actions rather than their physical condition that influenced our thinking. For instance, as many as three or four birds would fight over a single pigeon, fighting even though human observers would be only a few feet away; a trapped bird after being banded, weighed, and measured, returned to kill and eat the same pigeon he previously had been caught on. A bird with a heavy crop (believed to have been full of rabbit) still attempted to add a pigeon

[1]Contribution Number 2 of the *Hawk Ridge Nature Reserve.*

to its seemingly ample food supply. We had had reports early in the flight that certain Canadian areas were heavily infested with ticks and that this infestation seemed to be affecting grouse and rabbit survival in the area. A lynx invasion in northern Wisconsin and Minnesota may also be correlated with the same factors that could at least in part explain this unusually large Goshawk flight.

Manuscript received August 25, 1973.

NOTES ON NESTING GREAT HORNED OWLS IN SOUTHERN ARIZONA

by
William J. Mader
41 W. Alpia Way
Tucson, Arizona 85704

The Great Horned Owl (*Bubo virginianus*) is a common resident of the Lower Sonoran Desert in southern Arizona. This desert is dominated by stands of Saguaro Cacti (*Carnegiea gigantea*) and Palo Verde Trees (*Cercidium microphyllum* and *Cercidium floridum*) with Triangle Bur-Sage (*Franseria deltoidea*) as the predominant shrub species. Field data were gathered, incidental to a Harris's Hawk (*Parabuteo unicinctus*) study, on 16 different owl nests from 25 February to 15 June, 1972, in Pima and Pinal Counties, Arizona. Clutch size, nesting success and nest and cactus heights (to nearest six inches) were determined by a 25-foot (7.6 m) extension ladder and 10-foot (3 m) breakdown poles. A mirror was attached to the poles to aid in seeing nest contents.

Productivity

Laying dates of Great Horned Owl clutches centered around the second and third weeks of February (six nests). Late clutches were laid during the first and second weeks of March (three nests). The 16 owl nests contained 40 eggs (2.5 eggs per nest); nine nests had two eggs, six had three eggs, and one had four eggs.

Craighead and Craighead (1956) found averages of 1.8 eggs and 2.0 eggs (six and four nests, respectively) per active nest in Michigan; in Wyoming they found 2.2 eggs (four nests) per active nest. Wolhuter (1969) had an average of 1.9 eggs (nine nests) per active nest in Kansas. Seidensticker and Reynolds (1971) had an average of 2.2 eggs (six nests) per active nest in Montana. Of 14 horned owl nests in Florida (Bent 1937), "two contained three eggs or young, and the others were sets of two."

A nest was considered successful if at least one owl was raised to an age of approximately four weeks. Nine of 16 nests were successful and produced 1.1 young per nest (17 owls total). Orians and Kuhlman (1956) in their study of Red-tailed Hawk (*Buteo jamaicensis*) and Great Horned Owl populations in Wisconsin found that the owls fledged averages of 1.1 (13 nests), 1.9 (17 nests), and 1.3 (11 nests) per active nest in 1953, 1954 and 1955, respectively. Craighead and Craighead (1956) found averages of 0.5 and 1.0 (six and four nests, respectively) fledged per active nest in Michigan; in Wyoming they found 2.0 (four nests) fledged per active nest. Wolhuter (1969) had an average of 1.4 (nine nests) fledged per active nest. Hagar (1957) had an average of 1.7 (16 nests) fledged per active nest, for a four year period in New York state. Perry Conway reports (pers. comm.) an average of 1.6 owls (12 nests) fledged per active nest in eastern Kansas in 1971. In 1972, 1.7 (22 nests) were fledged per active nest.

The cause of nesting failure could be determined for only one nest. In this instance the nest saguaro collapsed at its base. No trace of the single owlet or the adults was found in the immediate vicinity.

There were two known renests of Great Horned Owls due to the loss of first clutches for undetermined reasons. One pair renested in a Red-tailed Hawk nest, which had failed several weeks prior. This owl nest contained two eggs and was approximately 200 yards (183 m) south of the previous site used by the owls. The second attempt was also unsuccessful. The other renest occurred in the same nest as that of the first clutch. It proved unsuccessful when the nest saguaro collapsed.

Nesting Sites

Fifteen Great Horned Owl nests were located in old hawk nests situated in saguaro cacti. The remaining nest was in an exposed saguaro "cavity" on the uppermost trunk of the cactus. The frequency of horned owl nests in saguaros can be partially explained by the fact that saguaro nests are considerably more numerous than tree nests in the desert. However, in previous years horned owls have been found nesting in old hawk nests in Palo Verde and Ironwood Trees (*Olneya tesota*). Three of the 15 horned owl nests were known to be old Harris's Hawk nests, while two were old Red-tailed Hawk nests. It is likely the other 10 nests were also built by Harris's and Red-tailed Hawks.

Of the 48 Great Horned Owl nests found by Orians and Kuhlman (1956) in their study, 31 (64%) were in old Red-tailed Hawk nests. In southeastern Massachusetts 11 of 13 horned owl nests were old nests of the Red-tailed Hawk (Bent 1937). Conway (pers. comm.) states that "in eastern Kansas, 80-90% of the Great Horned Owl nests are in old Red-tailed Hawk nests." He goes on to explain that this figure may be biased by the fact that cavity nests in trees are more difficult to locate than stick nests.

The 14 stick nests in my observations (not counting the nest used as a renest) had a mean height of 18.0 feet (5.5 m), ranging from 9.5 (2.9 m) to 26.0 feet (7.9 m). The saguaros used as nesting sites had a mean height of 27.0 feet (8.2 m), ranging from 21.0 (6.4 m) to 32.5 feet (9.9 m). Height of the cavity nest was 15.0 feet (4.6 m), while saguaro height was 18.5 feet (5.7 m).

Aggressive Behavior

Sixteen young owls were banded. Reactions to nest disturbances by observers were usually met by bill "popping" and hooting by the adult owls. Only twice, on two separate occasions at two different nests was I struck by adult horned owls flying at me. On both occasions I was banding by myself and was on an extension ladder climbing down from the nest at midday.

Acknowledgments

Special thanks to Harold Fetter, Steve Dobrott and my brother Tom Mader for their aid in helping me gather the field data essential to this investigation.

Literature Cited

Bent, A. C. 1937. *Life Histories of North American Birds of Prey. Part 2.* U. S. Nat. Mus. Bull. 167. Washington, D. C. 466 pp.

Craighead, J. J., and F. C. Craighead, Jr. 1956. *Hawks, Owls and Wildlife.* Harrisburg, Pa.: Stackpole Co. 443 pp.

Hagar, D. C., Jr. 1957. Nesting populations of Red-tailed Hawks and Horned Owls in central New York state. *Wilson Bull.* 69:263-272.

Orians, G., and F. Kuhlman. 1956. Red-tailed Hawk and Horned Owl populations in Wisconsin. *Condor* 58:371-385.

Seidensticker, J. C., IV, and H. V. Reynolds, III. 1971. The nesting, reproductive performance, and chlorinated hydrocarbon residues in the Red-tailed Hawk and Great Horned Owl in south-central Montana. *Wilson Bull.* 83: 408-418.

Wolhuter, B. 1969. Notes on a Kansas Great Horned Owl population. *Raptor Res. News* 3:23.

Manuscript received October 20, 1973.

LATE SUMMER FOOD HABITS OF ADULT BURROWING OWLS IN CENTRAL UTAH

by
Dwight G. Smith
Department of Biology
Southern Connecticut State College
New Haven, Connecticut 06515
and
Joseph R. Murphy
Department of Zoology
Brigham Young University
Provo, Utah 84602

This paper presents information on late summer food habits of Burrowing Owls (*Speotyto cunicularia*) in central Utah. Although we have previously reported food items brought to Burrowing Owl nests during the breeding seasons of 1969 and 1970 (Smith and Murphy 1973) we have no comparable information on their feeding habits and economic status during the post-breeding season summer months.

Burrowing Owls are a relatively common raptor of the central Utah deserts. They frequently form small and medium-sized colonies during the breeding season which lasts from early April through the first week of July in this part of the Great Basin. Fledged young remain in company with adults through July and part of August. The owls usually migrate out of the area before the end of September, but a few linger into October.

From 7 August through 24 September 1971 we made casual observations of three Burrowing Owls present in desert shrub habitat on the eastern bench of the Oquirrh Mountains in central Utah. Each appeared to be a solitary individual. Two were associated with burrows which may have been of Badger (*Taxidea taxus*) origin; the third was found most frequently in a small wash. All were lightly barred and were judged to be males on the basis of sexual plumage differences described by Thompson (1971).

Methods

On 8 August we cleaned all pellets from the most commonly used mounds, fence posts, and other roosts within the owls' territories. Because we could not be sure of the seasonal origin of these pellets we do not include them in the results. Thereafter, either we or Mr. Brent Osborne made weekly collections of pellets and loose prey remains from the roosts until 24 September, after which time no Burrowing Owls were present.

Pellet contents were analyzed following methods described by Maser and Brodie (1966). Vertebrate remains were identified by comparison with speci-

Table 1. Late summer food habits of Burrowing Owls in central Utah.

Species	Number of Individuals	Percent Frequency
Dipodomys ordi	12	3.1
Dipodomys sp.	1	0.2
Lepus californicus	11*	2.8
Peromyscus maniculatus	8	2.1
Microtus pennsylvanicus	7	1.8
Reithrodontomys megalotis	2	0.5
Lagurus curtatus	1	0.2
Eremophila alpestris	2	0.5
Unidentified birds	4	1.0
Nicrophorus americanus	168	43.3
Anuroctorus phaeodactylus	53	13.7
Melanoplus sp.	36	9.3
Aleoloplus tenuipennis	41	10.6
Formicidae	23	5.9
Scarabaeidae	16	4.1
Carabidae	1	0.2
Uta stansburiana	2	0.5
TOTALS	388	99.8

*Remains present in 11 pellets.

mens deposited in the Brigham Young University Life Sciences Museum collections or from microscopic comparisons of hair structure. A dissecting microscope was used to aid identification of arthoropod remains.

Results and Discussion

Pellet Characteristics and Composition. A total of 95 pellets were collected from the three territories. These averaged 23.8 ± 1.1 mm in length (range, 17.0-29.3 mm) and 6.1 ± 0.4 mm in width (range, 3.9-7.0 mm). Average weight of all pellets air-dried for 30 days was 0.83 ± 0.2 gm (range, 0.51-1.14 gm).

Prey remains found in pellets included (1) hair, mandibles, and various skeletal bones of mammals, (2) feathers, bills and synsacra of birds and (3) parts of legs, elytra, occasional wings, heads and tail segments of arthropods. Portions of prey or whole prey were occasionally found on the roosting mounds. Arthropod remains were found in 83 pellets, mammal remains in 27, birds in 6 and lizards in 2. Prey individuals per pellet were highly variable. Pellets containing vertebrate remains always consisted of but one vertebrate prey or portion thereof. Many also contained one or more invertebrate prey. Pellets consisting wholly of invertebrates contained from 3-13 prey of as many as three species. Pellets consisting only of a number of individuals of the same invertebrate taxon also were common.

Food Habits. A total of 388 individuals of 12 species were recorded (Table 1). Of these, 339 were arthropods (87.3%), 41 were mammals (10.7%), 6 were birds (1.6%), and 2 were reptiles (0.05%).

Silphid beetles were the most common prey. Almost 23% of the pellets were composed wholly of silphid remains, principally elytra and legs. Numbers of individuals per pellet, based on a pairing of elytra ranged from 3-7. In addition, silphids and formicids were common in pellets made up of Black-tailed Jackrabbit (*Lepus californicus*) remains. The frequent, simultaneous occurrence of these three types of prey, coupled with the large size of an adult jackrabbit, suggests that the owls may have been obtaining jackrabbit flesh as carrion from nearby road kills. Scorpions were another common prey. Their accurate identification and numbers per pellet were determined by tabulation of the telson segment of the tail. They ranged from 1-6 individuals per pellet and were found in 13.8% of the pellets. Two species of locustids, one carabid, and several scarabaeids comprised the remainder of the recorded invertebrate prey.

Ord's Kangaroo Rats (*Dipodomys ordi*) were the most common mammalian prey, followed by Black-tailed Jackrabbits. Four pellets containing rabbit remains were found within one week at the roost of one owl. Grant (1965) reported that Burrowing Owls frequently used food depots. It is quite possible that the owl we studied was utilizing a source of jackrabbit carrion as a food depot from which it fed periodically. White-footed Deer Mice (*Peromyscus maniculatus*) and Meadow Mice (*Microtus pennsylvanicus*), both relatively common members of the community, were also frequently taken. Of the avian prey, only Horned Larks (*Eremophila alpestris*) could be positively identified. Reptiles were represented only by the Side-blotched Lizard (*Uta stansburiana*).

Comparisons with other studies suggest that the late summer food habits of the Burrowing Owls we studied were generally similar to those reported from other parts of their range. Almost all such studies have shown heavy utilization of invertebrates. Vertebrates are taken less frequently. Maser *et al.* (1971), however, in an excellent study of seasonal food habits of Burrowing Owls in central Oregon, found that usage of vertebrates and invertebrates was roughly equal, and noted a similar pattern of feeding on silphids. The fact that most studies reveal predation on locally abundant species reveals the highly opportunistic aspect of predation of these owls.

Literature Cited

Grant, R. A. 1965. The Burrowing Owl in Minnesota. *The Loon* 37:2-17.

Maser, Chris, and E. D. Brodie, Jr. 1966. A study of owl pellet contents from Linn, Benton, and Polk Counties, Oregon. *Murrelet* 47:9-14.

Maser, Chris, E. Wayne Hammer, and Stanley H. Anderson. 1971. Food habits of the Burrowing Owl in central Oregon. *Northwest Science* 45:19-26.

Smith, Dwight G., and Joseph R. Murphy. 1973. Breeding ecology of raptors in the eastern Great Basin of Utah. *Brigham Young University Science Bull.* (Biol. Series) 18(3):1-76.

Thompson, Lise. 1971. Behavior and ecology of Burrowing Owls on the Oakland Municipal Airport. *Condor* 73:177-192.

Manuscript received February 1, 1974.

REPORT:
PROCEEDINGS OF THE CONFERENCE ON RAPTOR CONSERVATION TECHNIQUES, FORT COLLINS, COLORADO, 22-24 MARCH, 1973

Part 4. RAPTOR RESEARCH TECHNIQUES

edited by
Byron E. Harrell

The concluding session of the Conference on Saturday evening, 24 March, 1973, consisted of nine papers and was chaired by Joseph R. Murphy and Richard R. Olendorff. Four of the papers were completed for publication in this issue of *Raptor Research.* One paper was transferred to the management part of the proceedings. A list of papers and abstracts of those not published here are given below. [For other parts see *Raptor Research* 7(2) and 8(1) and *Raptor Research Report* No. 2 and 3.]

65. *Nelson, R. Wayne,* Department of Biology, University of Calgary, Calgary, Alberta, Canada T2N 1N4.
Field Techniques in a Study of the Behavior of Peregrine Falcons [published in *Raptor Research* 7(3/4):78-96, 1973].

66. *Clayton M. White and Steve K. Sherrod,* Dept. of Zoology, Brigham Young University, Provo, Utah 84601.
Advantages and Disadvantages in the Use of Rotary-winged Aircraft for Raptor Research [published in *Raptor Research* 7(3/4):97-104, 1973].

67. *Enderson, James H.,* Biology Dept., Colorado College, Colorado Springs, Colorado 80903.
Time-lapse Photography: Its Usefulness in Studying Nesting Raptors.

ABSTRACT. Inexpensive time-lapse cameras may be used to gather large quantities of otherwise nearly unobtainable data on parental behavior, nestling behavior, food, molt, and mortality at raptor nests. Such information has been successfully gathered by different workers at the nests of at least six species of raptors. Representative of the results are the findings that, in Alaskan Peregrines (1) the female incubates about twice as much as the male, (2) eggs were rarely uncovered for more than three minutes, (3) males only rarely brood the nestlings, (4) brooding rate drops rapidly two weeks after hatching, (5) young are normally fed within a few hours of hatching, (6) feedings occur every 4-5 hours, (7) nestlings do not feed themselves in the first 25 days, (8) the male did not incubate at a nest that failed, although he had repeated opportunity, and (9) unlike males, females interrupt their molt in this period. J. Craig has made success-

ful records of Great Horned Owl activity at night. Difficulties in time-lapse photography include inadequate recording of short-term events, equipment malfunction, and camera theft.

68. *Dunstan, Thomas C.,* Dept. of Biological Sciences, Western Illinois University, Macomb, Illinois 61455.

Application of Radio-telemetric Techniques to Studies of Strigiform and Falconiform Birds.

ABSTRACT. Radio-telemetric techniques were used to study various aspects of the life histories of 17 species of birds of prey. Methods of attaching transmitters to subjects were: (1) double body loop harnesses for both breast and back packages, (2) sutured rump package, (3) tail feather package, and (4) leg jess package.

Territories and home ranges of both breeding and wintering raptors, interspecific spatial and temporal relationships, and post-fledgling activities of juvenile birds were determined. Nest sites were located by: (1) tracking captured radio-tagged prey, and (2) locating nests in winter from an airplane and marking the locations with transmitters.

69. *Fuller, Mark R., and John R. Tester,* Dept. of Ecology and Behavioral Biology, University of Minnesota, St. Paul, Minnesota 55455.

An Automatic Radio Tracking System for Biotelemetry [published in *Raptor Research* 7(3/4):105-106, 1973].

70. *David H. Ellis,* Montana Cooperative Wildlife Research Unit, University of Montana, Missoula, Montana 59801.

A Telemetering Egg for Use in Studies of Incubation and Nesting Behavior [published in *Raptor Research* 7(3/4):73-77, 1973, with Joel R. Varney as junior author and a changed title].

71. *Kochert, Michael N.,* Idaho Cooperative Wildlife Research Unit, University of Idaho, Moscow, Idaho 83843.

Evaluation of a Vinyl Wing-marker for Raptors.

ABSTRACT. A color-coded, vinyl wing-marker was devised for birds of prey by wrapping a crescent-shaped piece of material around the leading edge of the wing and securing it between the secondaries and scapulars. Over 100 Golden Eagle (*Aquila chrysaetos*) nestlings were fitted with wing-markers. Birds have been wearing markers for over 2½ years with no adverse effects. Over 50 sightings of marked eagles have been reported since 1970, and all except two were in south Idaho and southeastern Oregon. Methods of handling birds and attaching the marker are discussed. Effectiveness of the marker style, materials used, and application of the marker to other raptor species is reported.

72. *Ellis, Cathy H.,* Montana Cooperative Wildlife Research Unit, University of Montana, Missoula, Montana 59801.
A Color-marking Technique for Permanently Dyeing Raptor Feathers.

ABSTRACT. Tags, dyes, paints, and bands have been widely used on raptors, but a permanent, easily applied color-marking technique practical for field use with raptors has not come to my attention. Experiments in 1970 and field testing in 1970, 1971, and 1972 have produced such a technique. The technique allows telescope identification of marked birds (eagles) for at least one mile and for a period of one to three years (depending on the completeness of annual molts).

73. *Sergei Postupalsky,* Dept. of Wildlife Ecology, University of Wisconsin, Madison, Wisconsin 53706.
Studies of Reproductive Success in Raptors: Some Problems with Criteria and Terminology [published in "Management of Raptors", *Raptor Research Report* No. 2, pp. 21-31, 1974].

The following transcription of the Raptor Research Techniques Session discussion period was edited for clarity and redundancy and irrelevancy and was reorganized in sequence. The discussion on the Postupalsky paper was included in the "Management of Raptors." Some discussion in the management area that was on techniques is also included.

Bio-telemetry

LESLIE BROWN. Could I ask Mr. Fuller how far away these things can be tracked, and secondly, how much does it cost?

MARK FULLER. With our system we have a range with hawks and owls of about three miles. This is a big system; and then we have portable receivers, and with them I can go out beyond that range and locate animals. With other systems described by Dr. Dunstan we get much longer range; and by going up in the air and tracking from the air you can get up to 15 or 20 miles on a bird. On the cost of the Cedar Creek System—this was the first permanent radio tracking system that was developed. It was developed over a number of years through the cooperation of engineering departments and so forth. So the real cost is hard to estimate, but we are funded by NIH grants and AEC grants and without those we'd be in no position to do anything. Other telemetry units, portable units that are used by many more people, are quite reasonable, I think, for the amount of data that you get.

JAMES ENDERSON. I'd like to ask Mr. Fuller if there is a reliable method for releasing the transmitters. In the case of some species in which I am interested this would be desirable.

FULLER. Well, there are two methods. One developed by Dr. Dunstan involves the suturing method of attaching the harness where after a certain amount of time the suture will dissolve away, and the harness will fall off. And that would be used on the back pack type of transmitter, and the tail transmitter of course will be molted out each year. And if a certain amount of weight is applied to the feather this will stimulate the follicle within about three weeks and that feather will be dropped. So depending upon the period of study and your particular wants and needs you can have a permanent package or one that will come off within an indeterminate amount of time by the suture loss or during the same molt period.

ROBERT COLEMAN. Mr. Fuller, what weight range were you talking about in terms of stimulating feather dropping? Is this in hawks and owls you're talking about?

FULLER. Yes, I found with a number of species that if the transmitter weighs under about 1.75% of the bird's body weight that it will be tolerated—that there's no follicle stimulation and it will remain on until the molt. With transmitters ranging from 2% to 4% of the bird's weight, I had dropping as early as three weeks and then as long as eight weeks.

ENDERSON. Is this, when attached, to a single feather?

FULLER. Yes.

Time-lapse Photography

VOICE. How long does it take to go through the 24 hour period in one reel?

ENDERSON. At one minute intervals a 50-foot reel lasts about 3½ days, something like that. The real success with this technique with super eight really awaits the development of large capacity magazines for super eight film.

THOMAS RAY. We did put the photoelectric cell on to turn the camera off during the night hours with diurnal bird of prey; then I altered it to put the strobe on at night to get a picture of the owls; the strobe would come on at night and go off during the day.

Marking Techniques

BROWN. Could I ask, Mr. Ellis, how far away from the original nest could the birds be seen some months, nine months later?

DAVID ELLIS. We observed one about 25 miles from the eyrie that she came from.

BROWN. So she wasn't still in the parental territory.

ELLIS. No. That's what we were trying to find with the technique.

LAURENCE FRANK. A couple of comments on standardization. Now that more and more people are color marking large raptors, particularly things like eagles that migrate large distances, ultimately there are going to have to be standard clearing houses so that different people aren't putting the same marks on eagles from very different populations. We are getting Goldens from Idaho all the way to northern California. It is clear that people in California, further west, people far north, had better not be using the same marks as people in Idaho are using.

RICHARD OLENDORFF. This of course is done by the Bird Banding Office.

FRANK. Do they control this?

OLENDORFF. Yes, very strictly.

Metric System

FRANK. I am always sort of surprised at wildlife studies in America which persist in the use of such barbarous measurement as inches, feet, square miles, acres, townships, etc. There are a lot of other wildlife biologists in the world and they're all talking in terms of kilometers, meters, hectares, etc. Well, it is obviously difficult for us to change over immediately and use these terms particularly in such matters as areas and distances, since we are so used to speaking in terms of acres and miles and so forth. I think it would be very useful, particularly for comparison with foreign studies, if we at least in our studies here give our data both in our measurements and in metric standards. We should join the rest of the scientists who have made conversion to the metric system.

OLENDORFF. I think that is very valid criticism.

POSTUPALSKY. I think a number of journals require that. Very often you see so many acres and in parenthesis you see so many hectares and so forth. I think this is being done, at least the bigger journals do.

THE RAPTOR RESEARCH FOUNDATION, INC. is a non-profit corporation whose purpose is to stimulate, coordinate, direct and conduct research in the biology and management of birds of prey, and to promote a better public understanding and appreciation of the value of these birds.

A major activity is publication. The quarterly *Raptor Research* prints research, reports, reviews, comments and news notes. The quarterly *Raptor Research Abstracts* summarizes and indexes literature on these birds. Longer papers or collections of papers are in *Raptor Research Report.*

Another important activity is the sponsoring of conferences. There have been three Captivity Breeding Conferences. The Conference on Raptor Conservation Techniques in March 1973 provided a very extensive review of current raptor research. The Proceedings will appear in issues of *Raptor Research* and *Raptor Research Report.*

Systems of information exchange on specialized areas have been initiated. Ninety "Breeding Project Information Exchange (BPIE) have appeared so far (available by subscription of $3 sent to BPIE, Laboratory of Ornithology, Cornell University, 159 Sapsucker Woods Road, Ithaca, NY 19850). A new project, "Raptor Telemetry Information Exchange" (RTIE), begins with a research survey report (subscription $1 from RRF). Additional special area information exchanges are anticipated soon.

Another active area has been the Pathology Committee. This group of professional veterinarians and others deals with the special health problems of raptors. They have conducted autopsies, treated ill birds, and provided consultation information as well as providing valuable information at several of our conferences.

MEMBERSHIP

Membership in the Raptor Research Foundation is open to all who contribute. *Raptor Research* is sent to all who contribute a minimum of $6.00 per year; those who wish to receive both *Raptor Research* and *Raptor Research Abstracts* contribute an additional $4.00. Memberships should be sent to: Edward S. Freienmuth, RRF Membership Services, RR 3, Box 301, Durango, Colorado 81301.

PUBLICATIONS

All previous publications are still available from RRF Membership Services.

Raptor Research News, 1967-1969, Vols. 1-3, 4 issues each, $2.00/vol.; 1970-1971, Vols. 4-5, 6 issues each, $3.00/vol.

Raptor Research, 1972-1973, Vols. 6-7, 4 issues each, $4.00/vol. Supplement to Vol. 6, $2.00.

Raptor Research Abstracts, Vol. 1, 1973, 4 issues, $2.00.

Raptor Research Report

No. 1. Richard R. Olendorff, "Falconiform Reproduction; A Review. Part 1. The Pre-nestling Period." February 1971, 111 pp., $2.50 ($2.00 to members).

No.2. Management of Raptors (Proc. Rapt. Cons. Tech. Part 4), August 1974, 146 pages, $5.00 ($4.00 to members).

No. 3. Population Status of Raptors (Proc. Rapt. Cons. Tech. Part 5) in press. $6.25 (members $5.00).