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THE RAPTOR ACTIGRAM: A GENERAL ALPHANUMERIC NOTATION FOR RAPTOR FIELD DATA

by Hartmut Walter
Ecosystems and Conservation Section
Department of Geography
University of California, Los Angeles (UCLA)
405 Hilgard Avenue
Los Angeles, CA 90024

"I don't want to have pages and pages of endless notes when we go home."

J.T. Harris (1979)

Abstract

Raptor actigrams are ethograms using an alphanumeric notation system that enhances the efficiency of observing, recording, and analyzing behavioral dta of individual birds. The actigram concept uses a small number of fixed elements, and a potentially large number of observer-specific subelements that permits maintenance of basic notations but generates high adaptability to different species and environments. Actigrams are therefore proposed for general use to promote comparative and quantitative field studies.

Introduction

In the rapidly developing area of raptor behavior progress has been hampered by significant inefficiencies encountered in recording, storage, access, transfer and quantitative analysis of data. The culprit is usually the familiar and indispensible notebook used by most observers during field and laboratory research.

Following is a technique that can substantially increase the overall efficiency of recording, using, and transferring data on raptor ecology and behavior. Departing from traditional procedures in ethology (where almost everyone designs his/her own ethogram code, etc.), this technique has been designed for general use. The two major reasons prompting this approach are (1) the unusual homogeneity found in the ecology and behavior of the *Falconiformes* and *Strigidae*; this opens up the potential for the development of an information management system that can be applied to all raptors and used by many researchers. And (2), we are standing at the threshold of interspecific and intergeneric comparative raptor studies (Walter 1979a): a general notation system would be an obvious advantage for this developing field.

The Actigram Concept

The need for higher efficiency and general applicability to a wide range of objectives, species, environments, and observers requires a work language that meets the following criteria:

(1) comprehensive but not too sophisticated,
(2) detailed and specific yet flexible,
(3) logical and easy to teach, learn and use,
(4) capable of recording and retrieving qualitative and quantitative data,
(5) time- and space-saving yet high in information content, and
(6) useful at different technological levels.

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After several drafts and field tests by at least a dozen researchers a shorthand notation system of letters, numbers, and symbols has been developed that can be used to construct ethograms containing all recognizable "ethons" (Ellis 1979) exhibited by a raptor. Such ethograms are termed *raptor actigrams*; they serve to replace or supplement other written, verbal or mechanical records. The actigram notation achieves its general applicability by using a limited number of fixed behavioral *elements* (Table 1), and by offering an *unlimited* number of user-specific *subelements*. Data entries are ordered along a time gradient, and grouped into *segments* of uniform time length. The use of the actigram concept is not only time- and space-saving but promises to meet the other criteria listed above.

Table 1: Actigram Elements

	Individual Behavior		*Social Behavior*
P-Group	*Physical Status*	S-Group	*Sexual/Territorial Behavior*
P1	perched	S1	display from perch
P2	flying (beating wings)	S2	display in flight
P3	soaring, gliding	S3	other display
P4	other type of flight	S4	soliciting food
P5	climbing, hanging	S5	offering food
P6	hopping, walking	S6	copulation
P7	swimming	S7	physically harassing, attacking
P8	lying down	S8	defensive, evasive behavior
P9	other	S9	other
F-Group	*Feeding & Body Care*	N-Group	*Nest-Related Behavior*
F1	feeding self	N1	inspecting nest site
F2	drinking/bathing	N2	coll./carrying nest materials
F3	asleep	N3	building, repairing nest
F4	panting	N4	sitting on nest
F5	preening, cleaning	N5	serious incubation
F6	scratching	N6	turning, rolling eggs
F7	shaking feathers, sunning	N7	brooding, sheltering nest content
F8	pellet extraction/defecating	N8	feeding young
F9	other	N9	other
H-Group	*Hunting & Prey Handling*		*User-defined groups*
H1	prey search from air	A-Group	*Acoustic Behavior*
H2	other prey search behavior		
H3	prey chase, pursuit	X-Group	*Other Activities*
H4	prey capture, in possession of prey		
H5	prey transport	Y-Group	*Environmental Elements*
H6	prey transfer		
H7	prey handling	Z-Group	*Human Impact Elements*
H8	prey storage, "caching"		
H9	other		

The Notation System

A literature search for all behavioral characters or ethons resulted in a list containing well over 100 terms; many are closely related to each other while others are distinct but extremely rare in occurrence. In order to achieve a simple *and* comprehensive notation only 45 ethons were selected as actigram *elements*; each represents at least several behavior patterns, displays, vocalizations, activities, etc. The elements are ordered into five groups (Table 1). The first three groups (P, F, and H) contain behavioral elements of raptors that can be observed year-round; the other two (S and N groups) are more often or always associated with reproductive seasons.

Each element appears in the actigram with its code composed of a capital letter and a single digit number (F4, P8, or N3). The ninth element in each group (i.e. P9, F9, H9, S9, and N9) is "open" (unspecified); it must be defined by the observer who needs an extra element in a particular group.

There are four additional groups listed in Table 1. Group A contains elements of acoustic communication, usually vocalizations. They remain unspecified here as there are too many vocalizations to permit a meaningful general definition of these elements. Group X is an entire unspecified group that may only be used if certain observed phenomena cannot be placed into any other group. Finally, group Y has been reserved for the listing of environmental "elements" (components of the bird's physical and biological environment), and group Z is comprised of human impact "elements" that we may wish to record.

Subelements do not appear in Tables 1 and 2 because they exist only *after* an observer has created and defined them. As an example, a falcon may use four perch sites near its nest site. We could simply write "P1" every time the falcon makes use of one of them. More accuracy can be achieved by creating four subelements of P1 (P11 =perch 1, P12 = perch 2, P13 = perch 3, and P14 = perch 4). Should there be more than 9 subelements per element, a third numerical digit (like P114 = perched on site no. 14) can be added.

Auxiliary symbols (Table 2) are a vital part of the actigram concept. They permit recording of action-response sequences, of simultaneously occurring ethons, and of accurate time data.

Table 2: Auxiliary Symbols

Symbol	*Definition*
	1. *Independent Symbols*
-	observed bird absent
!	bird present but not recorded
?	no data collected
/	end of time segment
+	repeat of last event
( )	inferred event(s), not directly observed or recorded
	2. *Element-dependent symbols*
	(To be used *after* the alphanumeric notation of element [and subelement]; followed by a numerical value)
* or .	duration in minutes within one time segment ("soaring for 3 minutes" — P3*3; "soliciting food for 15 seconds" — S4*0:15)
# or @	position of activity in an action-response sequence between individuals (male H4H5#1H6#3P2; female P1P2#2H5#4P2#5P1)
=	value or size (Y3 was user-defined as "air temperature in °C"; then Y3 = 27.5 means "air temp. 27.5°C.")
	3. *Interactive Symbols*
& or $	Simultaneous occurrence (P6&H4, F5&F7)

Observation time is divided into time *segments* of equal duration, determined by the observer (usually from one to ten min depending on research design and/or raptor activity levels). An example for a data sheet with six time segments reads:

P3P4P2P1F5/F5P2P3P1F5&6/P1P2-/-/P1F5/P1/

All segments *must* show a data entry (even if it should be +, −, !, ?). This encourages and maintains the observer's alertness and it generates data collections that can be quantitatively analyzed.

Preparation and Use of Actigrams

Nearly all imaginable situations can be recorded with the help of the alphanumeric codes; the observer must, however, possess a good command of the system. This requires some practice, preferably a field test and the transcribing of longhand notes into the actigram mode. Battery-operated "memoprinters" and electronic field recorders may also print or store the actigram notation (Stephenson & Roberts 1977, Morris & Shaw 1978, Dawkins 1971). Some can record an entire day's field work, then feed it directly into a computer for analysis. Programs for their quantitative and sequential analysis can be developed in different computer languages (BASIC, PASCAL, FORTRAN, etc.).

The actigram should never be regarded as the sole recording technique. Unexpected ethons may occur from time to time requiring an instant decision on the need for additional subelements; drawings need to be made of new postures or spatial features. Thus, pencil and paper, tape recorders, etc. and other field techniques (Nelson 1973) will always be needed during field work.

The definitions of subelements and other observer-specific coded information should be written down before or during the observation period. They should be placed in front of the observer at all times together with the actigram notation tables (Tables 1 and 2). Physical status elements are recorded only when they first occur. The change from flying to perched has to be P2P1 but if the bird then begins to preen we follow up with F5 (not P1&F5) as it is quite clear that the bird is perched while preening, and that it will remain perched until the codes P2,P3,P4, etc. indicate a change in physical status.

The final actigram should be preceded by a short paragraph containing the necessary introductory data on species, date, location, time segment, and observer-specified codes.

A relatively simple actigram is shown in Table 3; this is a transformation of Brown's (1980) written account of eagle activities.

A more complex actigram contains data on the Sooty Falcon (*Falco concolor*) during the nesting stage of the breeding season (Table 4), developed from many pages of notes taken in longhand (see also Walter 1981b).

Discussion

The selection of elements (Table 1) as well as alphanumeric notation may not be everybody's first choice. The guiding principles in the selection of elements were (1) their presence among most raptors, (2) the relative ease of recognizing these ethons in raptors, and (3) the need for descriptive, non-interpreting definitions. Because of the addition and subdivision potential of any actigram there should be few if any inconveniences in adhering to this structure.

The proposed notation itself was preferred over a part numeric or literary one. The latter two are more difficult to read and memorize than the proposed scheme. The reverse (a single digit number at the beginning of each element, the rest on letters) looks attractive as well but it seems more logical to have a group with nine elements where numbers 1-9 are right behind the capital letter.

The actigram has a built-in potential that can only be realized by the user. It offers a solution to a vexing problem: how to record and extract information in equally efficient ways. With the actigram there is no longer a need to glean information from dust-covered notebooks which often don't lend themselves to any quantitative analysis due to their anecdotal or incomplete nature.

In general, most raptor studies do not require the knowledge of exact minute and second for each ethon's occurrence; it is more important to record the context or behavioral sequence associated with a particular ethon, and to register the temporal distribution of peaks and lows in activity. This is accomplished with the use of uniform time segments; the duration of individual elements can also be recorded by using the auxiliary symbol * (see Table 2).

One reviewer felt that Table 1 might lead inexperienced observers to look with great determination for certain actigram elements, thereby overlooking other ethons, and perhaps misinterpreting certain behavior. This danger certainly exists with behavioral observations in general; the limited number of fixed elements tries, however, to avoid oversophistication and bias. On the other hand, I hope that Table 1 will contribute to the discovery of actually existing homologous and analogous ethons in different raptors.

The actigram concept should be of particular value for the behavioral studies of captive raptors (e.g. Wrege & Cade 1977), and in the long-term monitoring of a raptor pair's activities at the nest site. A full day's observations may fill only one or two pages of the finished actigram, reducing the otherwise unmanageable paper stack of longhand notes at the end of the season by a factor of 10 or more.

Acknowledgments

Quite a number of colleagues, students and friends have discussed the actigram concept with the author. Others made helpful comments on an early draft. Particular thanks go to R.W. Nelson for a very thoughtful letter; highly appreciated were the comments made by D.W. Anderson, C.T. Collins, J. Mosher, B.J. Walton, G.R. Bartolotti, W.G. Hunt, T. Kaiser, K. Garrett, D. Hector, and G. Lennon.

Table 3. African Fish Eagle *(Haliaeetus vocifer)*

Breeding pair with downy eaglet, Lake Naivasha, Kenya, 5 October 1971

Observer: Leslie Brown

Time segments: 10 minutes each

Adapted and transformed from field data (Brown 1980: 140-144)

See also graphical analysis (Brown 1977: 70, Brown 1980: 49)

Subelements: P11 perched on nest, P111 standing in nest (eaglet visible), P12 perched near nest, P13 behind nest, P14 west of nest, P15 east of nest, P16 perched near Colobus Monkey, P17 perched on papyrus edge of lagoon, P31 soaring above nest, P32 soaring high above lake, P41 descends for attack; H11 hunting sortie over water, H2 prey search from shore perch; S71 attacking strange, intruding ad. female, S72 forcing strange female down near shore; A1 male's calls, A2 female's calls, A3 duetting; Y1 sunrise, Y5 calls from other eagles, Y6 several Colobus Monkeys in same tree, Y8 ad. eagle passing overhead; symbol = gives distance in meters from nest (P14 = 80) or distance flown (H1 = 200).

Table 3 continued on next page

Table 3 cont. . .

Time	**Male**
05:40	?*5 P16 Y5 / A1A1/
06:00	A1 Y5 A1 Y5 A3 / P16 S22 P12*6 P2P1=20 / + /
06:30	+*1 P2 H11*2 P1=30 Y1 P1=30*6 / P1=30 / +*7 P2 H1P1P2 P1-50 /
07:00	+ /+*6 P2=40 P12 Y6 A1 / P12 /
07:30	P2=20 P12 / P2P3P14=70*7 P2 P3&H1 P15=200/+*P2P14*=80*5P2P3&H1P14=80 /
08:00	+*4 P2 P14=30 H2 A1 + + +/ H2 / + /
08:30	+*2 P2 & H1 P13 / + / + /
09:00	P13 A1 P2 P11*3 A3 / + P2 P12 / P2 P14=80 /
09:30	+*5 P2 P15=40 /+ *7 Y5 A1 +++ P2P3 / + /
10:00	P32*8 P2#1Y5#2P31 / + / + *9 P41 S71#1 S72#3 P14=80 /
10:30	+ *5 P2 P14 P2 P11 / + / P2P13 A3 P2 P13=40 /
11:00	+ / + / P2 P32 A1#1 Y5#2 P32 /
11:30	+ *7 P2 P11 P2P1 / P2 P11 / + *4 P2 (P1) /
12:00	(P1)*3 P2 P13 / + / + *8 Y8#1 A1#2 /
12:30	P13 P2=30 (P13) A1 / (P13P2P13) Al / (P13) P2 =#40 P13 /
13:00	+ A1 P13 / + / P2 P13 /
13:30	P13P2 (P2) H3 P2P12=30/P2(P2P12)A1 / (P12)*2 P2P1H2 /
14:00	H2 / + / + *8 P2 H3 P3 P1 /
14:30	P1 / + / + /
15:00	+/Y8#1A1#2P2H31H4P2P12P2P15#1 (F1#3) / + *2 P2P12 (H6) /
15:30	P2 P3 H1 P14=200 / P2 P12 / + *5 P2 P13 /
16:00	P13 / + / + *2 P2 P12=20 P2 P3 P16 /
16:30	+ / P2P1P2P3 H1=200 P2P14=80 H2 / + /
17:00	*H2**5 P2 H1&P3 P14=80 / + *8 P2 P3 P17*1 P2 (P1 H2) / - /
17:30	- / - / - /
18:00	- / P2 P3 *6 P13 / + /
Time	**Female**
05:40	? *5 P11 Y5 / A1 + /
06:00	+ Y5 A2 Y5 A3 / S22 P11 / + /
06:00	+ Y1 / P11 / + /
07:00	+ / + / + /
07:30	+ / + / + /
08:00	+ / + / + /
08:30	+ / + / + /
09:00	+ / + / + /
09:30	+ / + / + /
10:00	+ / + / + *9 P2 S71#2S72#3 P2#4 P11#5 /
10:30	P11 / + / + A3 P11 /

Table 3 continued on next page

Table 3 cont. . .

Time	Female
11:00	+ / + / + *5 P2 (P13) /
11:30	+ / + / + /
12:00	P13 / + / +*8 Y8#1 A2#2 /
12:30	P13 Y8#1 A3#2 / (P2P13) A3 + / (P13) /
13:00	(P13) / + / + *5 P2 P11 /
13:30	P11 / + / + /
14:00	+ / + / + /
14:30	+ / + / + /
15:00	+ / + *5 P111 A2 P2#2 P12 / P2 P12 A2 H4 F1 P2 (P1) /
15:30	(P1=300) A2 (F1) P2 (P1) / A2 P2P3P12P2P11 / + *5 N8 /
16:00	N8 *9 P11 / + / + /
16:30	+ / + / + /
17:00	+ / + / + /
17:30	P11*5 P111 / + / P2P3P1P2P1P2P3*3P2P11 /
18:00	+ / A2#2 / P11 /

Table 4: Sooty Falcon *(Falco concolor)*

Breeding pair near Hawar Island (Bahrain) with three young.

3 October 1977 from 5:00 - 7:30 and 15:45 - 18:00 from a boat anchored in front of the low breeding bluff. Shown here only period 06:00 ; 07:00 (local time).

Observer: H. Walter

Transformed from field notes and sketches. Five minutes per time segment. One line per time segment.

Subelements:

P11	perched at nest	A1	male's call on arrival with prey
P13	perched in full sunlight	A2	female's call of response to male
P14	perched in shade	A3	nestling's call when female flew by nest
P20	flying around nest site	A4	nestling's begging calls
P21	flying north	Y3	air temperature in the shade (°C.)
P24	flying southeast		

Table 4 continued on next page

Table 4 cont...

Time	Male	Female	Nestlings (3)
6:00	−*1P2#1A1#3H5#5#5H6#6P13	P2A2#2P2#4H5#7	P13
	P13	H7N8H7&N8P2P13	P13&F1
	P2H2*4:30	P13	F4
6:15	−(H2)	P13P2&P3	F4P13
	−P2*1	P2&P3	A3P13
	P24*4−P2&H5#1H6#4P21−H1	P24*2P20P2#3P13#5	P13A4#2A4#6
6:30	−(H1)	P13P2P13F1F5F1	A4
	−(H1)	P13P2&H5P13F1	P13
	−(H1)	P13&F1P2P11N8	P13F1
6:45	−(H1)	N8P2P1*1	F1P13
	−*3P2P1	P13	P13
	P13Y3−28.5	P13	P13*4P13&P14

Literature Cited

Brown L, 1977. Eagles of the World. New York.

Brown, L, 1980. The African Fish Eagle. Folkestone.

Dawkins, R. 1971. A cheap method for recording behavioral events for direct computer access. *Behavior* 40:162-173.

Ellis, D.H. 1979. Development of behavior in the Golden Eagle. *Wildl. Monogr.* 60:1-94.

Harris, J.T. 1979. The Peregrine Falcon in Greenland: observing an endangered species. Columbia (Missouri) & London.

Morris, M. and E. Shaw 1978. A new decoding and transcription device (DTD) for SSR Keyboard data.*Beh. Res. Meth. & Instr.* 10:571-575.

Nelson, R.W. 1973. Field techniques in a study of the behavior of Peregrine Falcons, *Raptor Res.* 7:78-96.

Stephenson, G.R. and T.W. Roberts 1977. The SSR System 7: a general encoding system with computerized transcription. *Beh. Res. Meth. & Instr.* 9:434-491.

Walter, H. 1979a. Eleonora's Falcon: adaptations to prey and habitat in a social raptor. Chicago & London.

Walter, H. 1979b. The Sooty Falcon *(Falco concolor)* in Oman: results of a breeding survey, 1978. *T. Oman Studies* 5:9-59 (publ. 1982).

Wrege, P.H. and T.J. Cade 1977. Courtship behavior of large falcons in captivity. *Raptor Research* 11:1-27.

NEW RELEASE FOR THE WORLD WORKING GROUP ON BIRDS OF PREY

The ICBP World Working Group on Birds of Prey published its first Bulletin in February. This comprises 240 pages covering a wide range of current topics including population censuses, conservation programmes, problems of protection, international smuggling, reports of conferences, etc. from many different countries.

Whilst primarily intended to serve as a means of communication between members of the Working Group, this Bulletin is available to anyone interested in birds of prey and copies can be obtained at $7.00 or £ 4.00 post free from the Working Group (Herbertstr. 14, D-1000 Berlin 33, Fed. Rep. of Germany) of from ICBP (c/o British Museum (Natural History), Cromwell Road, London, S.W.7, England). It is hoped to publish further issues biannually.

NEST BOX USE AND REPRODUCTIVE BIOLOGY OF THE AMERICAN KESTREL IN LASSEN COUNTY, CALIFORNIA

by
Peter H. Bloom[1]
Department of Biology
California State University, Long Beach
Long Beach, California 90840
and
Stephen J. Hawks
Susanville District
Bureau of Land Management
P.O. Box 1090
Susanville, California 96130

Abstract

During 1976 we implemented an American Kestrel (*Falco sparverius*) nest box program in the Great Basin of Lassen County, California. The primary goal was the creation of nesting habitat where no habitat existed, and the reestablishment of such habitat where it had been eliminated. Of 247 functional nest boxes examined between 1977 and 1980, 31% of these were active and 82% of these were successful. 3.1 young were fledged per active nest box. With careful placement of nest boxes, the percent active may be increased to more than 50%.

Introduction

Despite its widespread occurrence in California, the American Kestrel has received relatively little study in the state. Except for the major ecological study by Balgooyen (1976) and on seasonal weight variation (Bloom 1973), habitat partitioning (Koplin 1973), winter territoriality (Cade 1955), and predatory efficiency (Collopy 1973), basic natural history information is lacking for most of California.

In 1976 we implemented an American Kestrel management-study program in Lassen County, California. The objectives were, 1) to determine if kestrels would nest in artificial nest boxes in areas which lacked suitable natural nest sites, and 2) to investigate the species' reproductive biology. Data were collected over 4 breeding seasons (1977 - 1980).

Study Area

The study area covered about 900 km^2 of the Great Basin in Lassen County, California. Elevation ranged from 1,260 to 2,340 m. The dominant plant association was western juniper *(Juniperus occidentalis)* and big sagebrush *(Artemesia tridentata)*. Other sub-dominant plant associations included ponderosa pine *(Pinus ponderosa)*, white fir *(Abies concolor)*, and the greasewood-shadscale complex *(Sarcobatus vermiculatus, Atriplex confertifolia)*.

[1]Address all correspondence to Peter H. Bloom. Current Address: National Audubon Society, Condor Research Center, 87 N. Chestnut Street, Ventura, CA. 93001.

Methods

Nest box design followed Hamerstrom, et al. (1973), with modifications to meet dimensions of natural nest cavities (Fig. 1). Nest boxes were constructed of 1.9 cm thick pine and measured 18 cm deep, 20 cm wide and 33 cm tall inside. The hole was 7.6 cm in diameter and located 7.6 cm from the top, in the middle of the front of the box. The back of the box extended 5 cm above the top and 5 cm below the bottom and was fastened to the supporting structure by one nail through each extension. Boxes were placed 2 to 6 m above ground and faced all directions.

The top of each nest box was completely removeable and fastened on by eye hooks. This was later modified by bending the hook or by wiring the lid to the box since some nest boxes were later found without tops. Presumably they were blown off or sun warped. Nest boxes without tops were rendered useless; no birds of any species ever used them.

The juniper-big sagebrush habitat was chosen as the primary habitat for nest box placement because kestrel nesting densities were believed low and junipers made logical support structures for nest boxes. Junipers do not readily form natural cavities by limb breakage or rot; thus, kestrels relied primarily on woodpeckers, particularly the Common Flicker (*Colaptes auratus*), to excavate their nest holes.

Much of the Great Basin juniper country is composed of relatively young trees (Burkhardt et al. 1976). Generally, if large mature junipers are not present, Common Flickers are also limited in their choice of nest trees; thus, large areas may be devoid of suitable nest trees for either species.

Although the majority of nest boxes were placed on western junipers some nest boxes were placed on white fir, ponderosa pine, aspen (*Populus tremuloides*), cottonwood (*Populus trichocarpa*), and telephone poles to determine site preferences.

Figure 1. American Kestrel nest box in western juniper, Lassen County, California.

Results

Ninety-six nest boxes were erected during autumn 1976. Since this study was conducted supplementary to a general wildlife inventory of Lassen County, it was not always possible to check all boxes each year thereafter; 71 were checked in 1977, 67 in 1978, 49 in 1979, and 60 in 1980. Reproductive data are given in Table 1. Of the 247 boxes examined in all years, 35 lost tops, 1 had fallen from the tree, 2 had been vandalized (shotgunned), and the bottom of 1 box was destroyed by a Common Flicker. These 39 boxes were considered nonfunctional and not used in Table 1. Seven functional boxes were used by rodents, 5 by woodrats (*Neotoma* spp.), and 2 by Douglas squirrels (*Tamiasciurus douglasii*).

TABLE I

American Kestrel Nest Box Use and Reproductive Biology
Lassen, County, California

	1977	1978	1979	1980	TOTAL
Number of Boxes Examined	71	67	49	60	247
Number of Boxes Functional	65	53	40	50	208
Number (Percent) Active	14(%)	18 (34%)	14(%)	19(38%)	65(31%)
Number (percent) Successful	12(86%)	15(83%)	13(93%)	13(68%)	53(83%)
Average Clutch Size/	3.5	4.9	4.3	4.2	4.3
Box[1]/	6 boxes	14	7	11	38
Hatching Success[1]/	(81%)	(83%)	(83%)	(70%)	(79%)
	17/21	52/63	25/30	30/43	124/157
Average Brood Size/	2.8	4.7	4.2	3.8	4.0
Box[1]/	6 boxes	11	6	8	31
Fledging Success	(88%)	(88%)	(100%)	(87%)	(90%)
	15/17	46/52	25/25	26/30	112/124
Number of Young Fledged/	2.5	4.6	4.1	3.2	3.7
Successful Box[1]/	6 boxes	10	6	8	30
Number of Young Fledged/	2.5	3.5	3.6	2.6	3.1
Active Box[1]/	6 boxes	13	7	10	36

[1]/ Data not available from all nests in all years.

An additional 33 nest boxes were occupied by other species of birds. These included Bufflehead (*Bucephala albeola*), Flammulated Owl (*Otus flammeolus*), Common Flicker, Tree Swallow (*Iridoprocne bicolor*), Mountain Chickadee (*Parus gambeli*), House Wren (*Troglodytes aedon*), Mountain Bluebird (*Sialia currucoides*), Starling (*Sturnus vulgaris*) and House Finch (*Carpodacus mexicanus*).

A nest box was considered to be active (used by kestrels) if eggs, young, or evidence of nesting (eggshells, etc.) were found. The box was considered successfuf if it fledged at least 1 young.

Reproductive Biology

Biases may be present in some reproductive data since most boxes were not observed during the incubation period, and not all were reexamined to determine actual fledging success. Clutch size may thus be biased on the low side, and fledging success on the high side. However, 20 nests contained the maximum clutch or brood size observed, and since clutch sizes larger than 5 are rare, we believe that these represent complete clutches. Unhatched eggs were frequently found in the boxes along with young, allowing original clutch sizes to be calculated. For example, if an initial visit showed that 5 eggs were present, and on a later visit the box contained 4 young, the mortality was attributed to the nestling stage. Although the remains of some larger nestlings were found in the nest boxes, very small young may have disappeared without a trace due to cannibalism, or being consumed by the dermestid beetle larvae which often infest the box bottom. Although not documented, such losses would have similarly biased clutch size on the low side and fledgling success on the high side.

Incubation period was assumed to be 30 days (Brown and Amadon 1968). Hatching success was derived by dividing the number of eggs laid into the number that hatched and multiplying by 100, while fledging success was determined by dividing the number of young fledged by the number hatched and multiplying by 100.

Age of the young was estimated on the basis of body size and feather development. We believe that ages assigned to young were accurate to within 3 days. Average egg laying and hatching dates were derived by back dating from the estimated average age of the young in each brood. The dates on which surviving young would have fledged were determined by projecting forward from the estimated average age of the young in each brood at the last nest box visit. Because the ages were not based on detailed measurements and the sample size was small, we used median rather than mean to indicate central tendency of the data. However, in 1977 and 1978 mean and median were only different by one day and mean and median were identical in 1979 and 1980. The number of nest boxes in Table 2 is smaller than noted in Table 1 as the ages of the young in nine boxes were not recorded.

Kestrel use of boxes averaged 31%, and 82% of these fledged at least 1 young (Table 1). An average of 3.1 young fledged per active box. The rate of productivity reported for other studies of the American Kestrel ranged from 2.3 to 4.4 (Hamerstrom et al. 1973, Nagy 1963, Smith et al. 1972, Craig and Trost 1979, and Stahlacker and Griese 1979). Of the 99 nestlings that were old enough to be reliably sexed, 47 were females and 52 were males.

Because not all boxes were examined at fledging, we can only estimate number of young actually fledged. However, based on the number of young known to have fledged per successful box (3.7) and nest succes (82%) for the 65 boxes (Table 1), we estimate that 197 nestlings were fledged over the four-year period.

Egg laying to fledging period spanned 112 days, between 6 May and 25 August for the 4 years (Table 2). Young fledged in 28-30 days. Nesting phenology was similar to that reported in southeastern Idaho (Craig and Trost 1979). Median egg laying, hatching, and fledging dates for the 4 years were 22 May, 21 June, and 21 July, respectively (Table 2).

TABLE 2

American Kestrel Laying-Hatching-Fledging Chronology, Lassen County, California

	1977 n=7	1978 n=11	1979 n=4	1980 n=5	All Years n=27
Median Egg Laying Date and Range	05/23 05/13-06-04	05/16 05/06-05/24	05/23 05/23-05/24	05/30 05/08-06/26	05/22 05/06-06/26
Median Hatching Date and Range	06/22 06/12-07/04	06/15 06/05-06/23	06/22 06/22-06/23	06/29 06/07-07/26	06/21 06/07-07/26
Median Fledging Date and Range	07/22 07/12-08/03	07/15 07/05-07/23	07/22 07/22-07/23	07/29 07/07-08/25	07/21 07/05-08/25

Unlike species that do not tolerate human disturbances (Fyfe and Olendorff 1976, Bloom 1974), we found that kestrels tolerated disturbance during the incubation period, if parents were allowed plenty of notice of our approach, and were allowed to fly from the box. In one instance, a nest may have failed due to an investigator who surprised an incubating female that kicked her eggs while assuming a defensive posture on her back. However, not all incubating adults responded this way, and some could be captured, banded, and replaced in the box without any loss of eggs or young.

Kestrels used only those nest boxes with unobstructed entrances and open to moderate, but never dense canopy coverage. Dead snags or live trees with open trunks or large gaps in the branches were most often used (Fig. 1). All types of supporting structures to which nest boxes were fastened were utilized, including white fir, ponderosa pine, aspen, cottonwood, and telephone poles.

Of 54 boxes used by kestrels where direction was recorded, 19 faced south, 17 north, 11 west, and 7 east. Failure rates for each direction were 10, 18, 36, and 14%, respectively. The high failure rate of west facing nest boxes may be due to the intensity of the afternoon sun.

Discussion

American Kestrels readily accepted our nest boxes and fledged young in habitat that was previously unoccupied. Although it was not possible to qualify the increased number of pairs as a result of nest box installation, we are confident, because of earlier searches, that most areas lacked nesting kestrels before we installed nest boxes.

Because many of the nest boxes were intentionally placed in less than optimum trees or habitat conditions, we feel that the number of breeding attempts could be substantially increased. Particularly important is the placement of the box on the edge of a forest or on a lone tree and not deep inside the forest. Another important factor was unobstructed flight paths to next boxes. The lower use of an artificial box in an earlier similar study, also in juniper in the Great Basin of Utah (McArthur 1977), appears to be a result of the latter two variables (C.M White pers. comm).

During our study kestrel use of nest boxes steadily increased from 20% in 1977 to 38% in 1980. We feel that with careful placement, nest box use by kestrels could easily reach 50% in the Great Basin habitats of California.

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Literature Cited

Balgooyen, T., C. 1976. Behavior and ecology of the American Kestrel in the Sierra Nevada of California, *Calif. Publ. Zool.* 103:1-83.

Bloom, P.H. 1973. Seasonal variation in body weight of Sparrow Hawks in California, *West. Bird Bander* 48:4-5.

______. 1974. Some precautions to be used in banding studies of nesting raptors. *West. Bird Bander.* 49:4-5.

Brown, L. H., and D. Amadon. 1968. Eagles, hawks, and falcons of the world. 2 vols. McGraw-Hill, New York. pp. 771-776.

Burkhardt, W. J., and E. W. Tisdale. 1976. Causes of juniper invasion in southwest Idaho. *Ecology* 57:472-484.

Collopy, M. W. 1973. Predatory efficiency of American Kestrels wintering in northwestern California. *Raptor Res.* 7:25-31.

Craig, H. C., and C. H. Trost. 1979. The biology and nesting density of breeding American Kestrels and Long-eared Owls on the Big Lost River, southeastern Idaho. *Wilson Bull.*, 91:50-61.

Hamerstrom, Frances, F.N. Hamerstrom, Jr., and J. Hart. 1973. Nest boxes; an effective management tool for Kestrels. *J. Wildl. Manage.* 37:400-403.

Koplin, J.R. 1973. Differential habitat use by sexes of American Kestrels wintering in northern California. *Raptor Res.* 8:39-42.

McArthur, L. B. 1977. Utilization of nest boxes by birds in three vegetational communities with special reference to the American Kestrel (*Falco sparverius*). Abstract of theses, *Raptor Res.* 11:80.

Nagy, A. C. 1963. Population density of Sparrow Hawks in eastern Pennsylvania. *Wilson Bull.* 75:93.

Smith, D. G., C. R. Wilson, and H. H. Frost. 1972. The biology of the American Kestrel in central Utah. *Southwest Nat.* 17:73-83.

Stahlecker, D. W., and H. J. Griese. 1979. Raptor use of nest boxes and platforms on transmission towers. *Wildl. Soc. Bull.* 7:59-62.

PREY WEIGHTS FOR COMPUTING PERCENT BIOMASS IN RAPTOR DIETS

by
Karen Steenhof
Snake River Birds of Prey Research Project
Bureau of Land Management
3948 Development Avenue
Boise, Idaho 83705

Researchers have been assessing the relative importance of prey species in raptor diets for many years. Early in this century, biologists attempted to document the number of pest species consumed by raptors (e.g., Kalmbach et al. 1964). More recently, biologists have studied raptor diets to understand the effects of land use changes and environmental contaminants (e.g., Cade et al. 1968).

Frequency of an individual prey species in the diet is not always directly related to its nutritional importance (Southern 1954, Morris 1979). Raptors may consume several small items that provide less weight and energy than a single large prey item. To account for this, raptor diets are now usually reported in terms of biomass: frequency of a prey item multiplied by its average weight (e.g., McGahan 1966, 1967; Porter and White 1973; Smith and Murphy 1973; Marti 1974).

Accuracy of a biomass estimate depends on the accuracy of the weight assigned to a prey item. To ensure accuracy, weights for each prey species should be categorized by age and sex when appropriate. An average adult weight will distort relative importance of a prey species if raptors are consuming juveniles. Similarly, an average weight will distort results if one sex of a sexually diomorphic prey species is more vulnerable to raptor predation. Unfortunately, few studies have considered size classes in computing biomass in the diet.

Prey weights can rarely be obtained directly from pellet remains, partially consumed prey, or decomposed food items found in nests or under perches. Snout-vent lengths may be reliable indicators of snake weights (BLM unpublished data), and Morris (1979) and Hamilton (1980) reported a useful relationship between rodent jaw lengths and body weights. Unfortunately, similar relationships are not available for most prey species, and in most cases, weights of freshly collected animals or average weights reported in the literature must be used. During studies of raptor ecology in the Snake River Birds of Prey Area in southwestern Idaho, I compiled information on weights of 116 raptor prey species taken by 9 species of raptors (Table 1). These weights may be useful to others investigating predator-prey relations.

When possible, I used prey weights obtained in the area by BLM research project personnel. Nestling raptors and Common Ravens (*Corvus corax*) of various ages were weighted by BLM researchers in the nests; live cottontails (*Sylvilagus nuttallii*); woodrats (*Neotoma* spp.), and Townsend ground squirrels (*Spermophilus townsendii*) were weighted during trapping activities by BLM contractors from the University of Idaho; dead rodents captured in snap traps were weighed by contractors from Utah State University; and reptiles were weighed by L. Diller, University of Idaho. Weights of prey species not measured during the study were obtained from published literataure. In addition, C. Robbins and M. Fuller kindly provided weights for several birds from banding records, L.C. Stoddart provided weights for black-tailed jackrabbits (*Lepus californicus*), and M.R. Browning provided Say's Phoebe (*Sayornis saya*) weights from files at the National Museum. I calculated weights for prey items that could be identified only to class or genus by using the mean weight of identified individuals within that class or genus that were taken by raptors.

Size classes of prey were assigned either at the time remains were collected or when they were analyzed. Neonates included very small mammals just emerging from nests or burrows. Most other young of the year birds and mammals that were smaller than adults were classed as juveniles. An intermediate class was used for fledging-age birds, second year marmots (*Marmota flaviventris*) and rabbits less than approximately 3 months old but older than 1 month. Adults included any fully grown prey, and an average class was used for any prey item that could not be aged. Averages were calculated using relative proportions of known size classes in raptor diets. Juvenile weights for prey species that show large weight gains over a short period of time (e.g., Canada Goose (*Branta canadensis*); badger (*Taxidea taxus*), and mule deer (*Odocoileus hemionus*)) were estimated by considering the typical size of a young animal available to raptors during the nesting season. Because of large seasonal changes, weights assigned to Townsend ground squirrels depended on the months ground squirrels were found in nests.

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Table 1. Weights of Prey Species Captured by Raptors

Species	Size Class & Sex	Wt(g)	N	Reference
MAMMALS:				
Shrew-unid. (*Sorex* spp.)	Average	6	(1)	BLM Data
Pallid Bat (*Antrozous pallidus*)	Average	32		Burt & Grossenheider 1964
Bat-unid. (*Myotis* spp.)	Average	10	(2)	Porter & White 1973
Long-tailed Weasel (*Mustela frenata*)	Juvenile	85		Palmer 1954
	Adult	178		Smith & Murphy 1973
Badger (*Taxidea taxus*)	Neonate	2833		Estimated
Coyote (*Canis latrans*)	Juvenile	2043		Estimated
Domestic Cat (*Felis domesticus*)	Average	1800		Estimated

Table 1. Weights of Prey Species Captured by Raptors (cont.)

Species	Size Class & Sex		Wt(g)	N	Reference
Yellow-bellied Marmot	Neonate		500		Armitage et al. 1976
(*Marmota flaviventris*)	Juvenile		1000		" " " "
	Intermediate		2346	(38)	" " " "
		♂	2530	(10)	" " " "
		♀	2280	(28)	" " " "
	Adult		3222	(99)	" " " "
		♂	3900	(38)	" " " "
		♀	2800	(61)	" " " "
	Average		1808	(147)	BLM Data
Townsend Ground Squirrel	Juvenile:April		79	(480)	BLM Data
(*Spermophilus townsendii*)	Juvenile:May		120	(1282)	" "
		♂	127	(646)	" "
		♀	114	(636)	" "
	Juvenile:		199	(1331)	" "
	June-July	♂	184	(751)	" "
		♀	164	(580)	" "
	Adult:April		205	(1188)	" "
		♂	254	(440)	" "
		♀	178	(748)	" "
	Adult:May-June		222	(750)	" "
		♂	277	(285)	" "
		♀	188	(465)	" "
	Average:April		176	(3053)	" "
	Average:May-July		177	(4501)	" "
White-tailed Antelope Squirrel	Juvenile		40		Estimated
(*Ammospermophilus leucurus*)	Adult		106	(12)	Hall 1946
		♂	111	(6)	" "
		♀	101	(6)	" "
	Average		105	(40)	BLM Data
Ground squirrel-unid.	Juvenile		127		Calculated
	Adult		225		"
	Average		181		"
Least Chipmunk (*Eutamias minimus*)	Average		32	(108)	Schreiber 1973
Townsend Pocket Gopher	Juvenile		100		Estimated
(*Thomomys townsendii*)	Adult		248	(4)	Hall 1946
		♂	261	(3)	" "
		♀	236	(1)	" "
	Average		200		Calculated
Great Basin Pocket Mouse	Juvenile		10		Estimated
(*Perognathus parvus*)	Adult		17	(508)	BLM Data
Ord Kangaroo Rat	Juvenile		28		Estimated
(*Dipodomys ordii*)	Adult		53	(31)	Schreiber 1973
Harvest Mouse (*Reithrodontomys megalotis*)	Adult		11	(43)	Schreiber 1973
Deer Mouse	Juvenile		10		Estimated
(*Peromyscus maniculatus*)	Adult		19	(145)	Schreiber 1973

Table 1. Weights of Prey Species Captured by Raptors (cont.)

Species	Size Class & Sex		Wt(g)	N	Reference
Grasshopper Mouse (*Onychomys leucogaster*)	Adult		26	(76)	BLM Data
Mouse-unid.	Juvenile		10		Calculated
	Adult		17		"
Desert Woodrat (*Neotoma lepida*)	Juvenile		75		Estimated
	Adult		124	(10)	BLM Data
		♂	137	(6)	" "
		♀	105	(4)	" "
Bushy-tailed Woodrat (*Neotoma cinerea*)	Juvenile		155	(7)	Martin 1973
	Adult		338	(32)	" "
		♂	405	(16)	" "
		♀	271	(16)	" "
	Average		277		" "
Woodrat-unid. (*Neotoma* spp.)	Juvenile		195	(45)	BLM Data
	Adult		326	(87)	" "
		♂	335	(70)	" "
		♀	275	(16)	" "
	Average		281		" "
Muskrat (*Ondatra zibethica*)	Juvenile		1065		Donahoe 1966
		♂	1097		" "
		♀	1032		" "
	Adult		1277		" "
		♂	1298		" "
		♀	1256		" "
	Average		1171	(1895)	" "
House Mouse (*Mus musculus*)	Average		19	(16)	BLM Data
Montane Vole (*Microtus montanus*)	Juvenile		15		*
	Adult		50		"
		♂	60		"
		♀	40		"
	Average		35		"
Sagebrush Vole (*Lagurus curtatus*)	Average		30		Burt & Grossenheider 1964
Rodent-unid.	Juvenile		10		Estimated
	Adult		50		Estimated
	Average		50		"
Porcupine (*Erethizon dorsatum*)	Adults		5800		Smith pers. comm.
Black-tailed jackrabbit (*Lepus californicus*)	Fetus		20		
	Neonate		100		Stoddart pers. comm.
	Juvenile		500	"	" "

Table 1. Weights of Prey Species Captured by Raptors (cont.)

Species	Size Class & Sex		Wt(g)	N	Reference
Black-tailed Jackrabbit	Intermediate		1000		Stoddart pers. comm.
(*Lepus californicus*)	Adult		2114		" " "
		♂	1885		" " "
		♀	2344		" " "
	Average		1536		Calculated
Mountain Cottontail	Neonate		100		BLM Data
(*Sylvilagus nuttallii*)	Juvenile		215		" "
	Intermediate		500		" "
	Adult		650	(92)	" "
		♂	590	(45)	" "
		♀	720	(47)	" "
Pygmy Rabbit (*Sylvilagus idahoensis*)	Adult		340		Burt & Grossenheider 1964
Rabbit-unid.	Neonate		100		Calculated
	Juvenile		404		"
	Intermediate		1087		"
	Adult		1550		"
	Average		927		"
Mule Deer (*Odocoileus hemionus*)	Juvenile		3780		McGahan 1966
Pronghorn Antelope (*Antilocapra americana*)	Neonate		2700		Beuchner 1950
BIRDS:					
Great Blue Heron (*Ardea herodias*)	Average		1905	(1)	Poole 1938
Canada Goose (*Branta canadensis*)	Juvenile		450		Estimated
Mallard	Adult		1185	(3226)	Bellrose 1976
(*Anas platyrhynchos*)		♂	1248	(1809)	" "
		♀	1107	(1417)	" "
Northern Pintail	Adult		976	(556)	Bellrose 1976
(*Anas acuta*)		♂	1025	(390)	" "
		♀	866	(166)	" "
American Green-winged Teal	Adult		316	(192)	Bellrose 1976
		♂	322	(113)	" "
(*Anas crecca*)		♀	309	(79)	" "
Blue-winged Teal	Adult		395	(164)	Bellrose 1976
(*Anas discors*)		♂	463	(35)	"
		♀	377	(129)	"

Table 1. Weights of Prey Species Captured by Raptors (cont.)

Species	Size Class & Sex		Wt(g)	N	Reference
Cinnamon Teal	Adult		347	(24)	Bellrose 1976
(*Anas cyanoptera*)		♂	340	(13)	"
		♀	354	(11)	"
Teal-unid.	Average		361		Bellrose 1976
American Wigeon	Adult		794	(152)	Bellrose 1976
(*Anas americana*)		♂	821	(84)	" "
		♀	767	(68)	" "
	Intermediate		751	(731)	" "
		♂	794	(358)	" "
		♀	708	(373)	" "
Northern Shoveler	Adult		658	(41)	Bellrose 1976
(*Anas clypeata*)		♂	680	(21)	" "
		♀	635	(20)	" "
Duck-unid.	Nestling		100		Calculated
	Juvenile		425		"
	Adult		899		"
		♂	1003		"
		♀	659		"
	Average		767		"
Red-tailed Hawk	Juvenile		800		Estimated
(*Buteo jmaicensis*)	Adult		1049	(39)	BLM Data
		♂	957	(90)	" "
		♀	1154	(113)	" "
Ferruginous Hawk	Intermediate		1110	(49)	BLM Data
(*Buteo regalis*)		♂	1040	(20)	" "
		♀	1228	(13)	" "
Prairie Falcon	Intermediate		701	(87)	BLM Data
(*Falco mexicanus*)		♂	570	(195)	" "
		♀	810	(172)	" "
American Kestrel	Juvenile		57		Estimated
(*Falco sparverius*)	Adult		114	(117)	Craighead & Craighead 1956
Northern Bobwhite	Adult		171	(1591)	Johnsgard 1973
(*Colinus virginianus*)		♂	173	(899)	" "
		♀	170	(692)	" "
California Quail	Juvenile		70	(54)	Lewin 1963
(*Callipepla californica*)	Adult		170	(374)	" "
Ring-necked Pheasant	Juvenile		600		Estimated
(*Phasianus colchicus*)	Adult		1138	(361)	Robertson 1958
		♂	1362	(77)	" "
		♀	1078	(284)	" "
Chukar	Juvenile		300		Estimated
(*Alectoris chukar*)	Adult		602	(50)	Galbreath & Moreland 1953

Table 1. Weights of Prey Species Captured by Raptros (cont.)

Species	Size Class & Sex		Wt(g)	N	Reference
Gray Partridge	Adult		389	(144)	Nelson & Martin 1953
(*Perdix perdix*)					
Domestic Chicken	Bantam		908		Estimated
	Adult		3120		Welty 1962
Gallinceous bird-unid	Juvenile		444		Calculated
(Galliformes)	Adult		940		"
	Average		727		"
Rail-unid.	Adult		70	(2)	Poole 1938
American Coot	Adult		654	(47)	Fredrickson 1969
(*Fulica americana*)					
Killdeer	Adult		104	(2)	Robbins pers. comm.
(*Charadrius vociferus*)					
Shorebird-unid.	Adult		497		Estimated
(*Charadriiformes*)					
Ring-billed Gull	Juvenile		497	(39)	Vermeer 1970
(*Larus delawarensis*)					
Gull-unid.	Adult		633	(78)	" "
(*Larus* spp.)					
Rock Dove	Adult		332	(9)	BLM Data
(*Columba livia*)					
Mourning Dove	Juvenile		131	(10)	Ivacic & Labisky 1973
(*Zenaida mcroura*)	Average		134	(10)	" " "
Common Barn Owl	Adult		525	(78)	Marti pers. comm.
(*Tyto alba*)		♂	461	(28)	" " "
		♀	561	(50)	" " "
Great Horned Owl	Adult		1310	(188)	Earhart & Johnson 1970
(*Bubo virginianus*)		♂	1110	(94)	" " " "
		♀	1509	(94)	" " " "
Burrowing Owl	Average		170	(22)	Thomsen 1971
(*Athene cunicularia*)					
Short-eared Owl	Juvenile		200		Clark 1975
(*Asio flammeus*)	Adult		348	(4)	" "
		♂	304	(2)	" "
		♀	393	(2)	" "
Common Poorwill	Adult		43	(1)	Lasiewski et al. 1971
(*Phalaenoptilus nuttallii*)					
Common Nighthawk	Average		83	(2)	Esten 1931
(*Chordeiles minor*)					

Table 1. Weights of Prey Species Captured by Raptors (cont.)

Species	**Size Class & Sex**	**Wt(g)**	**N**	**Reference**
Say's Phoebe (*Sayornis saya*)	Adult	23	(16)	USFWS files
Horned Lark (*Eremophila alpestris*)	Juvenile	17	(14)	Beason & Franks 1973
	Adult	26		Trost 1972
Cliff Swallow (*Hirundo pyrrhonata*)	Adult	25	(10)	Withers 1977
Northern Rough-winged Swallow (*Stelgidopteryx serripennis*)	Adult	16	(2)	Poole 1938
Swallow-unid.	Adult	25	(10)	Withers 1977
Blue Jay (*Cyanocitta cristata*)	Adult	74	(1)	Esten 1931
Pinyon Jay (*Gymnorhinus cyanocephalus*)	Adult	108	(1)	Poole 1938
Black-billed Magpie (*Pica pica*)	Adult	170	(28)	Linsdale 1937
Common Raven (*Corvus corax*)	Adult	1234		White & Cade 1971
	Juvenile	650		BLM Data
	Average	876	(175)	" "
Common Crow (*Corvus brachyrhynchos*)	Adult	460	(6)	Balwin & Kendeigh 1938
Red-breasted Nuthatch (*Sitta canadensis*)	Adult	11	(19)	Mugaas & Templeton 1970
Marsh Wren (*Cistothorus palustris*)	Adult	11	(76)	Robbins pers. comm.
Canyon Wren (*Catherpes mexicanus*)	Adult	10	(2)	Johnson 1965
Rock Wren (*Salpinctes obsoletus*)	Adult	17	(1)	Easterla & Ball 1973
Sage Thrasher (*Oreoscoptes montanus*)	Adult	37	(2)	Killpack 1970
American Robin (*Turdus migratorius*)	Adult	79	(1781)	Robbins pers. comm.
Hermit Thrush (*Catharus guttatus*)	Adult	31	(4)	Baldwin & Kendeigh 1938
Mountain Bluebird (*Sialia currucoides*)	Adult	35		Balda et al. 1972

Table 1. Weights of Prey Species Captured by Raptors (cont.)

Species	Size Class & Sex		Wt(g)	N	Reference
Water Pipit (*Anthus spinoletta*)	Adult		19	(1)	Poole 1938
Loggerhead Shrike (*Lanius ludovicianus*)	Adult		51	(4)	Robbins pers. comm.
European Starling (*Sturnus vulgaris*)	Adult		79	(18)	Robbins pers. comm.
Yellow Warbler (*Dendroica petechia*)	Adult		10	(366)	Robbins pers. comm.
Yellow-breasted Chat (*Icteria virens*)	Adult		26	(4)	Stewart
Western Meadowlark	Juvenile		40		Estimated
(*Sturnella neglecta*)	Adult		95	(11)	Lanyon 1962
Yellow-headed Blackbird	Adult		74		Willson 1966
(*Xanthocephalus xanthocephalus*)		♂	91		" "
		♀	56		
Red-winged Blackbird	Adult		48	(203)	Robbins pers. comm.
(*Agelaius phoeniceus*)		♂	62	(28)	" " "
		♀	42	(18)	" " "
Northern Oriole (*Icterus galbula*)	Adult		33	(7)	Baldwin & Kendeigh 1938
Brewers Blackbird (*Euphagus cyanocephalus*)	Adult		65	(10)	Balph 1975
Brown-headed Cowbird (*Molothrus ater*)	Adult		41	(25)	Robbins pers. comm.
Lazuli Bunting (*Passerina amoena*)	Adult		15		Bock & Lynch 1970
House Finch (*Carpodacus mexicanus*)	Adult		22	(32)	Robbins pers. comm.
Rufous-sided Towhee (*Pipilo erythrophthalmus*)	Adult		41	(1116)	Robbins pers. comm.
Grasshopper Sparrow (*Ammodramus savannarum*)	Adult		16	(2)	Stewart 1937
Vesper Sparrow (*Pooecetes gramineus*)	Adult		27	(1)	Poole 1938
Lark Sparrow (*Chondestes grammacus*)	Adult		28	(1)	Robbins pers. comm.

Table 1. Weights of Prey Species Captured by Raptors (cont.)

Species	Size Class & Sex	(Wt(g)	N	Reference
Sage Sparrow	Juvenile	10		Estimated
(*Amphispiza belli*)	Adult	18	(77)	Moldenhauer & Wiens 1970
White-crowned Sparrow	Adult	27	(90)	Morton et al. 1973
(*Zonotrichia leucophrys*)				
Song Sparrow	Adult	21	(1553)	Baldwin & Kendeigh 1938
(*Melospiza melodia*)				
Sparrow-unid.	Juvenile	10		Calculated
	Adult	26		"
Passerine-unid.	Juvenile	28		Calculated
	Adult	56		"
AMPHIBIANS:				
Spadefoot Toad	Adult	12		Seymour 1973
(*Scaphiopus intermontanus*)				
Woodhouse's Toad	Adult	20		Diller pers. comm.
(*Bufo woodhousei*)				
Toad-unid.	Adult	20		Diller pers. comm.
Leopard Frog	Adult	38		Seymour 1973
(*Rana pipiens*)				
Bullfrog	Juvenile	250		Diller pers. comm.
(*Rana catesbeiana*)	Adult	500		" " "
Frog-unid.	Average	30		Estimated
REPTILES:				
Collared Lizard	Adult	34	(18)	BLM Data
(*Crotaphytus collaris*)	Average	23	(38)	" "
Leopard Lizard	Adult	26	(31)	BLM Data
(*Gambelia wislizenii*)	Average	23	(38)	" "
Western Fence Lizard	Adult	18	(40)	BLM Data
(*Sceloporus occidentalis*)	Average	17	(44)	" "
Side-blotched Lizard	Average	4	(69)	BLM Data
(*Uta stansburiana*)				
Horned Lizard	Adult	24	(42)	BLM Data
(*Phrynosoma platyrhinos*)	Average	18	(77)	" "
Whiptail Lizard	Adult	17	(39)	BLM Data
(*Cnemidophorus tigris*)	Average	15	(44)	" "

Table 1. Weights of Prey Species Captured by Raptors (cont.)

Species	Size Class & Sex	Wt(g)	N	Reference
Lizard-unid.	Juvenile	8		Calculated
	Adult	21		"
	Average	17		"
Racer (*Coluber constrictor*)	Average	77	(24)	BLM Data
Striped Whipsnake	Adult	111	(223)	BLM Data
(*Masticophis taeniatus*)	Average	102	(246)	" "
Gopher Snake	Juvenile	19		BLM Data
(*Pituophis melanoleucus*)	Adult	226	(355)	" "
	Average	202	(405)	" "
Long-Nosed Snake	Adult	85	(29)	BLM Data
(*Rhinocheilus lecontei*)		73	(35)	" "
Garter Snake (*Thamnophis elegans*)	Average	109	(8)	BLM Data
Ground Snake	Juvenile	2		BLM Data
(*Sonora semiannulata*)	Adult	9	(26)	" "
	Average	8	(31)	" "
Nightsnake	Adult	15	(45)	BLM Data
(*Hypsiglena torquata*)	Average	14	(52)	" "
Western Rattlesnake	Juvenile	19		BLM Data
(*Crotalus viridis*)	Adult	425	(319)	" "
	Average	393	(352)	" "
Snake-unid.	Average	190		Calculated
Reptile-unid.	Average	111		Calculated

* Weight values derived from a variety of sources including Hall (1946), Frenzel (1979), Marti (pers. comm.), unpublished BLM data and specimens examined at Boise State University.

Literature Cited

Armitage, K.B., J.F. Downhower, and G.E. Svendson. 1976. Seasonal change in weights of marmots. *Am. Midl. Nat.* 96:36-51.

Balda, R.P., G.C. Bateman, and G.F. Foster. 1972. Flocking associates of the Pinyon Jay. *Wilson Bull.* 84:60-76.

Baldwin, S.P. and S.C. Kendeigh. 1938. Variations in the weight of birds. *Auk* 55:416-467.

Balph, M.H. 1975. Development of young Brewer's Blackbirds. *Wilson Bull.* 87:207-230.

Beason, R.C. and E.C. Franks. 1973. Development of young Horned Larks. *Auk* 90:359-363.

Bellrose, F.C. 1976. Ducks, geese, and swans of North America. Harrisburg, PA.:Stackpole Books. 543 pp.

Beuchner, H.K. 1950. Life history, ecology, and range use of the pronghorn antelope in trans-Pecos Texas. *Am. Midl. Nat.* 43:257-354.

Bock, C.E. and J.F. Lynch. 1970. Breeding bird populations of burned and unburned conifer forest in the Sierra Nevada. *Condor* 72:182-189.

Burt, W.H. and R.P. Grossenheider, 1964. A field guide to the mammals. Boston: Houghton Mifflin Co. 289 pp.

Cade, T.J., C.M. White, and J.R. Haugh. 1968. Peregrines and pesticides in Alaska. *Condor* 70:170-178.

Clark, R.J. 1975. A field study of the Short-eared Owl *Asio flammeus* Pontoppidan in North America. *Wildl. Monogr.* 47:1-67.

Craighead, J.J. and F.C. Craighead, Jr. 1956. Hawks, owls, and wildlife. Dover Public., New York, N.Y. 443 pp.

Donahoe, R.W. 1966. Muskrat reproduction in areas of controlled and uncontrolled water-level units. *J. Wildl. Manage. 30.320-326.*

Earhart, C.M. and N.K. Johnson. 1970. Size dimorphism and food habits of North American owls. *Condor* 72:251-264.

Easterla, D.A. and R.E. Ball. 1973. The Rock Wren in Missouri. *Wilson Bull.* 85:479-480.

Esten, S.R. 1931. Bird weights of 52 species of birds (taken from notes of Wm. Van Gorder). *Auk* 48:572-74.

Fredrickson, L.H. 1969. Mortality of coots during severe spring weather. *Wilson Bull.* 81:450-453.

Frenzel, R.W. 1979. The effects of prescribed burning on small mammal communities in Lava Beds National Monument, California. M.S. Thesis. Oregon State Univ., Corvallis. 79 pp.

Galbreath, D.S. and R. Moreland. 1953. The Chukar Partridge in Washington. Wash. State Game Dept. Bio. Bull. 11. 54 pp.

Hall, E.R. 1946. Mammals of Nevada. Berkeley:Univ. Calif. Press. 710 pp.

Hamilton, K.L. 1980. A technique for estimating Barn Owl prey biomass. *Raptor Res.* 14:52-55.

Ivacic, D.L. and R.F. Labisky. 1973. Metabolic responses of Mourning Doves to short term food and temperature stresses in winter. *Wilson Bull.* 85:182-196.

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

Johnson, N.K. 1965. The breeding avifaunas of the sheep and spring ranges in southern Nevada. *Condor* 67:93-124.

Killpack, M.L. 1970. Notes on Sage Thrasher nestlings in Colorado. *Condor* 72:486-488.

Kalmbach, E.R., R.H. Imler, and L.W. Arnold. 1964. The American eagles and their economic status. U.S. Dept. Inter. Fish and Wildl. Serv. Circ. 27 & 30.

Lanyon, W.E. 1962. Specific limits and distribution of meadowlarks on the desert grassland. *Auk* 79:183-207.

Lasiewski, R.C., M.H. Bernstein, and R.D. Ohmart. 1971. Cutaneous water loss in the Road-runner and Poor-will. *Condor* 73:470-471.

Lewin, V. 1963. Reproduction and development of young in a population of California Quail. *Condor* 65:249-272.

Linsdale, J.M. 1937. The natural history of magpies. Cooper Ornithological Club, *Pacific Coast Avifauna* No. 25. 234 pp.

Marti, C.D. 1974. Feeding ecology of four sympatic owls. *Condor* 76:45-61.

Martin, R.J. 1973. Growth curves for bushy-tailed woodrats based upon animals raised in the wild. *J. Mammal.* 54:517-518.

McGahan, J. 1966. Ecology of the Golden Eagle. M.S. Thesis. Univ. of Montana. 78 pp.

McGahan, J. 1967. Quantified estimates of predation by a Golden Eagle population. *J. Wildl. Manage.* 31:496-501.

Moldenhauer, R.R. and J.A. Wiens. 1970. The winter economy of the Sage Sparrow, *Amphispiza belli nevadensis. Condor* 72:265-275.

Morris, P. 1979. Rats in the diet of the Barn Owl (*Tyto alba*). *J. Zool. Lond.* 189:540-545.
Morton, M.L., J.L. Horstmann, and C. Carey. 1973. Body weights and lipids of summering mountain White-crowned Sparrows in California. *Auk.* 90:83-93.
Mugaas, J.N. and J.R. Templeton. 1970. Thermoregulation in the Red-breasted Nuthatch. *Condor* 72:125-132.
Nelson, A.L. and A.C. Martin. 1953. Gamebird weights. *J. Wildl. Manage.* 17:36-42.
Palmer, R.S. 1954. The mammal guide. Garden City, NY: Doubleday and Co. 384 pp.
Poole, E.L. 1938. Weights and wing areas in North American birds. *Auk* 55:511-517.
Porter, R.D. and C.M. White. 1973. The Peregrine Falcon in Utah, emphasizing ecology and competition with the Prairie Falcon. Brigham Young Univ. Sci. Bull. 18:1-74.
Robertson, W.B., Jr. 1958. Investigations of Ring-necked Pheasants in Illinois. Ill. Dept. Conserv. Tech. Bull. 1. 137 pp.
Schreiber, R.K. 1973. Bioenergetics of rodents in the northern Great Basin desert. Ph.D. Thesis. Univ. of Idaho. 133 pp.
Seymour, R.S. 1973. Physiological correlates of forced activity and burrowing in the spadefoot toad *Scaphiopus hammondi*. *Copeia* 1973:103-115.
Smith, D.G. and J.R. Murphy. 1973. Breeding ecology of raptors in the eastern Great Basin of Utah. Brigham Young Univ. Sci. Bull. Biol. Ser. 18:1-76.
Southern H.N. 1954. Tawny Owls and their prey. *Ibis* 96:384-410.
Stewart, P.A. 1937. A preliminary list of bird weights. *Auk* 54:324-332.
Thomsen, L. 1971. Behavior and ecology of Burrowing Owls on the Oakland Municipal Airport. *Condor* 73:177-192.
Trost, C.H. 1972. Adaptations of Horned Larks *Eremophila alpestris* to hot environments. *Auk* 89:506-527.
Vermeer, K. 1970. Breeding biology of California and Ring-billed Gulls. Can. Wildl. Serv. Rep. 12. 52 pp.
Welty, J.C. 1962. The life of birds. Philadelphia: W.B. Lander Co. 546 pp.
White, C.M. and T.J. Cade. 1971. Cliff-nesting raptors and ravens along the Colville River in Arctic Alaska. *Living Bird* 10:107-150.
Willson, M.F. 1966. Breeding ecology of the Yellow-headed Blackbird. *Ecol. Monogr.* 36:51-77.
Withers, P.C. 1977. Energetic aspects of reproduction by the Cliff Swallow. *Auk.* 94:718-725.

NEST SITE SELECTION BY PEREGRINE FALCONS

by
David A. Ponton
Los Alamos National Laboratory
P.O. Box 1663
Los Alamos, New Mexico 87545

The Peregrine Falcon (*Falco peregrinus*) is known to use different nest sites (nest ledges) at a particular cliff, either in successive years, or in response to the loss of a clutch of eggs (Herbert and Herbert, 1965; Porter and White, 1973; Ratcliffe, 1980). In Great Britain, at least 4 alternative nest sites are used at most eyries, and one had 8 (one involving a repeat clutch) in 9 seasons (Ratcliffe, 1980).

A peregrine eyrie in northern New Mexico is unusual in that 10 different nest sites were used in 10 consecutive seasons. The nest sites are eroded potholes in volcanic tuff along 1 km of cliff, where approximately 150 similar holes are available.

The large availability of suitable sites apparently facilitated non-repetitive selection. In the 11th and 12th years, the female apparently failed to lay eggs. A new female appeared in 1976 and laid eggs in 1977, 1978, and 1979, continuing the pattern of selecting new nest sites each year. However, two second (repeat) clutches were laid in previously used sites. Specifically, the 1978 second clutch was laid in the 1977 nest site, and the 1979 second clutch was laid in the site used for the first clutch in 1978. This pattern, i.e., the second choice of nest site having been the first choice the year before, I have termed the "fall-back-one" behavior.

The only historical event common to both second clutch sites is egg laying. I suggest that preference for location of the second clutch is for a site where egg laying and associated behavior have been ritualized in the nearest past. Previous nesting success at that site is incidental. If the "fall-back-one" behavior pattern is, in fact, common in peregrines, it should aid in predicting the location of second clutches.

I thank Wayne Hanson for locating nest sites in 1978, and John Hubbard and Wayne Pilz for reviewing earlier drafts.

Literature Cited

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

Porter, R.D. and C.M. White, 1973. The Peregrine Falcon in Utah, Emphasizing Ecology and Competition with the Prairie Falcon. *BYU Science Bulletin*, Bio. Series, Volume XVIII, No. 1. 74 pp.

Ratcliffe, D. 1980. The Peregrine Falcon. Buteo Books, USA and T. & A.D. Poyser Ltd., Great Britain. 416 pp.

Carnus hemapterus NITZSCH FROM SWAINSON'S HAWK

by
Richard E. Fitzner
Ecological Sciences Department
Battelle, Pacific Northwest Laboratory
Box 999
Richland, WA 99352
and
Norman E. Woodley
Museum of Comparative Zoology
Harvard University
Cambridge, MA 02138

The wingless ectoparasitic fly (*Carnus hemapterus*, Nitzsch) was first reported on North American birds by Bequaert (1942) although in Europe, *C. hemapterus* seems to be fairly generally distributed. Bequaert (1942) identified the fly from 2 birds, a nestling flicker (*Colaptes cafer*) collected at Penn Yann, New York and a Screech Owl (*Asio otus*) taken in Florida. Capelle and Whiteworth (1973) have since reviewed the distribution of *C. hemapterus* in North America, siting records for 9 host species, including 3 woodpeckers, starling (*Sturnus vulgaris*), Black-billed Magpie (*Pica pica*) and American Kestrel (*Falco sparverius*). Main and Wallis (1974) found *C. hemapterus* on nestling Osprey (*Pandion haliaetus*) in Massachusetts and Wilson (1977) found Pileated Woodpecker (*Dryocopus pileatus*) nesting material to contain the parasites. These records, seem to indicate that *Carnus* is widespread in the United States. Its distribution, however, will be unclear until there is a systematic study of bird ectoparasites in this country.

Bequaert (1942) reports the *C. hemapterus* has been observed on 12 families and 26 species of birds in Europe. Seven raptor species, White-tailed Eagle (*Haliaeetus albicilla*), Imperial Eagle (*Aquila heliaca*), Peregrine Falcon (*Falco peregrinus*), Kestrel (*F. tennunculus*), Saker (*F. cherrug*), Barn Owl (*Tyto alba*), and Tengmalm's Owl (*Aegolius funereus*) have been noted as host.

In July of 1980, while examining nestling Swainson's Hawks (*Buteo swainsoni*), we found that 12 of the 15 nestlings we studied were parasitized by *C. hemapterus*. The flies occurred in groups of 3 to 5 and were found only in the axillary region of the hawks. No flies were attached and on being disturbed they moved from the bare axillary region to nearby feathered areas. The exact nature of the diet of *C. hemapterus* is unknown. Noller (1920) reports that the fly sucks blood from its host, while Hendel (1928) felt that *Carnus* feeds most probably on skin secretions. We observed dried blood spots on the hawks axillary region which is supportive of Noller's (1920) claim. The true diet of the fly is presently in question, but the fly could act as a vector of certain avian blood parasites.

Our findings are of interest, since few records have been reported for *C. hemapterus* in non-cavity nesting birds or from long-distance migrants like the Swainson's Hawk. Our report is also the first record of this dipteran parasite on the Swainson's Hawk.

Literature Cited

Bequaert, J. 1942. *Carnus hemapterus* Nitzsch, an ectoparasitic fly of birds, New to America (Diptera). *Bull. Brooklin Ent. Soc.* 37:140-149.

Capell, K.J., and T.L. Whiteworth. 1973. The distribution and avian hosts of *Carnus hemapterus* (Diptera:milichiidae) in North America. *J. Med. Ent.* 10:525-526.

Hendel, F. 1928. Zweiflügler order Diptera. II. Allgemeiner Teil. in F. Dahl, Die Tierwelt Deutschlands, XI, Dipt., Pt. 2, pp. 1-135.

Main, A.J., and R.C. Wallis. 1974. Primary records of two vertebrate ectoparasites in New England (Acarina:Argasidae and Diptera:Milichiidae). *Proc. Entomol. Soc. Washington* 76:427.

Noller, W. 1920. Die Ergebnisse der Hemoptroteus-Forschung. Zugleich vorläufige Mitteilung über Züchtungsversuche an einigen anderen Trypanosomen. *Arch. F. Protistenk.*, 41:149-168.

Wilson, N. 1977. Ectoparasites found in the nest cavities of Pileated Woodpeckers in Oregon. *Bird-Banding* 48:171-173.

THREE ADULT BALD EAGLES AT AN ACTIVE NEST[1]

by
James D. Fraser[2]
L.D. Frenzel
Department of Entomology, Fisheries, and Wildlife,
University of Minnesota, St. Paul, MN 55108
John E. Mathisen
Chippewa National Forest
Cass Lake, MN 56633
and
Mark E. Shough
Bemidji Aviation Inc.
Bemidji, MN 56601

Although Bald Eagle (*Haliaeetus leucocephalus*) trios have been observed at nests in Alaska (Sherrod et al. 1976, Heglund and Reiswig 1980), we are unaware of similar reports in the coterminous United States. Here we describe 4 observations of 3 adult eagles at a nest on the Chippewa National Forest, north central Minnesota. The nest was observed 93 times between March and October in 1976-1978. All observations were made from fixed-wing aircraft.

On 7 April 1976, an adult eagle was observed in the nest in incubating posture; 2 others, 1 in adult plumage and 1 with an off-white head similar to Southern's (1967) plumage F, were perched next to the nest. On 22 June 1977, an adult with a nearly white head was in the nest with 2 nestlings, another adult was in the nest tree, and a third adult was in a tree approximately 100 m to the south. On 7 April 1978, an adult was in incubating posture while 2 others were perched together in the nest tree. On 30 June 1978, 2 adults and 1 nestling were in the nest and a third adult was perched 200-300 m to the north. One fledgling was produced in 1976, 2 in 1977, and 1 in 1978. Because our observations were brief, we were unable to determine the nature of interactions among the eagles involved. It is not clear to us, therefore, what role, if any, the 3rd adult played in the nesting effort.

Sherrod et al. (1976) reported 3 sites occupied by trios on Amchitka Island, Alaska. Three Amchitka nests were also occupied by trios in 1980 and one of these contained 4 eggs (Heglund and Reiswig 1980). Both Herrick (1934:106) and Bent (1937:325) reported 4-egg clutches for the Bald Eagle, and Bent suggested that the eggs may have been produced by more than 1 female.

The data suggest that Bald Eagles are occasionally polygynous. Detailed behavioral observations of trios are required to test this hypothesis, however.

The Amchitka population apparently has not experienced the level of reproductive failure reported for eagle populations elsewhere (Sprunt et al. 1973, Sherrod et al. 1976) and the Chippewa population appears to be recovering rapidly from effects of contamination (Fraser 1981). The 4-egg clutches reported by Herrick (1934) and Bent (1937) were laid well before the earliest report of widespread Bald Eagle nest failures (Broley 1950). Perhaps trios occur most frequently at nests in healthy Bald Eagle populations. If so, trios may become more common in the coterminous states if Bald Eagle reproduction and survival improve.

[1]Paper No. 12,049, Scientific Journal Series, Minnesota Agricultural Experiment Station, University of Minnesota, St. Paul, MN 55108

[2]Present Address: Department of Fisheries and Wildlife Sciences, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061.

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Literature Cited

Bent, A.C. 1937. Life histories of North American birds of prey. Part I. U.S. Natl. Mus. Bull. 167. Dover Publ., New York. 409 pp.

Broley, C.L. 1950. The plight of the Florida Bald Eagle. *Audubon* 52:42-9.

Fraser, J.D. 1981. The breeding biology and status of the Bald Eagle on the Chippewa National Forest. Unpubl. Ph.D. Diss., Univ. of Minnesota, St. Paul. 236 pp.

Heglund, P.J., and B. Reiswig. 1980. 1980 Raptor survey, the breeding Bald Eagle population, Amchitka Island, Alaska. Unpubl. rep., U.S.D.I. Fish and Wildl. Serv., Aleutian Islands National Wildlife Refuge. 19 pp.

Herrick, F.H. 1934. The American eagle: a study in natural and civil history. Applet

Sherrod, S.K., C.M. White, and F.S.I. Williamson. 1976. Biology of the Bald Eagle on Amchitka Island, Alaska. *Living Bird* 15:143-182.

Southern, W.F. 1967. Further comments on subadult Bald Eagle plumages. *Jack Pine Warbler* 45:70-80.

Sprunt, A., IV, W.B. Robertson, Jr., S. Postupalsky, R.J. Hensel, C.F. Knoder, and F.J. Ligas. 1973. Comparative productivity of six Bald Eagle populations. *Trans. N. Amer. Wildl. Conf.* 38:96-106.

ABSTRACTS OF THESES AND DISSERTATIONS

ARTIFICIAL PERCH USE BY RAPTORS ON RECLAIMED SURFACE MINES IN WEST VIRGINIA

Raptor use of 24 artificial perches on 4 reclaimed surface mines in West Virginia was studied from May to October, 1980. Each perch had crosspieces at heights of 3 and 6 m. Perch use was documented by direct observations and use of 24 automatic event recorders. More than 99% of total use by raptors was made by American Kestrels *(Falco sparverius.)* Red-tailed Hawks (*Buteo jamaicensis*) and, as indicated by the event recorders, possibly Great Horned Owls (*Bubo virginianus*) made relatively small use of the perches. The 6-m crosspieces were used substantially more than the lower heights and this choice was independent of topography. Relationships among perch use, prey abundance, and vegetational structure were evaluated and, based on these variables, models were generated to predict perch use by the 3 raptor species. Vegetational structure appeared to be important in determining perch use by all 3 species but use by kestrels may be determined more by insect prey.

Forren, John D. 1981. Artificial perch use by raptors on reclaimed surfce mines in West Virginia. M.S. Thesis, West Virginia University, Morgantown. 199 pp.

KESTREL USE OF NEST BOXES ON RECLAIMED SURFACE MINES IN WEST VIRGINIA AND PENNSYLVANIA

Kestrel (*Falco sparverius*) use of mines with boxes (treatment) and without boxes (control) was studied in a 4-county area in northern West Virginia and southern Pennsylvania during March to August of 1980 and 1981. Kestrels did not nest on nor was any breeding activity observed at 6 control mines during either year of the study. In contrast, Kestrels accepted 14 of

60 (23%) boxes on 10 of 18 (56%) treatment mines in 1980, and accepted 33 of 91 (36%) boxes on 19 of 24 (79%) treatment mines in 1981. During the 2-year study, 122 young fledged from these boxes. Of 14 boxes accepted by Kestrels in 1980, 13 (93%) were reoccupied in 1981. Nesting chronology, clutch sizes, and productivity were comparable to published studies of kestrels on unmined areas.

A search of the mines and adjacent woods borders revealed that natural cavities were absent on 20 of 30 (67%) sites. Kestrels nested in 1 natural cavity, on a treatment mine, and nested in boxes on 14 mines that lacked natural cavities.

To examine the relationship among box use, mine, and site characteristics, the following information was recorded: individual box use by Kestrels, site characteristics for individual nest boxes, vegetation characteristics for each mine, and insect and rodent abundance. Stepwise discriminant analysis of 10 nest box location variables revealed that a single variable, the distance of a box to a woods border was the most important for classifying box use by Kestrels during each year of the study. Group means of this variable were significantly higher for used boxes than unused boxes, indicating that used boxes were farther from a woods border. Only 10 of 65 (15%) availble woods border boxes were used during the study period while 47% of all boxes erected 50 m or more from a woods border were used. Effective management of kestrels involves erecting boxes on isolated trees that are at least 50 m from a woods border.

Mines where boxes were used were characterized by a significantly lower percent of bare ground and a deeper litter depth than unused mines. Unreclaimed or marginally reclaimed mines with excessive bare ground may be unsuitable Kestrel habitat even if boxes are provided. Recommendations for managing Kestrels on reclaimed surface mines are provided.

Noteworthy behavioral observations were made during the study period. Vigorous defense of a nest box containing 3 downy eyasses by 4 fully-feathered Kestrels was observed during July at 1 mine. Ground-perching on barren spoil areas was noted during both years of the study. In 1981, this habit was observed on 11 mines, and involved as many as 14 individuals on a single mine. Nearly all ground-perching was observed during July of both years.

Examination of prey remains found in boxes used by Kestrels revealed 4 species of birds not previously recorded as prey items. Incubation by male Kestrels was observed at 6 boxes. With 1 exception, males were found incubating after 1800 hr.

Wilmers, Thomas J. 1982. Kestrel use of nest boxes on reclaimed surface mines in West Virginia and Pennsylvania. M.S. Thesis, West Virginia University, Morgantown. 182 pp.

ANNOUNCEMENTS

SECOND SYMPOSIUM ON AFRICAN PREDATORY BIRDS

The Natal Bird Club, a branch of the Southern African Ornithological Society, will be holding a symposium on African Predatory Birds from 22-26 August 1983. The first symposium on this topic was held in Pretoria in August 1977.

Four sessions are planned: The role of captive breeding in conservation; The effects of pesticides, particularly in the 3rd World; The energetics of large predators, and; The biology of rare and poorly known species.

The meeting will be held at the Golden Gate National Park in the Orange Free State. Further information and application forms are obtainble from Dr. John Mendelsohn, Durban Museum, P.O. Box 4085, Durban, South Africa 4000.

REQUEST FOR INFORMATION

The Marsh Hawk (*Circus cyaneus*) is a commonly-observed bird of prey of grasslands and marshes throughout California. It feeds largely on rodents, but is opportunistic in hunts on other avian, mammalian, and occasionally reptilian and amphibin species. Sexes are identifiable in adult plumage due to color dimorphism. Nests are on the ground; large broods are common.

Although Marsh Hawk wintering habitat in California is extensive, breeding habitat (largely marshes or some other natural grasslands situation) is *severely* reduced. Some estimate marshland habitat has been reduced in terms of acreage in excess of 90% since the early 1900s. Coastal bay and estuary and Central Valley habitats are continuing to decline.

The Marsh Hawk is a Species of Special Concern for the state of California (Remsen, 1982). Unfortunately funds are not available for studies by California Department of Fish and Game (CDFG) at this time. As a result, the Santa Cruz Predatory Bird Research Group (SCPBRG) is attempting to establish baseline information on this species to provide to CDFG, U.S. Fish and Wildlife Service (USFWS), and other government agencies who have management responsibility for birds of prey or habitat protection.

We are requesting information from all sources regarding Marsh Hawk natural history observation. Of special importance are observations of breeding attempts, both successful and failing; and also both current and historic. Information on Marsh Hawk breeding in areas no longer suitable is equally important to observatios in areas remaining habitable.

Should you be able to provide observations or have opinions or comments on any aspect of Marsh Hawk ecology in California, please respond.

Send responses to:

Santa Cruz Predatory Bird Research Group
Room 231 Clark Kerr Hall, University of California
Santa Cruz, CA 95064 (408) 429-2466

Information obtained in this project will be provided in the form of a report to Ron Schlorff, Non-Game Wildlife Management Section, California Department of Fish and Game, 1416 Ninth Street, Sacramento, CA 95814.

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