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**YELLOWSTONE BIRDS OF PREY:
AN INTRODUCTION
TO THEIR BIOLOGY, ECOLOGY, AND MANAGEMENT**

**John W. Martin
Yellowstone Institute**



Revised March 1995



Hawks and humans have a special history, a tradition of association rivaled by only two other animals, the horse and the dog. But hawks stand apart because they have never been domesticated. Indeed, though the degree to which the horse and dog have abandoned ancestral instinct and behavior determines their attractiveness to humans, the opposite could be stated of hawks - it is their wildness and freedom in flight that commands the respect of humans.

*after Dan O'Brien, *The Rites of Autumn: A Falconer's Journey Across the American West*, 1988*



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A

RAPTOR PROTECTION AND MANAGEMENT GUIDELINES

excerpted from
Interagency Rocky Mountain Front Wildlife Monitoring
and Evaluation Program, September 1987.
Management Guidelines for Selected Species.
Bureau of Land Management Report BLM-MT-PT-87-003-4111,
Bozeman, MT.

B

LAND USE AND WILDLIFE WITH EMPHASIS ON RAPTORS

copied in its entirety from
P.C. Benson. 1979.
Land Use and Wildlife with Emphasis on Raptors.
U.S. Dept. Agriculture, Forest Service,
Intermountain Regional Office, Ogden, UT.

C

AMERICAN KESTREL
courtesy of Nevada Dept. Wildlife

D

BARN OWLS IN NEBRASKA
courtesy of Nebraska Game and Parks Commission

E

HOW TO HANDLE AN INJURED RAPTOR

F

RAPTOR IDENTIFICATION NOTES

PROLOGUE

Systematically preening itself, a red-tailed hawk perched on a snag of an old leafless oak tree and warmed itself in the early morning sunlight.

It shook its feathers in an effort to get the dampness out and prepare for the day's activities. One at a time each primary feathers was taken in its beak and followed from base to tip, nibbling at places to straighten bends. The hawk sat up occasionally to look over the surroundings and for a meal. With its back to the sun, it could be seen by anyone scanning the horizon, but it was not concerned with that, this bird was hungry.

Migrating south from the boreal forests of Canada to escape the harsh winter, it stopped temporarily in this mixed hardwood-coniferous forest. Cottontail rabbits were plentiful in the surrounding croplands, and being relatively easy to catch, the hawk could remain for several days before moving farther south.

A black-capped chickadee spotted the red-tail and took a perch about five feet from the hawk on the same branch. The chickadee scolded as it flipped upside-down, up and down, much to the confusion of the hawk which rolled its head in an effort to keep up with the birds nimbleness. The hawk must have gotten bored with all this harassment and again turned to scan the fields for a meal. It spread its wings to absorb the sun's radiant heat and limber flight muscles. The chickadee disappeared.

The red-tailed hawk's wings folded together quickly as it leaned towards the rabbit it was focusing on, about 200 yards down the field to the northeast. It waited anxiously for the rabbit to move more out into the open. The feathers on the back of its neck stood out. It

dropped, spreading its wings, the airfoil carrying the hawk to its prey. Sliding low, quickly and quietly, across the field, beginning to lower its legs and open its feet, showing needle-tipped talons. There was a whistling, a thud of flesh, a flurry of feathers, and the breath of life rushed out. The red-tailed hawk lay dead on the ground.

The farmer ejected the spent cartridge from a pump Ithaca Featherlight and let it fall to his side. He weaved across the field to the hawk. Looking pleased with his deed, he picked up the dead bird and started back to the farmhouse. On the way back, he hooked one talon over a barbed-wire fence, leaving the hawk to rot as a sign of victory, a score for a missing chicken settled.

As the farmer disappeared behind slamming door of the house, the rabbit came out of hiding and continued its morning meal.

personal observation
winter 1970
near Marshall, Missouri

**YELLOWSTONE BIRDS OF PREY:
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John W. Martin
and the
Yellowstone Institute

CHAPTER ONE - INTRODUCTION

The biology and ecology of this relatively small group of birds makes them sensitive to natural or man-made disturbances. Under continuing pressure to develop natural and recreational resources in and surrounding Yellowstone National Park, these birds represent special environmental problems and conservation considerations. Studies into the causes of population declines after World War Two for several of these birds were largely responsible for unveiling the environmental threats of DDE and other chemical toxins. Recent monitoring of the recovery of bald eagle and osprey populations, the reintroduction of captive-raised peregrine falcons into the wild, captive breeding of the California condor, and the timber industry-spotted owl controversy, has brought these birds repeatedly into public attention. This in turn has created greater public interest for these large conspicuous birds, leading to increased conservation and protection measures for birds of prey which has served as a catalyst for larger nongame species management programs.

Birdwatching is already a well established outdoor hobby with a long list of "field guides" attesting to its popularity. Specialty field guides are being published at an increasing rate, e.g., shorebirds, waterfowl, gulls, passerines indicating the demand for more information and possibly a heightened awareness of the role birds play as indicators

of environmental quality. The "hawkwatchers" are no exception to this trend. With the publication of *A Field Guide to Hawks of North America* and *Hawks in Flight*, among others, hawkwatching has blossomed into a recognized subset in the birdwatching family.

This book is designed as an introduction to breeding birds of prey common to the Greater Yellowstone Ecosystem and generally the surrounding states: Idaho, Montana, and Wyoming. Identification of these birds, from the "field" perspective is emphasized. However, understanding the biology and ecology of birds of prey, their role as predators within an ecosystem, makes the field guide pictures come alive, and the isolated, often distant encounters in the wild relate to the larger biological community. It is not my intention to replace available bird identification guides but supplement them with specific information on birds of prey that hunt throughout the Greater Yellowstone Area.

During the past 10-20 years our understanding of birds of prey has increased dramatically through substantial research and management efforts. The results have been published in a variety of sources, sometimes annoyingly obscure, or overly technical. A principal guideline in writing this book was to summarize much of this scientific research for those wanting to know more about this specialized group of birds.

Not everything known about the biology and ecology of birds of prey could be covered in one short narrative. With this consideration, this book attempts to provide a usable reference tool for the reader long after the first reading. To this end I hope I have achieved my goal. Every effort has been made to make this work as unbiased as possible. I freely admit formal training as a wildlife biologist and a passion for birds of prey, in case the reader detects a slant in the text.

Acknowledgements - No venture like the writing of this book, the Yellowstone Birds of Prey short-course, or any other at the Yellowstone Institute are solitary efforts, rather they

are social. I am deeply indebted to many individuals who have encouraged and supported the creation of this book and course.

This book initially began as a collection of handouts for the Birds of Prey class offered through the Yellowstone Institute, which I took as a student in 1979. Eventually a narrative was written to go along with pictures and charts, and binding was provided. Gene Ball and later Don Streuble, both former Directors of the Yellowstone Institute, and the current Director of the Yellowstone Institute, Don Nelson, have provided encouragement and valuable feedback. Thanks also to my wife, Marsha, without whose support this venture would not be possible - and John and Lorien too.

Thanks to Craig McClure, Don Despain, and Steve Mealey for their interest and support. My harshest critics and best supporters have been the students of the birds of prey class - my thanks to them. Also, thanks to the staff at the Yellowstone Institute, especially Jeanne Peterman and Pam Gontz.

None of the information contained herein is new or noteworthy, and I am indebted to the research of others. This text is solely a compilation of pertinent data for a brief, yet intense, introduction to raptors. The entire text was rewritten in spring 1994, incorporating advances in the state-of-the-knowledge regarding raptors since the first writing in 1986.

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CHAPTER TWO - CHARACTERISTICS OF RAPTORS

Eagles, Hawks, and Falcons - The Order *Falconiformes* (one of 27 orders recognized by ornithologists) contains about 287 species worldwide, of which 33 species are found in North America north of Mexico. All are generally referred to as birds of prey (because they derive their living by "preying" on flesh), "raptors" (because of their "raptorial" characteristics), or "hawks." They are considered "nongame" species, and all are protected by state or federal laws, principally two federal laws, the Migratory Bird Treaty Act of 1916, amended to include Canada, Mexico, Japan, and (formerly) Soviet Union, and the Endangered Species Act of 1973.

Most species hunt during daylight (diurnal as opposed to nocturnal), are good flyers (either actively or passively through soaring), possess strong hooked bills, and grasping feet with sharp curved talons. The four families found within the *Falconiformes* are *Cathartidae* (new world vultures), *Accipitridae* (accipiters, hawks, and eagles), *Pandionidae* (osprey - one species with worldwide distribution), and *Falconidae* (falcons and caracaras).

Owls - The Order *Strigiformes*, or owls, are also considered birds of prey. They typically have the same characteristics as the diurnal raptors but normally hunt nocturnally or crepuscularly (twilight/dawn), have larger eyes requiring proportionately larger heads, increased auditory acuity, feathered facial discs, and are soft feathered to aid in silent flight. Within the order there are two families, *Tytonidae* (barn owls) and *Strigidae* (typical owls) containing 135 species worldwide, of which 18 found in North America north of Mexico.

Owls have excellent nocturnal vision and auditory acuity with the two senses being closely linked. Owls see only in black and white in difference to most bird species. The retina of the eye is densely packed with rods (no room for color sensitive cones) and

resolution is reported to be nearly 100x better than human night vision. The eyes of a great horned owl are larger than an adult human. the barn owl has the highest auditory acuity of any animal worldwide. Three factors combine to aid owls in hearing:

- 1) muscular ear openings that can focus sound,
- 2) a large flap of skin behind the ear opening to which feathers are attached, forming the characteristic facial "disc" shape of owls, channeling sound into the ear opening (Fig. 1), and,
- 3) asymmetrical ear opening with one ear higher than the other (Fig. 1).

Hawks and Owls - Other characteristics of raptors, and all birds in general, include 14 cervical vertebrae which allows 180° agile movements of the neck and skull (Fig. 2 - keep in mind that with few exceptions, all birds have 14 cervical bones and it is most likely an adaptation for preening, i.e., access to the back and wings); bones which support powerful muscles of the eye (sclerotic rings, particularly noticeable in owls)(Fig. 2); short modified digestive systems with crops from which "pellets" or "casts" of hair, bones, feathers, and other nondigestibles are regurgitated (Fig. 3). Diet or prey habit studies often rely heavily on analyses of pellets to determine raptor prey species preferences. Diurnal raptors have keen eyesight because of extremely high densities of rods and cones on the retina of the eye and not due to a telescopic-like eye lens. Owls, having only rods on the retina, see only black and white, as there is no benefit to color vision in low light levels. In comparison with human eyesight, humans often lose shapes in shadows at great distances whereas raptors can still distinguish shapes and movement because of enhanced visual resolution (Fig. 4).

All *Falconiformes* have a fleshy saddle of skin at the base of the beak called the cere. *Strigiformes* have binocular vision, similar to humans. Many owls have asymmetrical ear

openings allowing such species as the common barn owl and long-eared owl to hunt by auditory cues in very low intensity levels of light.

Variable flight speeds have been observed from routine hovering of American kestrels, rough-legged hawks, and northern harriers, to slow soaring of vultures, condors, and buteos (30-35 mph) to "stoops" (high speed dives) of over 175 mph by prairie falcons and peregrine falcons. Reversed sexual dimorphism, where females are larger than males, is observed for many species (Figs. 5, 6). Some raptors migrate great distances each year from traditional wintering grounds to summer breeding sites. The Swainson's hawk, as an example, nests throughout the North American Great Plains, winters in Argentina, and has the longest migration of any raptor species (Fig. 7). The general topography of raptors is noted in Figures 8 and 9.

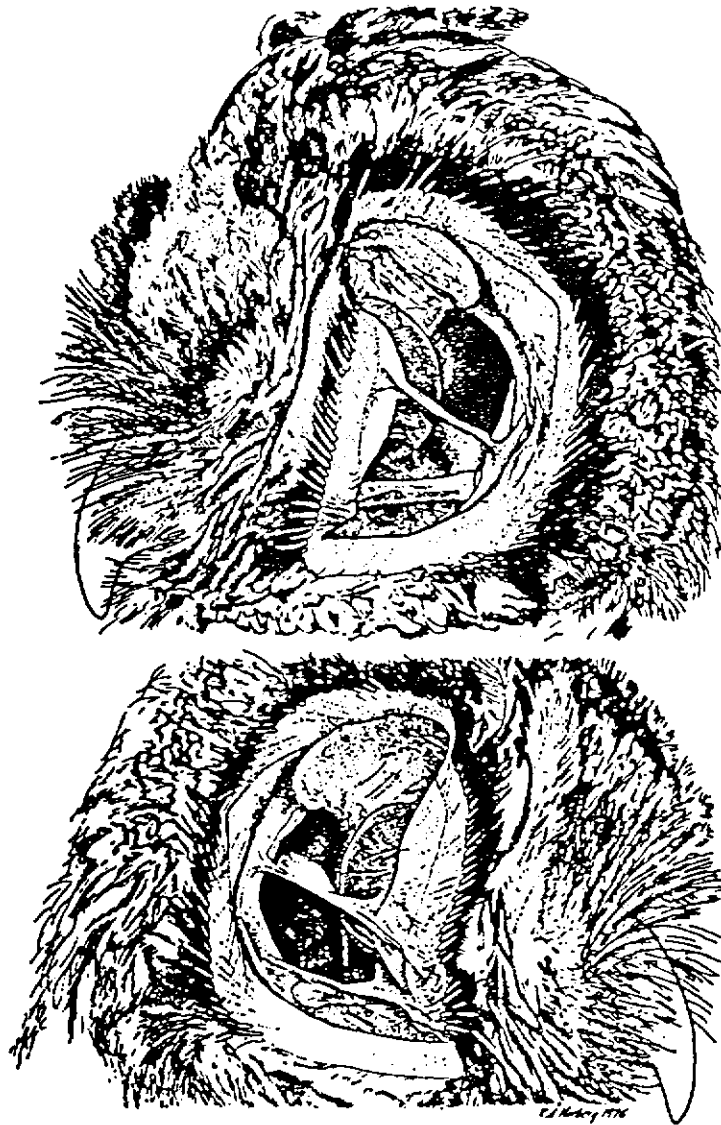
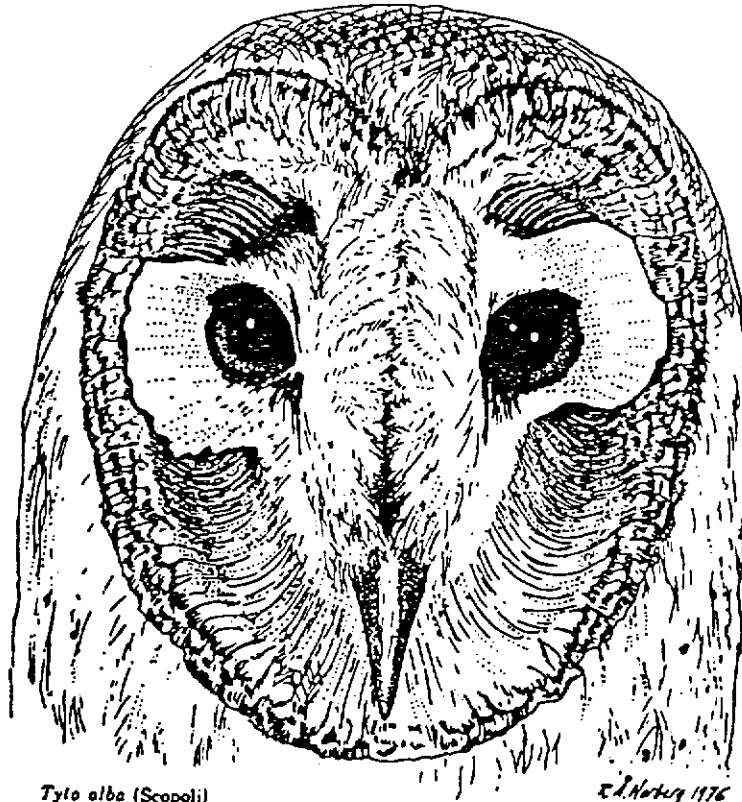


Figure 8.5 Asymmetry of the external ears in the Long-eared Owl *Asio otus*. The head is viewed from the side and the feathers parted at the edge of the facial disc, to reveal the ear openings. The flaps of skin in front and behind the ear openings are displaced, to show the difference in the positions of the ear openings. While the total height and width of the ear openings are the same on both sides of the head, the entrances to the inner ears are in different positions, with the openings on the left side (top), higher than that on the right (bottom). (From Norberg 1977.)

Figure 1. Ear of an owl from Martin (1990).



Tyto alba (Scopoli)

Figure 8.6 Asymmetry of the external ears of the Barn Owl *Tyto alba*. The facial disc feathers have been removed to reveal the asymmetrically positioned flaps of skin in front of the ear openings (the preaural skin flaps). The ear openings themselves are small and almost square, and are concealed behind the flaps. Removal of the facial disc feathers also reveals the feathers of the facial ruff. These lie behind the preaural flaps and almost completely surround the face. It can be seen that they form a concave hollow surrounding each ear opening. (From Norberg 1977.)

Figure 1 continued. Ear of an owl from Martin (1990).

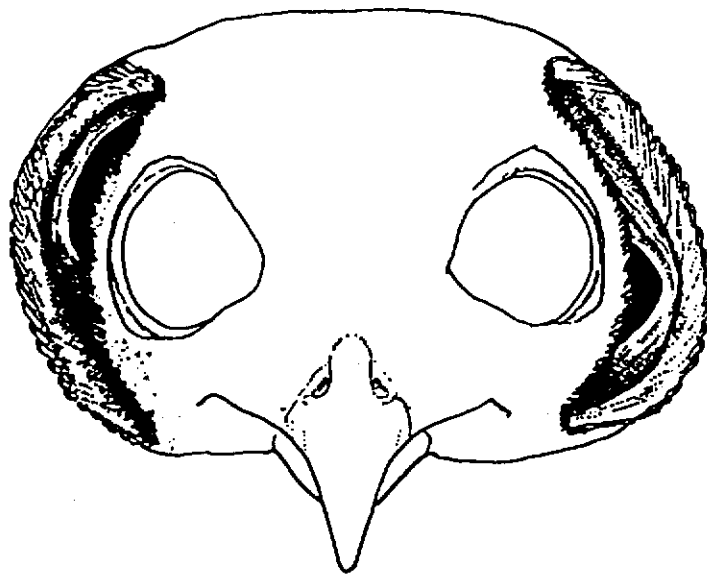
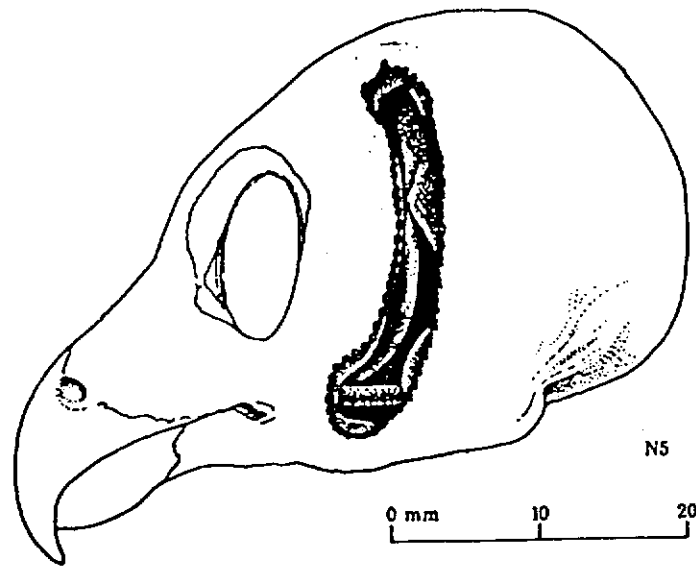


Figure 8.7 Asymmetry of the external ears of Tengmalm's Owl *Aegolius funereus*. The head is intact but the feathers have been removed. The edges of the flaps surrounding the ear openings are indicated by the stumps of cut feathers, but the flaps are shown in their natural position and have not been folded back as in Figure 8.5. The full extent of the outer ear cavity beneath the skin is indicated by shading. The asymmetry in the positions of the openings and also the underlying asymmetry in the skull (Figure 8.8) are clearly evident. (From Norberg 1978.)

Figure 1 continued. Ear of an owl from Martin (1990).

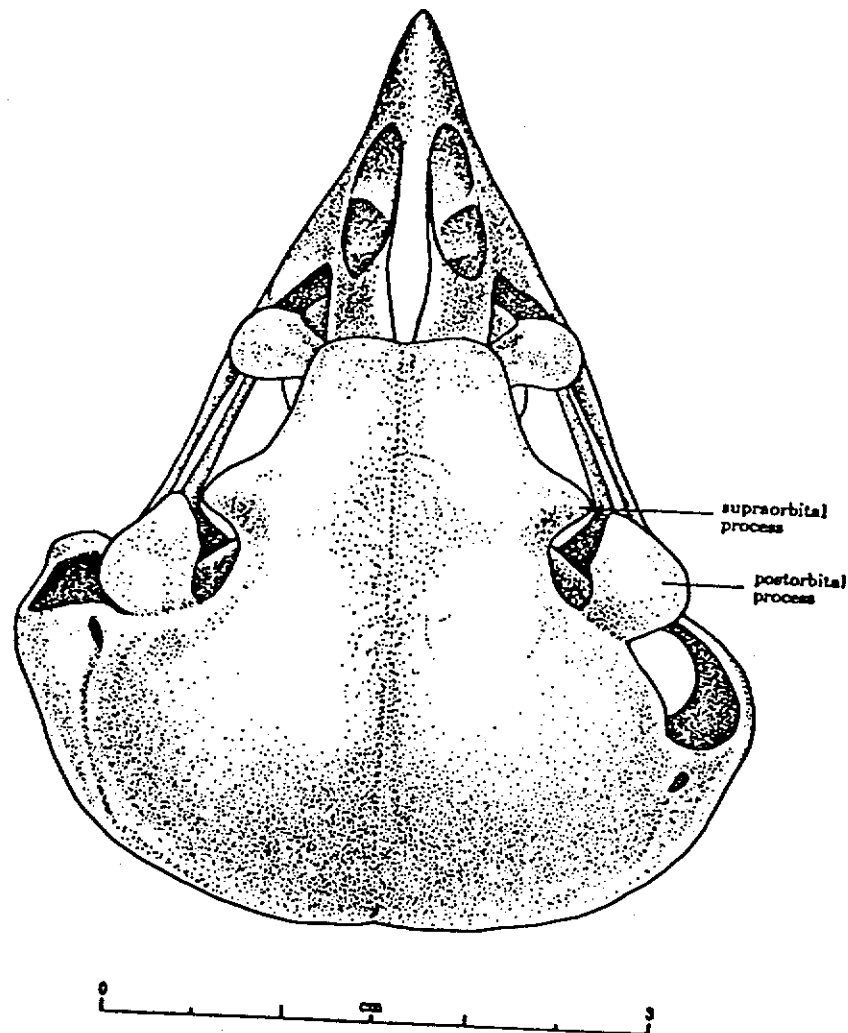


Figure 8.8 The skull of Tengmalm's Owl *Aegolius funereus* showing the marked asymmetry associated with the external ears (cf. Figure 8.7). (From Norberg 1978.)

Figure 1 continued. Ear of an owl from Martin (1990).

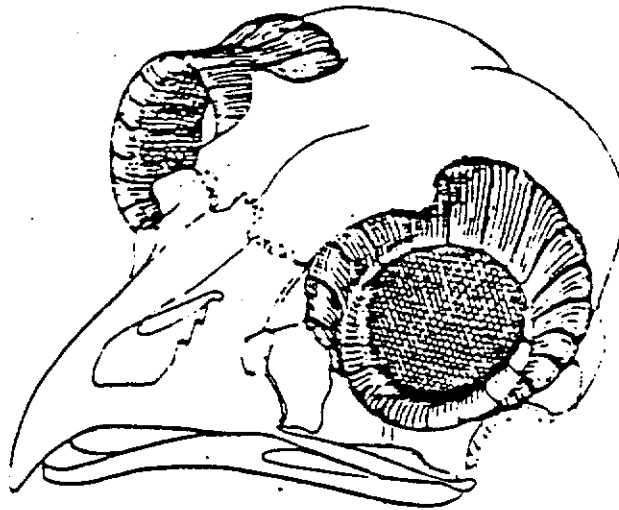
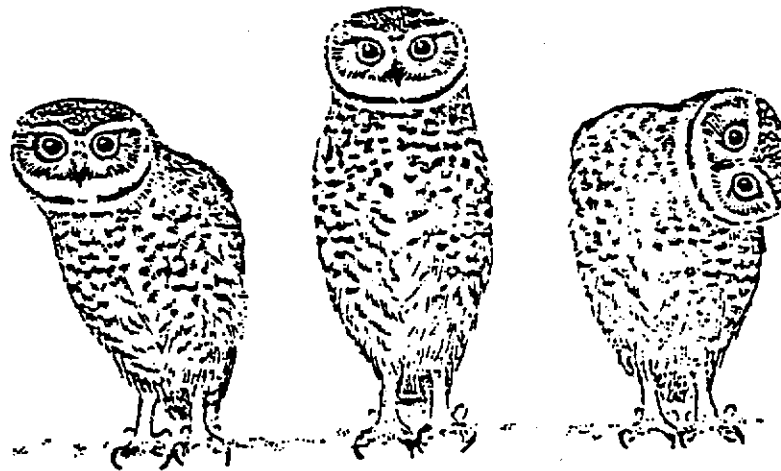


FIG. 11.1. Skull of Sawmy Owl (*Nyctea scintillans*) to show the tubular sclerotic rings. (By permission from Berger, 1961.)



Little owl assessing distance by bobbing and turning its head

Figure 2. Sclerotic rings and agility of bird necks (14 cervical neck bones) (top illustration from George and Berger 1966, bottom illustration from Sparks and Soper 1989).

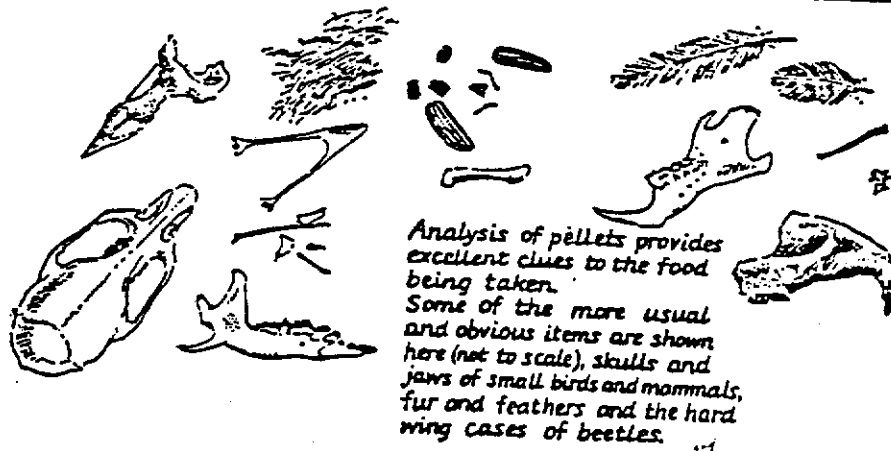
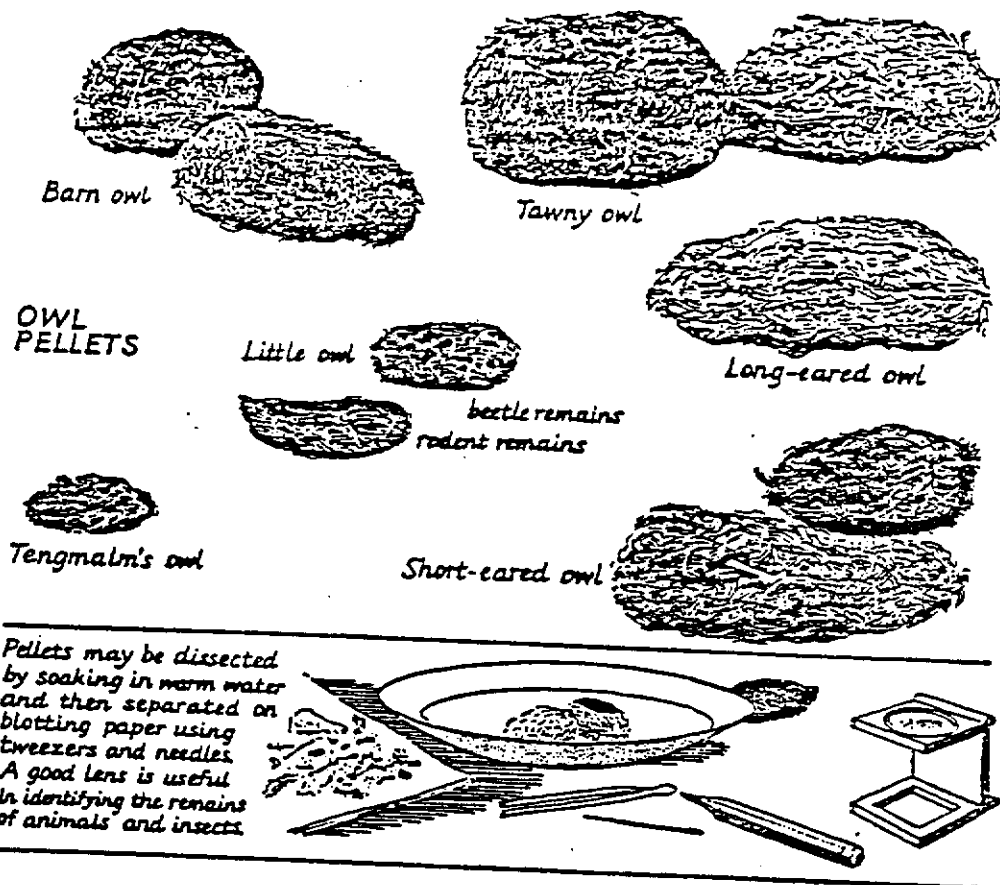


Figure 3. Hawk and owl pellets from Sparks and Soper (1989).

THE HAWK'S KEEN EYE

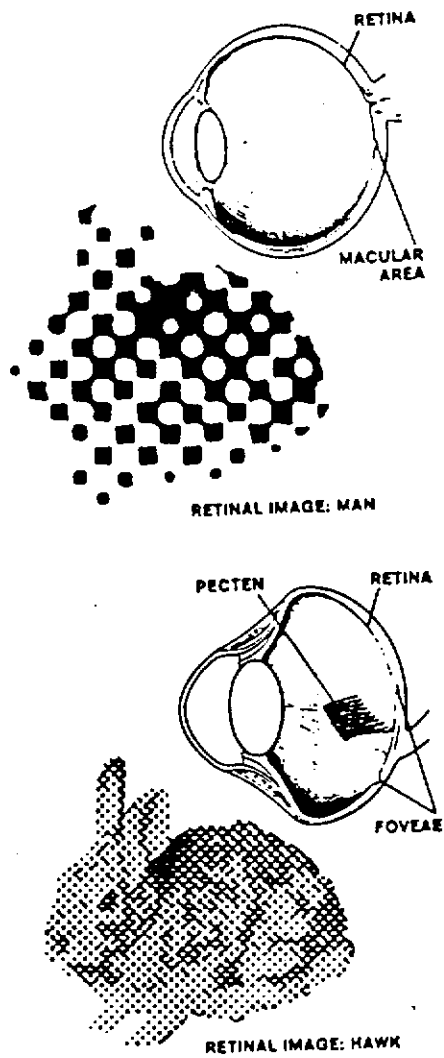


Figure 4. Raptor and human eyesight compared, from Perterson (1962).

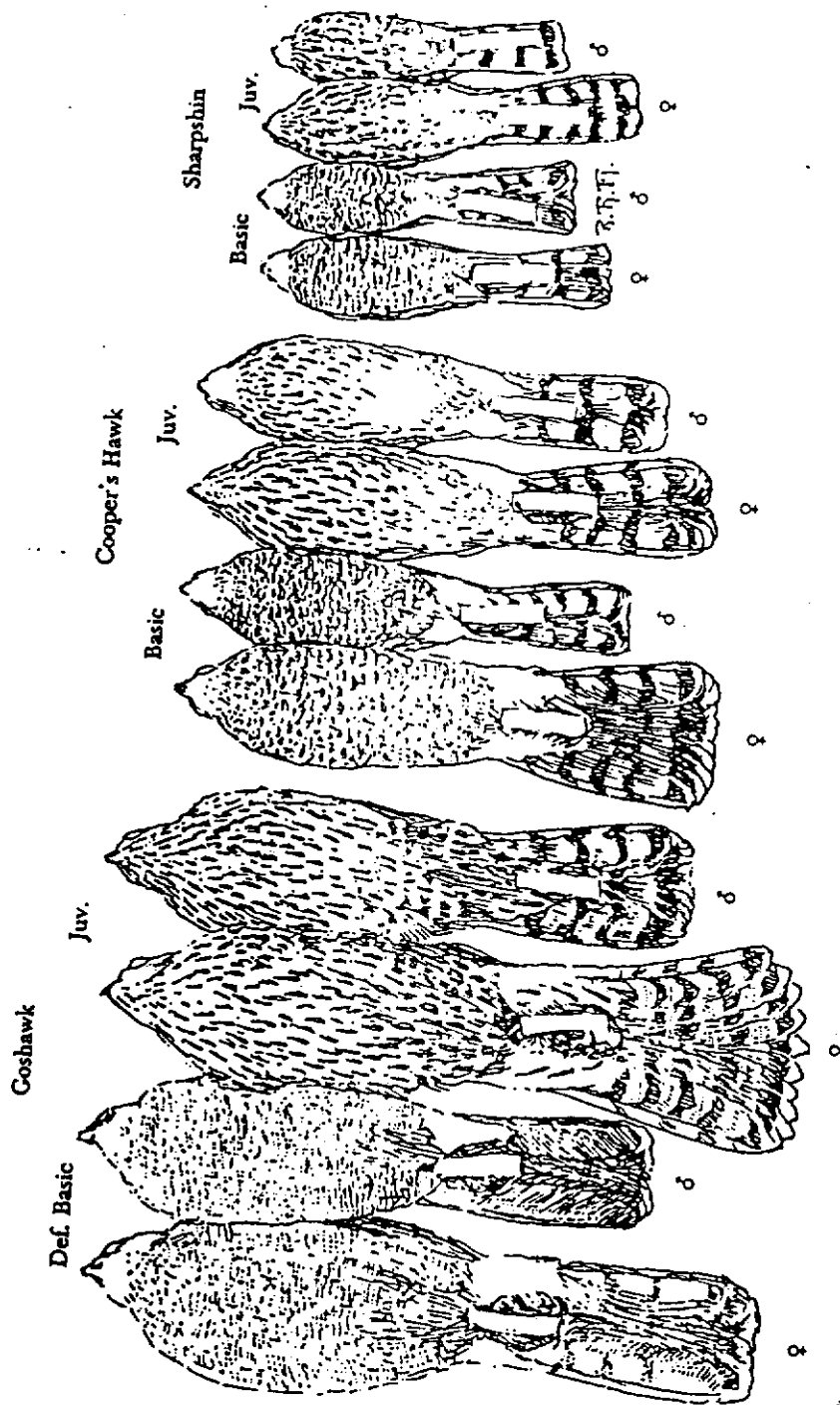


Figure 5. Reversed sexual dimorphism (RSD) in Accipiters, from Palmer (1989).

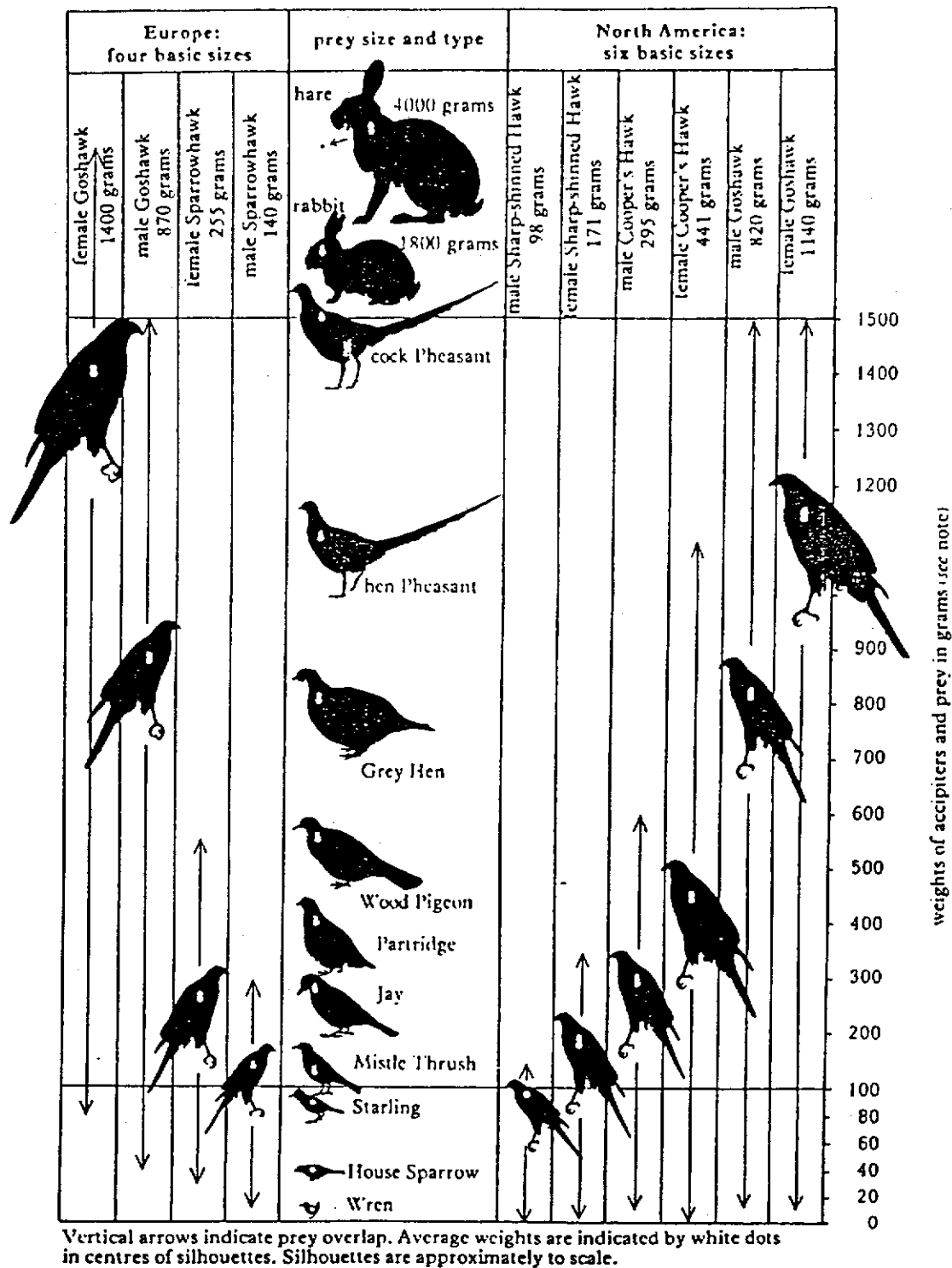
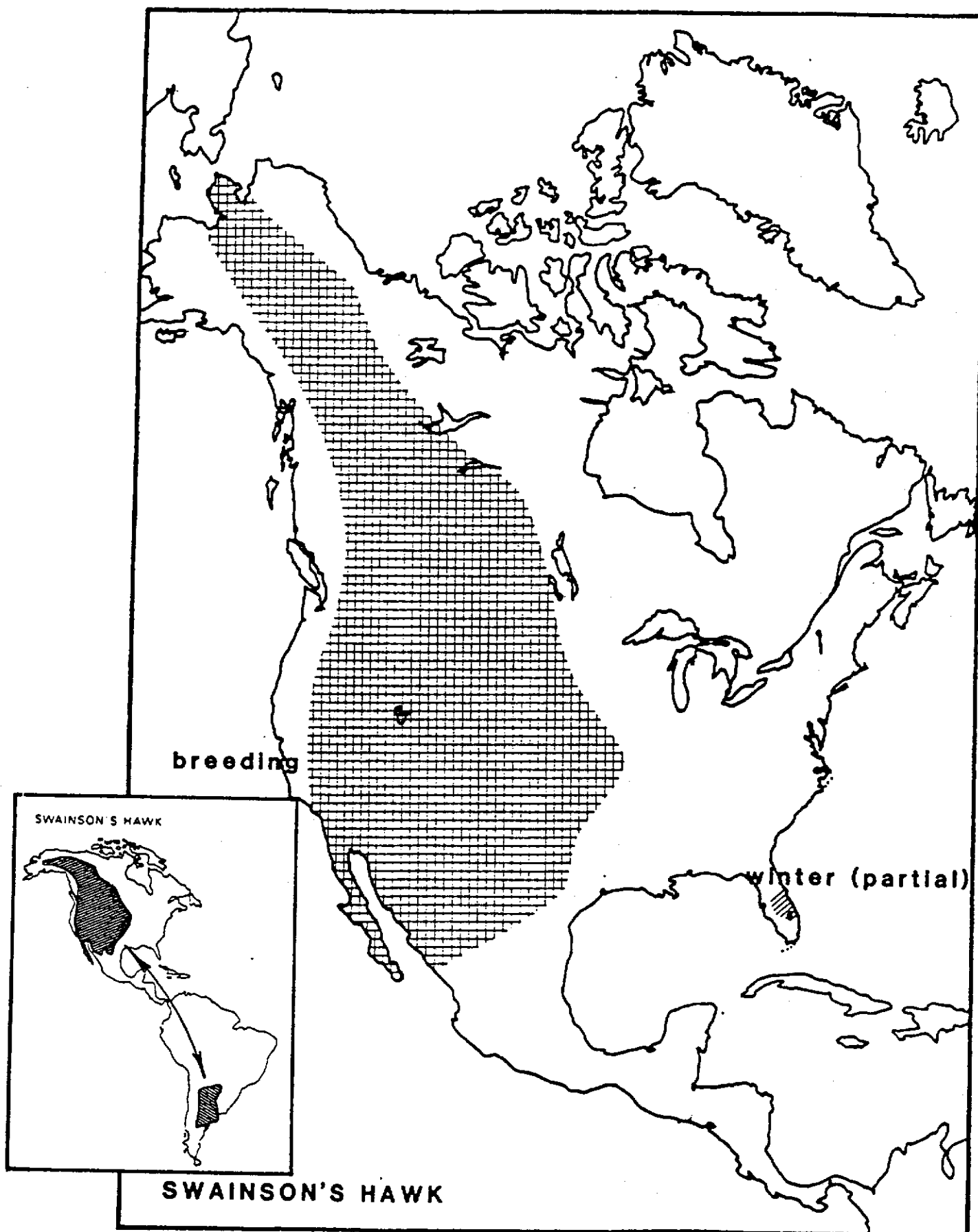


Fig. 46 Ecological separation among European and North American accipiters.

Figure 6. Reversed sexual dimorphism (RSD) in Accipiters, from Brown (1976).



majority of population winters in Argentina

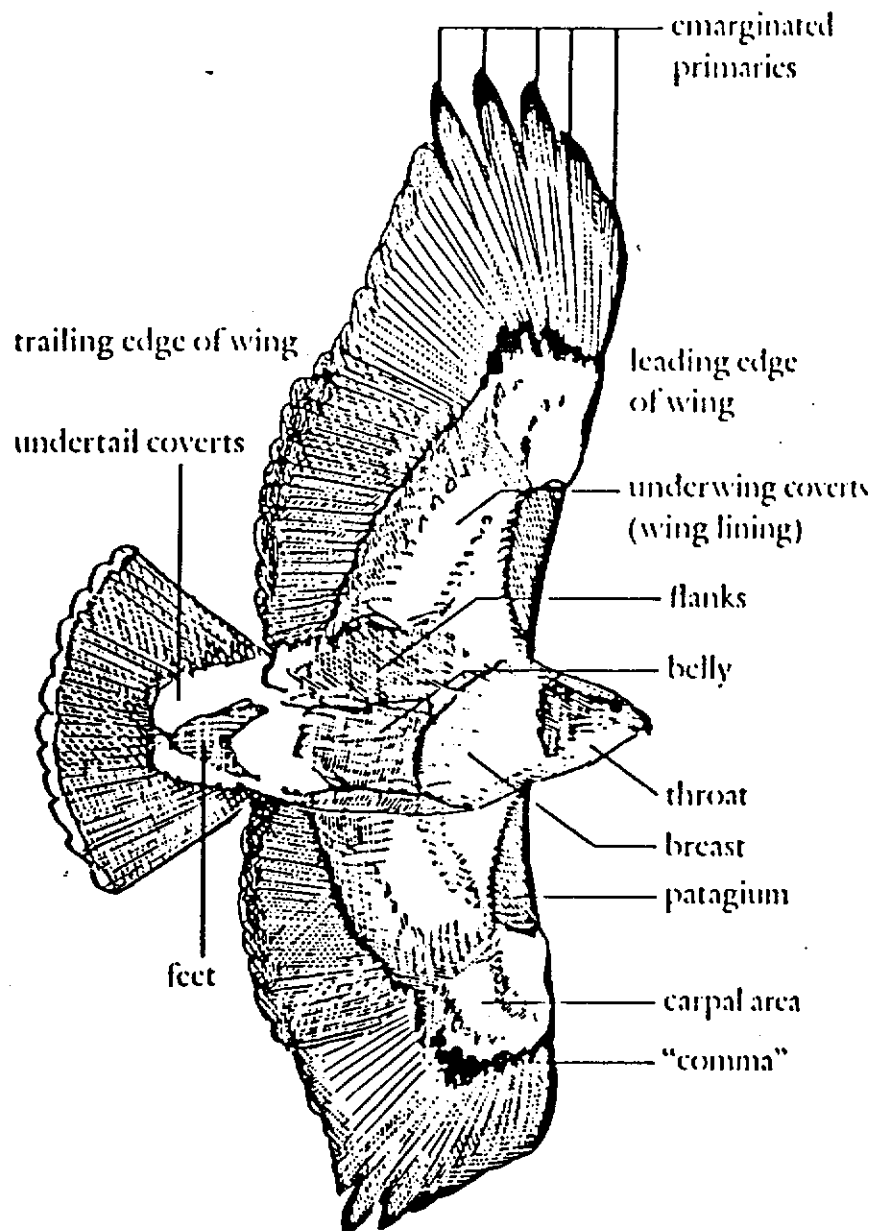


Figure 8. General topography of a raptor (*Buteo*) from Dunne, Sibley, and Sutton (1988).

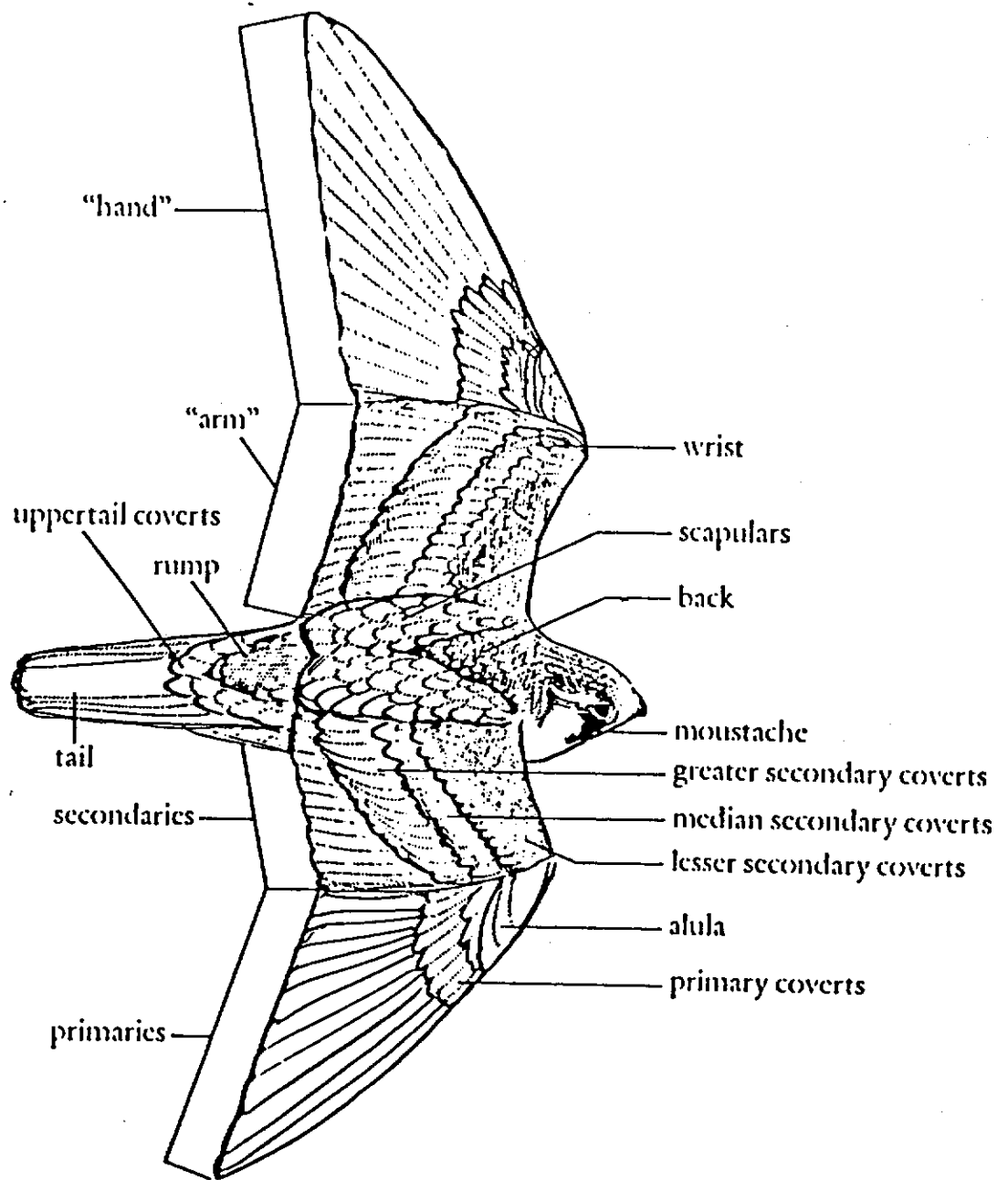


Figure 9. General topography of a raptor (falcon) from Dunne, Sibley, and Sutton (1988).

CHAPTER THREE - YELLOWSTONE HABITATS AND ENVIRONMENTAL CONSIDERATIONS

Habitat is usually thought of as the plant life of a biological community where a specific collection of animals occur. However, it consists of a myriad of factors from vertical structure (not limited to cliffs, but also implies the number of vegetation layers from ground cover to forest canopy), climatic regimes, stability or fluctuations of food resources (which can mean a wide variety of sources depending on the species), etc.

Many biotic (living) and abiotic (nonliving) factors influence the type of habitat that will occur in a given location. Elevations in Yellowstone vary from about 5000 feet to over 11,000 feet. Temperatures are variable from well below freezing in the winter into the high 70's (°F) during the summer. Precipitation varies from less than 10 inches annually in the desert-like area near Gardiner, MT, to over 80 inches along the Continental Divide in the southwest region of the park, most of it falling during the winter months.

For much of the year precipitation is unavailable for plant growth as it lays on the surface as snow or ice and cannot be absorbed by the frozen soil. When conditions permit thawing, the snow (snowpack) turns into surface runoff (meltwater) swelling streams during the spring, benefiting elevations below those originally receiving it. In addition to the general lack of water as noted, low average humidity along with drying winds create an environment that is considered arid. Soils are variable, from shallow, nutrient poor rhyolitic types of volcanic origin, to relatively rich glacier-deposited types of valley floors. Micro-climate variables such as differences in solar exposures on north and south facing slopes, cold air masses settling in valley floors each night, daily up-canyon winds and nightly down-canyon winds, temperature inversions, all influence what and where each plant species will grow.

Despite the confusion of variables, Yellowstone National Park (YNP), part of the Greater Yellowstone Ecosystem (GYE)(as part of an even greater montane coniferous and northern cold desert biomes) can be divided into several major vegetation types. The last successional growth, and usually the most stable plant association, supported by a given combination of soil, moisture, and other micro-climate variables, is termed the "climax" community. What may be a climax community for one set of conditions may be a "seral" or sub-climax community for another set of conditions. For example quaking aspen stands are usually considered seral to Engleman spruce/sub-alpine fir stands but under some conditions may be a climax community. The major vegetation or community types are listed in Table 1.

The major part of the Yellowstone ecosystem consists of the lodgepole pine association. Typically this is a dense, closed canopy habitat allowing little sunlight to penetrate to the ground. Because sunlight is lacking, ground cover is sparse, if at all present. With little plant diversity, this habitat supports a meager collection of wildlife species. Wildlife species require variety of water, space, food resources, and escape, resting, or thermal cover on a daily, seasonal, and annual basis. It follows that few raptors are found in homogeneous stands of lodgepole pine, as prey is unavailable to support them.

Through natural processes such as lightening-caused fire, earthquake, or landslide, the forest canopy is opened and the micro-climate is significantly modified. New plant species invade and a different vegetation association is established. With the creation of a forest opening, an interface (ecotone) between one habitat type and another is formed. Vegetation structure and density becomes more diverse with the occurrence of wildlife

Table 1. Major habitat associations, estimated acreages, percent area, and common raptors within each habitat type within Yellowstone National Park.

Habitat Type Community	Area in Acres	Percent of Total	Elevation Range	Common Raptor Species
Lodgepole Pine	1,249,485 ac	58.0	7600-8400	northern goshawk, great gray owl
Douglas Fir	104,188 ac	4.8	6000-7600	northern goshawk, Cooper's hawk, sharp-shinned hawk, great gray owl, great horned owl, flammulated owl
Englemann Spruce-Subalpine Fir	99,183 ac	4.6	8400-10,000	American kestrel
Whitebark Pine	207,439 ac	9.7	10,000 +	golden eagle, peregrine falcon, prairie falcon
Quaking Aspen	3,927 ac	1.7	6000-7600	Cooper's hawk, sharp-shinned hawk, American kestrel, screech owl, long-eared owl, great horned owl
Sage-steppe	497,281 ac	5.0	5900-8000	golden eagle, Swainson's hawk, ferruginous hawk, red-tailed hawk, American kestrel, peregrine falcon, prairie falcon, northern harrier, short-eared owl
Dry Grassland	----	ca 0.2	varied	golden eagle, Swainson's hawk, red-tailed hawk, northern harrier, American kestrel, short-eared owl
Wet Meadows -Mesic Grasslands	----	ca 3.6	varied	golden eagle, bald eagle, Swainson's hawk, American kestrel northern harrier, short-eared owl screech owl
Riparian (cottonwood-willow)	----	ca 1.2	varied	Swainson's hawk, American kestrel long-eared owl, great horned owl, screech owl
Open Water	100,565	4.7	varied	bald eagle, osprey
Miscellaneous (lava flows, talus slopes, barren soils, cliffs)	----	ca 6.4	varied	cliffs provide nesting substrate for most ravens, eagles, buteos, falcons, and great horned owls

Notes

- 1 = Changes due to the 1988 fires
 - a - decreased but unquantified
 - b - increased but unquantified
 - c - no change

2 = approximate acres, does not reflect data from the 1988 fires

3 = range of elevations, higher on northern slopes and lower on southern slopes

4 = typical association but not limited to these species

species often greater along the edge, or ecotone, than in either of the adjacent habitat types. Examples may be observed in the forest-burn mosaic created by the 1988 fires.

Because of the arid nature of the montane forests and cold northern deserts, free water becomes particularly attractive to wildlife. Riparian (streamside) habitats may also be viewed as linear ecotones with high diversity and density of plant and animal life. In some locations these riparian communities bordering forest, grasslands, and deserts support the highest known density and diversity of species recorded.

The habitat can have a great influence on animal species and their distribution. Considering only raptors and their prey, certain species are typically found or associated with selected habitats (Tables 1, 2). Habitat cover, density, or structure may limit how or what a raptor hunts. Prey species, which are associated with a given habitat type may affect where a raptor species occurs. Red-tailed hawks, which have relatively high wing-loading (body weight-wing surface ratio) and a perch-preferred hunting method, are usually limited to habitats with an abundance of perches or high topographic relief. Ferruginous and Swainson's hawks, with lighter wing-loading, hunt more while gliding, and are found in open steppe or grassland habitats. Species with high wing-loading are highly maneuverable and usually found in structured habitats such as forests. It is in these structured habitats that the 3 accipiters species, sharp-shinned hawk, Cooper's hawk, and northern goshawk, are typically found.

Lamar Valley, in the northeastern corner of the park, may illustrate how habitat characteristics and raptors are interrelated. Only about 41% of Lamar Valley is forested, compared with 80% for YNP overall (based on pre-1988 data with post 1988-data unavailable but the 1988 fires had little effect on Lamar Valley habitats). The Lamar Valley is more open or "park-like", with forest habitats occurring in discontinuous stands

called "habitat islands." This factor increases the edge effect between habitat types. Numerous small tributaries of the Lamar River further increase edge effects. Hunting perches and nest sites are abundant among the habitat islands. American kestrels (formerly sparrow hawk) often use tree cavities for nests, and red-tailed and Swainson's hawks use trees as resting or hunting perches. Dense stands of trees may be used for hunting and nesting by the accipiter hawks. For such species as golden eagles, prairie or peregrine falcons, requiring cliff cavities/ledges for nesting, these are abundant along Specimen Ridge and other cliffs bordering the valley.

Prey species such as montane voles, Uinta ground squirrels, northern pocket gophers, and other small mammals and birds prefer open grasslands and sage-steppe habitats. In open habitat types, these species can observe and avoid potential predators at greater distances than more highly structured types. Because these habitats are preferred by these small animals, their numbers are relatively dense, providing an adequate food supply for several species of raptors. Prey species in open habitats are available and accessible to a variety of hunting methods employed by raptors, including hovering, ambush, and short and long pursuits. Open habitats, such as noted here, often support some of the highest density raptor populations.

Table 2. Typical Prey Items and Breeding Habitats, Migratory Status, Selected References, and Occurrence of Common Raptors of the Greater Yellowstone Ecosystem.

Species	Prey Items ¹	Breeding Habitats	Resident-Migratory ²	Sources	Occurrence in GYE ³
turkey vulture	carion (has been known to kill prey)	cliff-tree cavities	migratory	Rea 1973 Prior 1990	uncommon
bald eagle	fish, waterfowl, lagomorphs, big game carion	large trees near open water	migratory	Edwards 1969 Murphy 1965, Platt 1976 Swenson <i>et al.</i> 1986	common within habitat
golden eagle	lagomorphs, ground squirrels	cliffs-trees near sage-steppe, pinyon-juniper	resident	McGahan 1968 Smith & Murphy 1973, Olendorff 1976 Bloom & Hawks 1982 Swenson 1974, 1978, 1979, 1981	common within habitat
osprey	fish (<u>rarely</u> mammals or birds)	tall cliffs or trees near or over open water	migratory		common
ferruginous hawk	lagomorphs, ground squirrels, small rodents	sage-steppe or pinyon-juniper w/two topographic relief, on ground, cliff, or tree	resident-migratory	Weston 1969 Smith & Murphy 1973 Thurrow & White 1983 Janes 1985 Snow 1974 Jaksikoff 1982	uncommon - most likely spotted near Gardner
red-tailed hawk	lagomorphs, ground squirrels, small rodents, snakes	sage-steppe or forest w/topographic relief, usually cliff or tree	resident-migratory	Seidensticker & Reynolds 1971 Smith & Murphy 1973 Johnson 1973 Janes 1985	common

Table 2. Typical Prey Items and Breeding Habitats, Migratory Status, Selected References, and Occurrence of Common Raptors of the Greater Yellowstone Ecosystem.

Species	Prey Items ¹	Breeding Habitats	Resident-Migratory ²	Sources	Occurrence in GYE ³
Swainson's hawk	passerines, ground squirrels, insects (insectivorous for most of year)	sage-steppe, pinyon-juniper, riparian forests w/wo topographic relief, usually in tree	migratory (winters in Argentina)	Fitzner 1978 Smith & Murphy 1973 Dunkle 1977 Thurow & White 1983 Janes 1985	common
rough-legged hawk	voles, shrews, small rodents	arctic tundra of AK, Canada, usually cliff along river or ground	migratory (winters in lower 48 states, esp Great Plains)	Craighead & Craighead 1956 Watson 1984, 1985, 1986 Zarn 1975	common - winter only in open habitats
sharp-shinned hawk	small birds	dense coniferous or deciduous forests or wooded islands	migratory	Storer 1966 Reynolds 1983 Jones 1979	rare (secretive)
Cooper's hawk	small birds	dense coniferous or deciduous forests or wooded islands	migratory	Storer 1966 Reynolds 1983 Jones 1979	rare (secretive)
northern goshawk	lagomorphs, grouse, small birds - mammals	coniferous, mixed, or deciduous forests	resident	Storer 1966 Reynolds 1983 Schuster 1980 Jones 1979	rare (secretive)
northern harrier	voles, small birds, small mammals	grasslands (may be tolerant of agricultural areas) nests on ground	resident - migratory	Breckenridge 1933 Martin 1987, 1989 Hamerstrom 1969, 1979	common

Table 2. Typical Prey Items and Breeding Habitats, Migratory Status, Selected References, and Occurrence of Common Raptors of the Greater Yellowstone Ecosystem.

Species	Prey Items ¹	Breeding Habitats	Resident-Migratory ²	Sources	Occurrence in GYE ³
peregrine falcon	waterfowl, shore birds	cliffs overlooking open areas, boreal steppe	migratory	Ratcliffe 1980 Cade 1982	uncommon
prairie falcon	ground squirrels, small birds, rodents	cliffs in sage-steppe	resident	Porter & White 1973 Enderson & Craig 1974 Ogden 1973, 1974 Cade 1982	uncommon
merlin	small birds and mammals	variable	migratory	Cade 1982 Oliphant & McTaggart 1977	uncommon
American kestrel	insects, small birds and mammals	highly adaptable, but prefers cavity nests in trees (abandoned buildings)	northern population migratory	Cade 1982 Rudolph 1982	common
western screech owl	insects, small birds and mammals	cavities in trees, especially riparian areas	resident		uncommon
great grey owl	voles, small rodents	dense coniferous forests with openings	resident	Nero 1980 Bull & Henjum 1990 Forsman & Bull 1988	uncommon
snowy owl	small rodents (lemmings)	open tundra	resident (cyclic)	Pitelka <i>et al.</i> 1955	uncommon (winter only)
northern pygmy owl	insects, small rodents	coniferous forests	migratory	Brock 1958	rare

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Species	Prey Items ¹	Breeding Habitats	Resident-Migratory ²	Sources	Occurrence in GYE ³
barred owl	small mammals	dense forests (eastern deciduous but moving west into spotted owl habitats)	resident	Forsman & Bull 1988	accidental
spotted owl	small mammals, especially wood rats	mature temperate coniferous rain forest of Pacific NW	resident	Forsman <i>et al.</i> 1984 Forsman <i>et al.</i> 1985 Forsman & Bull 1988 Laymon <i>et al.</i> 1985	NOT RECORDED IN YNP or GYE
great horned owl	lagomorphs, grouse, skunks, small birds and mammals - anything	highly variable	resident	Craighead & Craighead 1956 Rausch <i>et al.</i> 1972 Marti 1973, 1974 Forsman & Bull 1988	common
long-eared owl	voles, small mammals	usually old magpie nests along riparian forests near open habitats	migratory	Armstrong 1958 Marks & Yensen 1980 Marks 1980 Marti 1973, 1974	uncommon
short-eared owl	small mammals	open grasslands or meadows	migratory	Clark 1975	uncommon
boreal owl					
northern saw-whet owl	small mammals		resident	Boula 1982	uncommon

Table 2. Typical Prey Items and Breeding Habitats, Migratory Status, Selected References, and Occurrence of Common Raptors of the Greater Yellowstone Ecosystem.

Species	Prey Items ¹	Breeding Habitats	Resident-Migratory ²	Sources	Occurrence in GYE ³
common raven	vegetable matter, small birds and mammals (eggs & young of year)	variable - cliffs or tree nests	resident	Knight and Call 1980	common
Notes					

¹ = general prey habits are found in Bent 1937; 1938; Brown and Amadon 1968; Sherrod 1978.

² = typically northern populations tend to be the most migratory, often "leap-frogging" over resident populations to local wintering grounds.

³ = sources are not intended to be comprehensive, but introductory.

CHAPTER FOUR - PREDATION IN RELATION TO COMMUNITY DYNAMICS

Twenty-three species of hawks (15) and owls (8), plus one passerine, the raven, are considered "common" raptors in the GYE (Table 3, Figure 10). In identifying hawks and owls as a "guild" (assembly) of avian predators, it must be emphasized that they are but only a few of many predators in a given community or ecosystem. Continuing with the example of Lamar Valley, warblers, vireos, swallows, great blue heron, belted kingfisher, mountain chickadee, northern shrike, and American robin are also considered avian predators, but they are not raptors. These non-raptorial species variously predate fish (piscivore), insect and other invertebrates (insectivore), and amphibians, reptiles, or small mammals (carnivore).

The common raven is considered a member of the raptor guild in many biological communities of the western states. Food habits include vegetable matter, eggs and nestlings, and small mammals (omnivore). In some locations it is often in direct competition with true raptors. Ravens build nests that are often used secondarily (the next year) by hawks and owls (see commensulism, Table 4), without which they might be unable to nest in some locations. Other predators in an ecological community include mammals, reptiles, amphibians, and fish. Those found commonly in Lamar Valley include the vagrant shrew, longtail weasel, badger, coyote, black and grizzly bear, sagebrush lizard, bullsnake, leopard frog, and cutthroat trout.

Predation and competition have a stronger influence on a population than any other interspecific relationship. Prey species affect their potential predators, particularly regarding where and how to hunt. The snail kite (formerly Everglade kite) distribution coincides to that of the apple snail. Throughout North America, the northern harrier (formerly marsh hawk) breeding distribution coincides with that of the meadow vole.

Table 3. Species List of Birds of Prey in the Greater Yellowstone Ecosystem.

Vultures, Hawks, Falcons, Eagles ...	Owls
turkey vulture (uncommon)	flamulated owl
osprey	western screech owl
bald eagle	great horned owl
northern harrier	snowy owl (rare - winter only)
sharp-shinned hawk (rare)	northern hawk-owl (rare)
Cooper's hawk (rare)	northern pygmy owl
northern goshawk (rare)	burrowing owl
Swainson's hawk	barred owl (accidental)
red-tailed hawk	great grey owl
ferruginous hawk	long-eared owl
rough-legged hawk (rare - winter only)	short-eared owl
golden eagle	boreal owl
American kestrel	northern saw-whet owl
merlin	
peregrine falcon	
prairie falcon	

Voies live in moist grasslands or meadows and are often concealed from potential predators. Harriers have adapted by locating concealed prey by using auditory cues, similar to the common barn owl and long-eared owls. Other raptors are influenced by prey even though the relationships may not be readily apparent.

Predation is more complex than a simple capture and consumption of prey by a predator. Predator-prey relationships have been interpreted variously from two levels; and interaction between two individuals, and as one population interacting with another. Predation has been defined as a process by which an animal spends effort (energy) to locate prey and expends another effort (energy) to mutilate or kill it. Some ecology texts define predation as one animal deriving energy resources from another's flesh (where flesh can mean any animal tissue, i.e., single-celled organisms to the highest vertebrates). On a

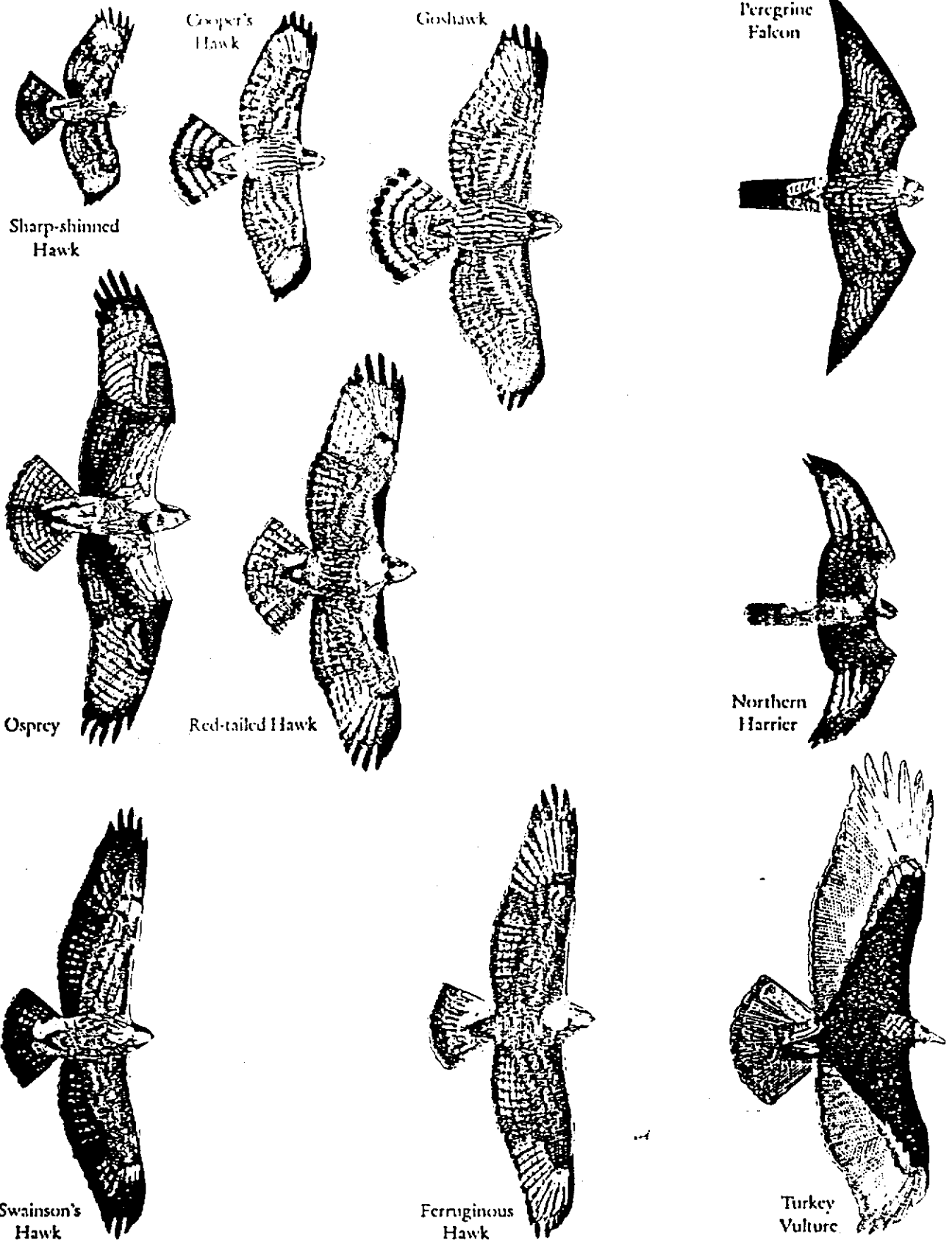


Figure 10. Some common hawks of Yellowstone National Park, from Dunne, Sibley, and Sutton (1988).

Table 4. Major relationships between populations in typical biological communities.

Benefit-Loss		Relationship
Species A	Species B	
+	+	Mutualism - <i>obligate symbiosis</i>: two species have evolved to a situation in which they must live together (i.e., the microflora in the gut of a grouse, cow, or termites to aid in the digestion of chlorophyll).
+	+	Mutualism - <i>proto-cooperation</i>: both species gain benefits but are not required to live together (some species of birds picking parasites off the back of ungulates).
+	0	Commensulism: one species gains while the other is not affected (such as woodpeckers excavating cavities which are subsequently occupied by bluebirds, chickadees, kestrels, etc., or prairie dog-constructed burrows occupied by burrowing owls).
-	0	Ammensulism: one species may or may not gain and others loose (examples include desert plants that extrude toxins that prevent other plants from growing too near or possibly taking water from their roots).
-	-	Competition: a <u>major</u> driving factor affecting allocation of resources in "short" supply or otherwise not abundant, such as food, nest sites, escape cover - general ecological theory states no two species can occupy the same niche.
-	+	Predation: obviously one species is the eater and the other the meal; the eater gains and the eaten loses.
-/0	+	Parasitism: very similar to predation in many respects, but a single parasite does not kill its host. However, most parasites occur in high densities often hampering, sometimes killing the host.
0	0	Neutralism: two species do not interact, neither influences the other.

community level, predation can be viewed as one population interacting with another population or the transfer of energy from one trophic level to another.

Relationships between prey and predator involve one population reacting and adapting to another's behavior, biology, and ecology. These relationships evolve over considerable time periods, and continue to change, with the prey always evolving new behaviors to avoid predation, while the predator is evolving new hunting behaviors. A dynamic equilibrium is thus created between two species where the prey is never at risk of extinction by the predator. When a predator can no longer easily find a particular species, hunting of that species is reduced due to the increased effort (energy) that the predator must expend to find that particular species. In other words, more energy is spent attempting to locate a meal than is gained from it. No predator can keep this up for any length of time. Therefore, if prey are not abundant, predation pressure on that species is reduced, and the population recovers in numbers until it is again abundant.

However, in biological communities, relationships between two populations are uncommon. One population is usually prey for more than one predator, and predators hunt from several prey populations. Thus a complex weaving of relationships between many predator and prey populations becomes one of several types of relationships in a dynamic community. Major relationships between species are listed in Table 3.

Some of the predator-prey relationships may be determined and predicted mathematically. Such mathematical and theoretical treatment is beyond the scope of this book. However, mathematical modeling may be summarized in to two types of predator responses to changes in prey density or availability; functional and numeric.

In functional responses, when prey is unavailable due to low density, predator consumption is low, as would be expected in a density-dependent relationship. As prey

numbers increase, so does predation on that species. There are some exceptions, notably involving "search images." If the prey density drops below a theoretical point in which the predator rarely encounters a prey species (image), the predator must shift to an alternate prey source (acquire a new search image), or starve.

Predator numbers increase as prey density rises in numeric responses (Fig. 11). An increase in predator reproduction is commonly observed; adults are in better physical condition to meet reproductive demands and more young survive to fledgling as parents can supply abundant prey resources to growing young. Since reproduction requires a variable time period to complete, a time lag is usually associated with numeric responses. Reproductive and predation responses of this type have been observed for great horned owls, red-tailed, Swainson's, and ferruginous hawks.

The predation process may become periodically cyclic depending on the biology of the prey and predators. Rodents cycle from high densities through low densities and back to high levels about every 4 years, lagomorphs (cottontails and jackrabbits) every 10 years, and grouse depending on location, every 4-10 years. Such fluctuations can have a dramatic influence on raptors with prey preferences limited to cyclic prey species. Northern populations, typically in arctic tundra and boreal ecosystems, often exhibit cycles of high and low densities. Cyclic species include snowy, great grey, great horned, short-eared, and pygmy owls, northern goshawk, ruffed grouse, lemmings, voles, and various finches (Figure 5 & 6).

Some considerations influencing predation in general are:

- ▶ the importance of predator influence on a given prey population
- ▶ changes in genetics (pheasant-hunting), weather, cover, parasites, predator numbers, prey numbers

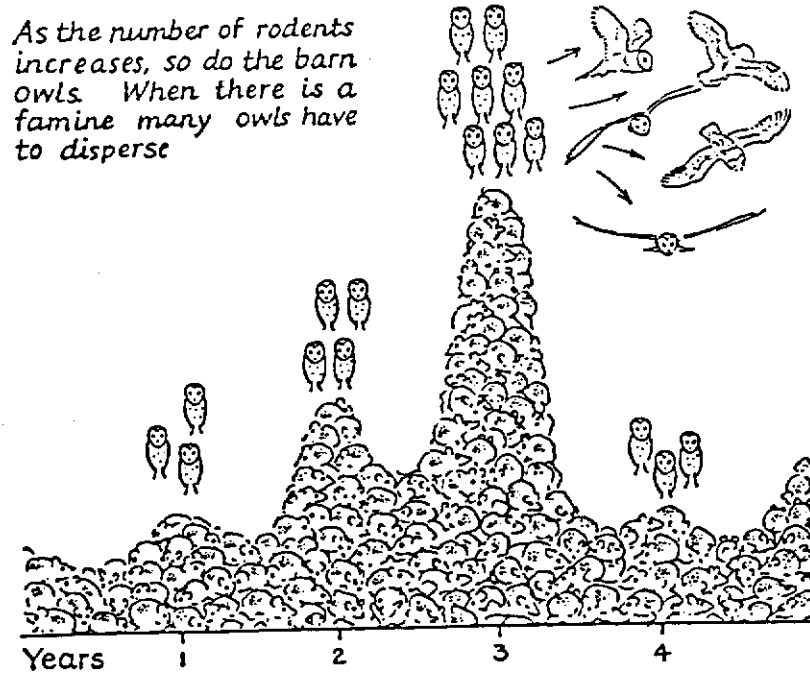


Figure 11. Numeric response of raptors to fluctuations in prey densities, from Sparks and Soper (1989).

- ▶ stress and physiological condition of prey or predator
- ▶ ease of capture and prey availability or the ability of the predator to capture prey, i.e., biology and availability of prey to avoid predation versus the experience of juvenile or adult predators to capture prey
- ▶ emigration or immigration; movement into or out of a given location by predator or prey
- ▶ availability of alternate prey species
- ▶ adequacy of escape cover (structure and density) and species escape mechanisms
- ▶ the caloric (energy) value of one prey species over an alternative species; the energy required to find one species over another

CHAPTER FIVE - A LOOK AT PREY SPECIES

Microtines (voles) may be as dense as 12,000 per acre in some western states during cyclic peaks. This is possible, in part, through their biology; non-hibernating, with up to 13 litters of 4-8 young per year. Few biologists could dispute the fact that this would provide an adequate prey base. Popular literature has calculated that with no predation pressure, breeding small rodents would amass to a depth of 2.5 inches of the earth's surface in one year. Fortunately, most voles and other small rodents do not live a full year, typically falling victim to various predators, including hawks and owls.

To understand a predator's prey base is to fully understand the predator. Predation pressure from a variety of predators controls, in part, the population density of a given prey species, while the enhanced reproductive biology of the prey species attempts to compensate for the losses. The prey influences the predators, as the prey's abundance and availability determines the rate of predation upon its population.

One of the many behaviors prey species have evolved to reduce predation is flocking (herding for mammals). This is particularly noticeable in wintering small birds, when these birds are under increased stress. A predator attempting to capture a meal can only chase one individual at a time. If a predator were to chase one, then another, and another, as each member of a flock (or herd) crossed its path, it would soon be exhausted. That is why inexperienced young, disabled, or weakened individuals are quickly identified by a predator as they vary from the norm, or stand out from among many similar individuals, i.e., they can be tracked in a crowd. The confusion of a flying flock of birds may be viewed as a group effort to confuse a predator, and reduce predation.

Mobbing is somewhat related to flocking. One or more individuals of one species mob or harass a recognized predator. Kingbirds, blackbirds, and crows will repeatedly dive on flying butes. I have observed red-winged blackbirds dive in succession, one after another, on flying or perched northern harriers or short-eared owls. Magpies and jays will often locate a roosting hawk or owl and repeatedly harass and vocalize, warning other individuals (both conspecific and nonspecific). There appears to be an innate recognition and attack response by prey species to their predators. Exceptions are the accipiters, which may be a little too swift for close-proximity harassment. Several theories have been offered regarding the purpose and significance of mobbing behavior. Included among these theories are; mobbing interferes with the ability of a predator to hunt with stealth, and it serves to warn or attract attention to all prey species in the immediate area.

CHAPTER SIX - RAPTORS AS HUNTERS

Predators can be grouped into two broad categories based primarily on foraging adaptiveness; generalized and specialized. As is typical with nature, nothing can be categorized with certainty, so most raptors fall in between the two extremes.

The Snail Kite is highly specialized, principally foraging a single species, the apple snail. The California Condor may also be considered a specialized raptor, not that scavenging decaying flesh is specialized but size and habitat constraints effectively limit where and how the bird forages. Other vultures may be considered specialists also because carrion diets no longer require strong grasping feet and tearing bills typical of most raptors. These efficient raptors make use of animal remains that few other species will, and aid in nutrient recycling. Digestive enzymes of the crop destroy bacteria and body excretions act as antiseptics, whitewashing legs instead of voiding away from the body as in other hawks and owls. The head is bare so feathers, difficult to preen on this part of the anatomy, do not mat and become caked with putrid flesh. Also, the ultra-violet rays of the sun, which kills bacteria, act to further sanitize the naked head and crops of these birds.

The red-tailed hawk is found from dense tropical rain forests of the Caribbean islands, arid Sonoran deserts of Arizona, to the tundra of the Alaskan Barrens. Considered a generalist, the red-tailed hawk's diet includes a variety of prey species including insects, carrion, and plant material. Red-tails are tolerant of variable habitats conditions and a pair may build its own nest, or secondarily occupy the nest of another species such as a raven; in trees, cliffs, ground, near man-caused disturbances, or in pristine wilderness. In fact, the plasticity of red-tailed hawks and their occupation of habitats adjacent to human habitation is typically and indicator of disturbance rather than "wilderness" qualities.

The American kestrel is also a generalist as it preys on a wide selection of prey, both vertebrate and invertebrate; builds or occupies a variety of nests, and is tolerant of a range of environmental factors, including man-made disturbances. The prairie falcon is considered a generalist in prey selection, not limited to hunting only birds as other large North American falcons. However, prairie falcon nesting is usually limited to cliff cavities, making its nesting locations specialized.

The rough-legged hawk is more specialized, being about the same size and weight as the red-tailed hawk, but with smaller feet adapted to capturing its preferred prey, lemmings and voles. The sharp-shinned hawk, Cooper's hawk, and northern goshawk, collectively called "bird hawks," are swift, maneuverable, and capture small to medium sized birds in densely structured forest habitats. As previously noted, the northern harrier has adapted to locating prey by using auditory cues, but it may be classed as a generalist as it occupies a wide range of habitat types.

The specialist raptors are vulnerable to disturbances or habitat alterations, both man-caused and natural but especially man-caused, as each of these species must have some particular condition to nest, food requirements, or other survival factor to provide offspring for the next generation.

Several feeding economies have been identified among raptors based on habitat structure and composition, foraging behavior of the raptor species, distances traveled, and frequency of capture, and prey species. They include the following with the caution that overlap may occur.

1. *Aerial insectivore* - usually kites; however, Swainson's hawks have been observed on numerous occasions catching grasshoppers and other flying insects (an adult and immature Swainson's hawk were observed in June 1983, at Buffalo Crossing Picnic Ground hawking emerging Mayflies from the Yellowstone River, making over 20 trips

from selected perches to capture flying Mayflies. In July 1990, an adult red-tailed hawk was observed hawking emerging salmon flies at Tower Falls overlook. As least 8 captures were observed by an entire class from about 100 yds. Hawking is not typical hunting behavior of Swainson's or red-tailed hawks.

2. *Cavity searching* - African harrier hawk; no example for North America.
3. *Passive or Perch* - most buteos, i.e., red-tailed, ferruginous, and Swainson's hawks although the Swainson's hawk has very light wing loading for hunting while gliding.
4. *Aerial hover* - osprey and kestrel, occasionally rough-legged hawks and northern harriers.
5. *Aerial pursuit* - accipiters (northern goshawk, Cooper's and sharp-shinned hawk) and prairie and peregrine falcons; rapid and active flights, short or long chase.
6. *Scavenging* - carrion-eating Old and New World vultures, and bald eagle, especially during wintering months, but most raptors at one time or another have been observed feeding in this manner.
7. *Coursing* - northern harrier, Swainson's hawk, and occasionally ferruginous hawk; quartering low over potential prey habitat, a type of ambush hunting.

Raptors are generally viewed as efficient predators, diving on unsuspecting prey with deadly accuracy, rarely missing the "mark." Overall, this is true or there would be serious consequences to their survival. Studies have shown the red-tailed hawk successful about 79% of capture attempts (roughly 1 out of 4 strikes). It is estimated that during a single breeding season about 90 days, 1000 small mammals will be brought to the nest by a red-tailed hawk pair. An adult great gray owl can consume 1400 voles per year. Hunting success for ospreys is about 80-90%, but as summer progresses, waters warm and fish seek deeper cooler temperatures, and hunting success declines. Weather (precipitation and wind) may greatly influence the hunting success of raptors, and may play a significant role in mortality of nestlings and immature birds.

CHAPTER SEVEN - A LOOK AT RAPTOR BEHAVIOR

Complexity in behavior corresponds to an increase in the intelligence level of a given life form. Raptors are highly evolved and specialized. For the most part, they are efficient hunters, leaving them with "spare time" (termed "loafing" by ethologist), especially outside the breeding season. A variety of spare time activities may be observed, especially oriented towards enhancing hunting skills. In domestic predators this behavior is well known. Cats will stalk, pounce-on, or bat-about yarn pulled across the floor. Dogs will chase and retrieve, using both sight and scent to locate objects. Both dogs and cats may be observed chasing, rough-housing, or otherwise playing tag with siblings, conspecifics, or their human owners - all simulating contact behavior necessary to obtain and capture prey. Note that play behavior by prey species, such as rodents and rabbits, develops hiding, evasion, or outrunning siblings and conspecifics, with little or no physical contact. Peregrine falcons have been observed playing with feathers in mid-air, dropping and catching them repeatedly. Merlins have been observed seizing pine cones from the tops of trees. American kestrels may be observed harassing larger birds such as ravens, eagles, and buteos. Young of many raptor species as they approach fledging have been observed in mock-attacks on sticks in the nest. Inanimate objects mock-attacked by northern harriers were similar in size and weight to actual prey species (voles).

Raptors know by instinct how to kill. Capture techniques, strategies, and handling of prey once captured for a particular species must be learned through experience. Many immature hawks and owls consume insects and other invertebrates, which are abundant and "easily" captured, and provide experience for developing skills for subsequent "advanced" prey. Immatures are especially vulnerable during this learning period. Death is

the harsh teacher for those young-of-the-year that do not learn quickly to capture and handle prey.

Predators have often been accused of killing more than necessary to satisfy physiological requirements. Often this occurs in the fall when adults continue high capture rates after young have fledged and are no longer dependent on parent birds. Food caching has been observed for several raptor species. Raptors are above all, opportunists. They may kill disproportionate prey for their physical needs if the opportunity presents itself, or they may go several days without successful capture.

As opportunists, raptors (and all predators in general) are constantly searching for any behavior or characteristic that sets a single individual apart from the group, flock, or herd. Often unwary juveniles or immatures, disease weakened, or old individuals are predated disproportionately in comparison to the whole population. This is the natural selection process which ultimately improves the vitality and health of the prey population.

An example may better illustrate this point. During the late 1950's the rabbit plague myxomatosis was purposely introduced into populations in France. Nearly all the rabbits in western Europe were affected by this epidemic with up to 99% mortality. In the mountains of Spain, however, kites, eagles, and other raptors are more numerous than elsewhere in Europe, and predated the infected rabbits so quickly that the disease was never a major mortality factor to the rabbit population.

A final point regarding raptors as opportunists. Bald eagles and other raptors do occasionally pirate prey from smaller, more vulnerable species. Bald eagles often steal prey from ospreys. Also, raptors, particularly eagles, do kill livestock, i.e. domestic fowl, small calves and lambs, when and if the opportunity occurs.

CHAPTER EIGHT - RAPTOR MORTALITY

While most invertebrates and small vertebrates live a life constantly "looking over their shoulder" for potential predators, only a few raptors are immune to natural predation. Tree nesting raptors are subject to predation by raccoons, crows, jays, and snakes which predate eggs and young, (not to mention that the nest could be blown out, or the tree fall down). Kestrels, northern harriers, immatures peregrine falcons, and small owls have been found in the prey remains of golden eagles, great horned owls, and northern goshawks.

Ground nesting species such as the short-eared owl, northern harrier, and occasionally the ferruginous hawk, are subject to predation by coyotes, fox, skunks, snakes, etc., and nest-trampling by livestock, big game, and tractors. Removing birds from wild populations for falconry constitutes a form of predation by man. Overall, nest predation incidents are exceptions to normal mortality patterns.

More than half of the young fledged die within their first year from all causes. For species such as the ferruginous hawk, up to 80% are lost in certain localities, mostly due to shooting. With most raptor species laying only two to four eggs mortality factors in relationship to productivity becomes highly significant. Causes of mortality include; starvation, disease, predation, pesticides, electrocution, shooting, trapping, poisoning, and collisions with power lines or vehicles. High winds sometimes blow nest out of trees, persistent rains interfere with parents provisioning prey and chill young birds beyond their ability to maintain body-core temperatures. All of these factors influence the number of young that will eventually replace parents within a local population.

CHAPTER NINE - WINTER HAZARDS

The winter months are a period of stress for raptors, especially nonmigratory populations. Maintenance of body heat through cold weather requires increased caloric intake, but prey is generally scarce as some species hibernate and snow provides additional cover for others. Into this period, immature birds enter, independent of parental feedings for the first time, and somewhat inexperienced at prey capture.

Physiological condition of adults emerging from winter influences the success of reproduction for each breeding season. Survival of declining populations may be greatly affected by the availability of suitable wintering grounds. There is an added threat to species wintering outside the United States, such as the osprey, Swainson's hawk, and some peregrine populations. Although banned in the U.S., Mexico and many Central and South American countries continue to use DDT/DDE and its derivatives, and other chlorinated hydrocarbons, as pesticides. These chemical compounds accumulate through food chains so that raptors are highly susceptible to contamination. DDT/DDE is soluble in body fat and is known to interfere with egg formation and reproductive behavior.

CHAPTER TEN - RAPTOR BREEDING FACTORS AND STRATEGIES

Those species in which long range survival (life span) is sacrificed for large short-term reproductive output are termed "r-strategists." These are species in which energy beyond simple body maintenance is directed to reproduction and typically die due to "burn-out" or predation. Those species in which large reproductive output is sacrificed for long-term survival are termed "K-strategists." These species have a prolonged life span and the

reproductive effort, although small, is extended over a long period. K- and r-strategies apply to most vertebrates.

Most r-strategy species are small generalists or invaders, able to exploit fluctuating prey or resources rapidly (like weeds on bare soil). Most have poorly developed antipredator defenses and their densities and reproductive rates compensate for high mortality. Most occupy seral communities and adapt to variable prey bases, habitats, and environments. Examples include the northern harrier, short-eared owl, and American kestrel. In contrast, most K-strategy species are specialists, depending on stable but limited resources, or "uncommon" prey, as indicated by low diversity diets. Because most are large, a larger home range is required to meet energy demands. Most occupy climax (stable) communities and cannot adapt (rapidly) to new or changing environmental conditions. Also, of note is the low annual (or greater for condors) reproductive output. Combined with large home range requirements, limited prey/resources, basic non-plasticity, and low replacement capability, these species are highly susceptible to depletion by natural or man-caused disturbances. Most of the world's threatened and endangered species fit into this group. Examples of raptors include the large African vultures, California and Andean condors, most eagles, island raptors, and spotted owl of the Pacific northwest.

However, distinct categorization in nature is tenuous at best, so raptors exhibit a wide variety of reproductive strategies in between the r- and K- extremes. In general, the larger the species, the more prolonged is the juvenile period, and the later the time at which sexual maturity is attained. The bald eagle does not reach sexual maturity, as indicated by the white head and tail, until 5-7 years of age. Also, the larger the species, the longer the total breeding season. Finally, the larger the species, the smaller the clutch size.

CHAPTER ELEVEN - MANAGEMENT CONSIDERATIONS

In short, twenty centuries of "progress" have brought the average citizen a vote, a national anthem, a Ford, a bank account, and a high opinion of himself, but not the capacity to live in high density without befouling and polluting his environment, nor a conviction that such capacity, rather than such density, is the true test of whether he is civilized. The practice of game management may be one of the means of developing a culture which will meet this test.

Aldo Leopold
Game Management, 1933

Rapid advances in our knowledge of raptor biology and ecology have resulted from investigations of species such as the peregrine falcon, bald eagle, and osprey. The first studies were generated to determine the causes of rapid (and noncyclic) population declines observed during the late 1940s through mid-1960s.

The peregrine falcon probably provides the best example of how serious these declines were to some raptor populations. It is estimated that 3500 peregrines lived and nested in the lower-48 states just after World War Two. Widespread use of DDT caused drastic population reductions in many species, but especially the peregrine falcon. It was discovered that bioaccumulation of DDT/DDE and other organochlorides used in agricultural crop production and insect pest control, collected in the body tissues and was detrimental to reproductive behavior and physiology, most notably aberrant maternal behavior and eggshell thinning. During the late 1960s and early 1970s, probably less than 100 individual peregrines survived in the United States outside of Alaska. By 1964 the peregrine falcon was extinct in the eastern seaboard states, and the Rocky Mountains, with less cropland, became the stronghold for the falcon.

In December 1972, DDT was banned by the Environmental Protection Agency, in part, due to the evidence of contamination to peregrine falcons. Recent population studies estimate about 1000-plus peregrine falcons in the continental United States with an increasing trend. Much of the success has come from the Peregrine Fund, based in Boise, ID, which supplies captive breed young for state recovery programs, sponsored in cooperation with the U.S. Fish and Wildlife Service. In June 1987, the 2000th peregrine falcon raised through this breeding program was released into the wild. Yellowstone National Park and several of the surrounding national forests have sponsored hack stations for captive-breed falcons. In 1992, Yellowstone National Park had 10 known peregrine falcon nest sites.

The Peregrine Fund has been very successful. The program now has shifted from domestic emphasis to research, captive breeding, and reintroductions of rare and endangered raptors from other continents and islands.

With control of contaminants, the peregrine has proven to be extremely adaptable in habitat use, moving into the concrete cliffs of metropolitan areas. Salt Lake City has hosted breeding falcons since 1986. Other cities include New York, Boston, Madison, Denver, Los Angeles, and San Francisco.

Similarly, the bald eagle was found to be sensitive to pesticides and other contaminants. It is believed that up to 25,000 eagles once resided in the lower-48 states. After significant declines, similar to the peregrine falcon, bald eagle populations are rebounding. There is open discussion regarding the delisting of the eagle, which is still protected under the federal Endangered Species Act.

Raptors are now widely accepted as indicators of environmental health and quality. Their presence or absence infers a variety of habitat concerns. The U.S. Forest Service

places considerable emphasis in planning and implementation of management actions on Management Indicator Species and Regional Sensitive Species, among which are the flammulated owl, great gray owl, and northern goshawk. Other species that are good indicators of habitat-environmental quality, used to differing degrees by some federal and state agencies (including the U.S. Forest Service) are: burrowing owl, boreal owl, sharp-shinned hawk, Cooper's hawk, and ferruginous hawk. Exceptions to the rule may be observed in such species as the American kestrel, red-tailed hawk, and great horned owl, which are highly adaptable and tolerant to a wide array of "disturbances" or conditions close to human activities.

As a result of increased understanding of raptor biology and ecology, better management plans can be developed to specifically benefit these birds but also all nongame wildlife. Management of raptors may be categorized into one of several approaches:

- ▶ *upgrading or enhancing existing habitat* - an example would be cutting the top off a mature conifer tree near a lake or reservoir, simulating a lightning strike, for a nest platform for a bald eagle or osprey
- ▶ *moderating human disturbances* - an example is the preclusion of human traffic (hiking, biking, horse-packing, etc.) from a known nest site until nesting is completed (Table 7). The exclusion of human traffic from Antelope Valley below Mount Washburn in Yellowstone National Park for grizzly bears is based on similar management logic.
- ▶ *inclusion of raptors as an integral component in comprehensive management plans* - for years wildlife management has emphasized big game as nearly the sole objective in resource plans. State-of-the-art planning places equal emphasis on the conspicuous as well as the inconspicuous, nongame with game, elk and bear with sparrow and toad, and hawks and owls.

Examples of these approaches are included in the Appendices. Table 5-8 suggest other impacts and mitigation measures for raptors.

Table 5. Seasonal, critical periods to avoid human-related disturbances for selected raptor species (Interagency Rocky Mountain Front Wildlife Monitoring and Evaluation Program 1987).

Northern Goshawk, Dates of Nesting Season (Approximate) (based on nationwide breeding dates, Reynolds <i>et al.</i> 1992)	15 April - 15 August (1 March - 30 September)
Cooper's Hawk, Dates of Nesting Season (Approximate)	15 April - 15 August

Table 6. Recommended raptor nest buffer zones related to various human activities. These recommendations are generalized and do not account for details of terrain, vegetation, type, duration, and familiarity to disturbance, specific temperament of individual birds, phase of nest cycle, etc., which all enter into determining the actual needed buffer at a given nest site. Preclusion of human activity at a given nest site should be tempered with as many variables as possible, and on a site specific basis (Interagency Rocky Mountain Front Wildlife Monitoring and Evaluation Program 1987).

ACTIVITY	RECOMMENDED BUFFER ZONE
Off-Road Vehicle Use	¼ mile - ½ mile
Camping	¼ mile - ½ mile
Hiking, Biking, Horse Riding, Fishing from Shore	¼ mile - ½ mile
Rock Climbing	½ mile - 1 mile
Road Construction	½ mile - 1 mile
Controlled Burning (Slash)	1 mile - 2 miles
Trail Clearing	¼ mile - ½ mile
Building Construction	½ mile - 3 miles
Heavy Equipment Operation - Blasting	1 mile - 3 miles
Logging	½ mile - 1 mile
Aircraft Overflight (Low Altitude)	¼ mile - 1 mile

Table 7. Raptor nesting phases, activities, sensitivity to disturbances, and comments. Raptor nesting chronology can be generally divided into 5 phases, each varying in sensitivity to human activities. This table should be used in connection with Table 5 and Table 6 to determine human activity restrictions, buffers zones, and duration (Benson 1979; Interagency Rocky Mountain Front Wildlife Monitoring and Evaluation Program 1987).

PHASE	RAPTOR ACTIVITY	SENSITIVITY TO HUMAN DISTURBANCE	COMMENTS
I	Nest Building and Courtship Behavior	Extremely Sensitive - period most likely to desert	1. Most critical time period from the standpoint of desertion.
II	Egg Laying	Extremely Sensitive - period most likely to desert	2. Human disturbance of even limited duration may cause desertion, not only of nest site, but also established territories.
III	Incubation	Extremely Sensitive - period most likely to desert	3. Nest site tenacity is weakest on new territories or when birds first establish territories. 4. Flushed birds may puncture, crush, or eject eggs from nest. 5. Flushed birds leave eggs unattended; susceptible to predation, cooling, moisture loss, and over heating.
IV	Hatching and Brooding	Moderately Sensitive	6. As hatching-rearing approaches, most birds become tenacious to clutches of eggs. 7. Generally, uncommon to desert nest after young have hatched.
V	Post Fledging	Moderately Sensitive	8. First half of nestling period, young most susceptible to elements. 9. Unattended nestlings may chill - over heat, susceptible to predation. 10. Nestlings may miss feedings. May affect overall health of young birds. 11. Premature fledging caused by disturbance is threat to survival of young birds which may not be able to escape predators while on ground.

Table 8. Summary of the effects of various land use practices on western raptor populations (Murphy 1989).

Negative Impacts	Mining	Linear ROW	Recreation	Livestock Grazing	Water Development Projects	Agriculture or Agricultural Practices	Urbanization	Logging Activities	Fire Management	Contaminants
		♦								♦
	♦	♦	♦	♦	♦	♦	♦	♦	♦	
	♦	♦	♦	♦	♦	♦	♦	♦	♦	
	♦	♦	♦		♦	♦	♦	♦	♦	
	♦	♦		♦	♦	♦	♦	♦	♦	♦
	♦		♦				♦	♦		♦
			♦							♦
	Positive Impacts									
creation of new nesting, foraging, or roosting habitats	♦	♦		♦	♦	♦	♦	♦	♦	
provision of artificial perch or nest structures	♦	♦		♦		♦	♦	♦		
increased prey density, diversity, vulnerability		♦		♦		♦	♦	♦		
behavioral adaption to habitat modifications	♦	♦		♦	♦	♦	♦		♦	

CHAPTER TWELVE - CONSERVATION CONSIDERATIONS

Raptors normally occur in low densities due to their place in the food chain hierarchy and are sensitive for the most part to human disturbances. For the Greater Yellowstone Ecosystem, raptors do not carry the management or public interest "weight" of grizzly bear or wolf reintroduction, but they are still an important, integral component of the ecosystem, in addition to being conspicuous.

An interesting follow up to the landmark raptor community study by Craighead and Craighead (1956 - *Hawks, Owls, and Wildlife*) was completed by Craighead and Mindell (1981), which compares present observations or conditions to those of the initial study in the Teton National Park environs. The salient findings of the Craighead and Mindell study are taken from the authors' abstract:

"Numbers of nesting raptors on a 31.1 km² area in w WY declined 30% between 1947 and 1975. The common raven population increased from 3 to 11 pairs, and Swainson's and red-tailed hawks combined declined from 17 to 9 pairs. Data from 1948, 1978, and 1979 support these changes. Nesting success was 50% less in 1975 than in 1947, and nesting dates for most species were later in 1975 (due to environmental factors). *Increases in human disturbance and changes in natural environment are described and indicated as factors effecting raptor population decline.*"

Other important observations of Craighead and Mindell are:

"Comprehensive monitoring of raptor populations is critically important to raptor management and conservation efforts.

"Considering ravens as ecological equivalents of raptors on the basis of overlapping prey and nest-site preferences, a decrease in the combined nesting population is still evident. Ravens had a more positive reaction to increased human activity. To their advantage, ravens are winter residents and select nest sites before migrant red-tailed and Swainson's hawks return. Details of niche overlap between red-tailed hawks, Swainson's hawks, and ravens are not entirely known; however, increasing nesting raven densities in traditional red-tailed and Swainson's hawk nesting areas may result in less available habitat for nesting Buteos. We suspect the decline in the raptor population facilitated the raven increase, while, at the same time, increasing raven densities compounded problems for certain raptors, particularly less aggressive Swainson's hawks.

"In 1947, 88% of the raptor pairs fledged young, but only 40% fledged young in 1975. In 1947, 2.6 young fledged/raptor and raven pr compared to 0.98 in 1975. In 1975, failure to lay eggs, egg destruction, and infertility were more often the causes of nesting failure than was mortality after hatching. In the only known instance of nestling mortality, 4 young sharp-shinned hawks were killed by a great horned owl.

"Henny (1972) calculated that 1.33-1.38 young red-tailed hawks must be fledged/breeding-aged female above latitude 42°N to maintain a stable population. The 1947 recruitment rate for red-tailed hawks (1.4) meets these limits, but the 1975 recruitment rate (0.7) does not. The recruitment rate for Am kestrels was above Henny's (1972) critical value of 2.88 in 1947 (3.8) and below in 1975 (1.4).

"Since 1947 the study area has experienced increasing human activity. During the original population study, a small NPS housing and administration area was located adjacent to the study area. In subsequent years, as the study area became part of Grand Teton National Park, a housing complex, visitor center, maintenance facility, post office, gas station, and tackle shop was relocated or built within the study area. Park visitation increased from 640,973 in 1951 to 2,807,027 and 3,856,000 in 1975 and 1976, respectively. Seasonal NPS employees increased from 50 in 1951 to 229 in 1975. About half of the seasonal employees worked in Moose, WY, area. In 1975, over 76,000 visitors floated the Snake River within the study area, compared with a few dozen at most in 1947. A narrow blacktop highway served the area in 1947. A few years later a major highway was constructed through the study area. This highway bisects Grand Teton National Park, and carries a large portion of the visitor traffic to YNP. A small private airport bordering the study area on the south has gradually expanded, and now handles over 31,000 commercial passengers per year. Almost all flights pass over some portion of the study area.

"Swenson (1979) found a relationship between human use of an area and productivity and distribution of osprey nests in YNP, WY, accompanied by a decline in the population since 1917.

"Prey availability can also affect raptor breeding density and productivity. There is no evidence that availability or lower prey abundance was a major factor influencing the raptor decline".

A final note, regarding conservation considerations of raptors, their habitats, and prey bases in light of the summary above; if these changes can occur in our nation's wildest places, sanctuaries set aside for wildlife, what are we as a nation, a worldwide community of humans, doing for our wildlife in less pristine or protected areas?

My final admonishment, if not plea, is that public policy is not dictated by the public agencies (state or federal) in question. In fact, policy comes from the public - the grassroots level - the voting public - and moves up from the bottom. If raptors are

important in your life, or at least part of it among the many other things, get involved - write your representatives and resource agencies, voice your concerns and approvals, gather information, attend public meetings, maybe join a conservation organization. Your interest in wildlife and their habitats counts.

GLOSSARY

biodiversity or *biotic diversity* = the variety of life and its processes, inclusive of genetic differences, within the biotic communities and ecosystems in which they occur.

biome = a major regional association of plants and animals with similar life forms and environmental conditions (i.e., weather patterns, soil types, etc.): the largest geographical biotic unit and typically named after the dominant vegetation type, i.e., grassland, tropical rain forest, desert, etc.

cere = saddle of flesh (usually yellow in color) at the base of the beak, unique taxonomic characteristic of Falconiformes.

community or *biotic community* = a collection of populations of different species, plant, animal, or combinations thereof, occurring in a given location - no reference to abiotic factors.

cover type = terrestrial or aquatic area with similar physical, chemical, and biological characteristics that meet a specified (i.e., man-made) definition of homeogeneity, specific or general

crepuscular = dawn/dusk activity period of animals

ecology = the study of plants and animals and their relationship to each other and their environment

ecosystem = plants, animals, and abiotic factors that interact with each other - may contain many communities: emphasis placed on abiotic factors (temperature, wind, elevation, soils, energy flow, etc.).

ecotone = the boundary between two habitat types

edge effect = the boundary or *ecotone* between two adjoining habitats may support more animals and plants (diversity) than either of the two surrounding habitats

environment = the total of all factors (living and nonliving) and conditions that may influence the distribution and occurrence of animals and plants

distribution = (sometimes also called *range*) - the total geographical limits (area) an animal or plant occupies, both migratory and resident

diurnal = daytime activity period (of animals that sleep at night)

guild = a group of animals or plants that may or may not be related, that share common ecological characteristics. Guilds may be defined as burrowing animals, cliff dwelling animals, tree or cavity nesting birds, seed eating animals, grazing animals, etc.

habitat = a term having a wide range of meanings in various fields of study - typically is best defined as where an animal or plant lives - its "address" in a biotic community. The major components of habitat must include:

- ▶ food
- ▶ water
- ▶ shelter (for escape from enemies, protection from weather)
- ▶ space (for *territories*, bear and hawks need large areas, mice not so large)

home range = for birds, usually defined as the spatial area necessary for a species to obtain all life requirements, not necessarily the defended territory.

migration = periodic or seasonal two-way movement of a species: *emigration* = one-way movement out of an area; *immigration* = one-way movement into an area.

Neotropical migrant = any bird species nesting in the United States or Canada and wintering in the highlands of Mexico, Central, or South America, including the Caribbean Islands.

niche = is best viewed as the "job" or "occupation" of an animal or plant in its *habitat*, such as carnivore (insectivore, piscivore), omnivore, herbivore...

nocturnal = nighttime activity period

population = a geographically distinct group within a given species, morphological differences may or may not be observed.

range = the geographical area in which a group of individuals is found during a specified period, i.e., winter range, summer range, etc. Often used synonymously with *distribution* = the total limits of occurrence of a species.

snags = dead standing timber or dead parts of living trees that are usable by wildlife, particularly cavity nesters such as woodpeckers (which create secondary nests for kestrels, owls, and other birds) and several species of squirrels.

succession = the orderly and directional (often predictable) process by which one biotic community is replaced (succeeded) by another. The last community supported by a given set of environmental factors or characteristics is the *climax* community. Intermediate communities are termed *seral* stages or communities. Some communities assumed to be *seral* have now been proven to be *climax* due to certain environmental conditions that preclude further succession, i.e., lodgepole not being succeeded by spruce-fir, or aspen not being succeeded by conifers.

territory = the area defended against other individuals of the same or similar species, for birds this implies the breeding or nesting site of a mated pair.

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APPENDIX

RAPTOR PROTECTION AND MANAGEMENT GUIDELINES

excerpted from

Interagency Rocky Mountain Front Wildlife Monitoring
and Evaluation Program, September 1987.

Management Guidelines for Selected Species.

BLM-MT-PT-87-003-4111,

Billings, MT

copied in its entirety

P.C. Benson, 1979.

Land Use and Wildlife with Emphasis on Raptors.

U.S. Dept. Agriculture, Forest Service,

Intermountain Regional Office

Ogden, UT

Interagency

Rocky Mountain Front

Wildlife Monitoring/Evaluation Program



SEPTEMBER 1987

**Management Guidelines for Selected Species
Rocky Mountain Front Studies**

INTRODUCTION

The Interagency Rocky Mountain Front Monitoring and Evaluation Program was initiated in 1980 in response to the collective needs of the participating agencies. These needs involved both the proactive management of the diverse wildlife resource as well as planning and evaluation of a multitude of human use activities and management of other natural resources. The guidelines developed from this coordinated interagency effort are best management practices to maintain or enhance selected wildlife species and their habitats. Application and monitoring of the guidelines will assist land and wildlife managers in meeting their wildlife and habitat objectives, will assist managers in coordinating multiple-use objectives with the biological requirements of these wildlife resources and will provide an analytical tool in evaluating effects of proposed activities.

It is recognized that all potential activities cannot be conducted simultaneously while maximizing outputs from all resource uses. Multiple-use involves both complimentary and competing activities at various times and locations and by definition may involve maximizing benefits from one resource use while precluding all or parts of the benefits of a competing use. The guidelines were not developed with the intent of precluding certain activities, but rather to assist in providing a balance of land uses while at the same time preserving the integrity and diversity of these wildlife resources. It is recognized that application of these guidelines in designing activities may require certain activities to be modified, restricted, or even precluded in order to conserve the diverse wildlife resources of the Rocky Mountain Front. On the other hand, they identify windows of opportunity where little or no competition exists, they identify opportunities for enhancement of these wildlife resources, and finally, they identify those instances where there is competitive overlap so more informed management decisions can be made, resulting in balanced stewardship of the broad array of national resources.

In the event that future efforts or information result in the need for a new guideline or the modification of an existing guideline, it can be submitted at anytime to an appropriately designated interagency committee for review and approval.

The following management guidelines are based on the best information currently available. They are a result of current or recently completed studies on selected wildlife species. Field investigators conducting the studies have completed extensive literature reviews on the various species considered. The guidelines which have been formulated and presented in this document are not only the result of the study findings and literature review, but incorporate the professional judgement of the technical personnel involved.

OBJECTIVES

The need for management is predicated on management concerns involving the effects of existing and proposed land uses and human activities upon various wildlife species and their habitat. The objective of the development and application of management guidelines is to avoid or minimize the following effects of human related activities which may adversely impact some or all of the selected wildlife species being considered:

- A. Physical destruction of important wildlife habitat components.
- B. Human disturbance that would displace various wildlife species from important seasonal use areas.
- C. Increased direct human caused mortality.
- D. Increased stress due to higher human activity levels.
- E. Direct mortality or physical impairment resulting from environmental (chemical) contaminants.
- F. Increased wildlife/human interaction resulting from habitat intrusion or displacement.

RAPTORS

The following raptor guidelines were developed from 1982-1984, Rocky Mountain Front Raptor Study, previous studies from this area, and current literature. These guidelines stated herein are subject to revision as new information becomes available.

General Raptor Guidelines

A variety of raptors, both diurnal and nocturnal, use the Rocky Mountain Front during some part of their annual activities. Because of wide differences in their inherent behavior and broad spectrums of habitats utilized, consideration should be given to all of the following area wide general guidelines.

1. Develop public information and education programs which are tailored specifically to raptors of the Rocky Mountain Front.
2. Maintain or enhance all riparian habitats.
3. Do not allow the use of chlorinated hydrocarbon insecticides.
4. Promote regulations intended to prevent accidental trapping of raptors.
5. Discourage and/or carefully plan all human related activities that will occur in key raptor habitats or key use areas, which result in long-term habitat alteration.
6. Restrict the use of exposed bait poisoning of rodents or predators in areas that are seasonally important to raptors.
7. Plan telephone and power lines to reduce the possibility of raptor injury or mortality. Modify existing lines which are documented to cause raptor mortality. Install markers on wires spanning rivers, canyons, and other areas heavily used by raptors to reduce collision with the wires.
8. Do not allow surface-charge seismic exploration or other use of explosives within 1 mile of known occupied raptor nests.
9. Avoid human disturbances at nesting territories during sensitive nesting phases (see tables 1, 2, and 3).
10. Due to the dynamics of raptor biology and ecology, site specific surveys should be completed during management activity evaluation. Adequate nest searches should be conducted for species involved, utilizing techniques which will maximize success in locating them.
11. Site specific habitat management plans should be developed for unique or special habitat features, or areas, which tend to concentrate raptors in the nesting, wintering or migration periods.
12. Raptor nest locations should only be revealed to authorized personnel.

ENDANGERED AND THREATENED RAPTOR SPECIES GUIDELINES

Bald Eagle Guidelines

CURRENTLY OCCUPIED NESTING HABITAT

No currently occupied bald eagle territories have been located in the Rocky Mountain Front area.

1. Should nesting bald eagles be discovered, site specific nest management plans should be developed for each nesting territory. References used to develop these plans should be: The Approved Pacific States Recovery Plan and the Montana Bald Eagle Management Guidelines.

POTENTIAL NESTING HABITAT

Recovery of the bald eagle depends on consideration of habitat needs not only for identified key use areas, but also potential habitats. Historical evidence suggests bald eagles nested along riparian systems in the Rocky Mountain Front area.

1. Secure significant potential nesting habitat through lease, exchange, easement, cooperative agreements or purchase.
2. Maintain and improve quantity, quality and availability of prey base in riparian and aquatic zones.
3. Maintain or improve mature and old growth forested habitat within 1.0 mile of water bodies that possess good supplies of fish and/or waterfowl.
4. Because the Montana bald eagle nesting population is expanding, potential habitats should be monitored annually for the presence of nesting territories.

NON-NESTING SEASON

Spring and fall migration habitat, communal roosts, traditional key use areas and winter habitat are essential elements in the maintenance and recovery of the species.

1. Encourage provision of a sufficient and safe food base for migrating and wintering eagles.
2. Identify key use areas, and employ timber best management practices on timber resources when necessary to maintain or enhance the integrity of these sites.
3. Avoid disturbance which may cause eagles to flush from communal roosts, feeding sites and perches during migration and at wintering sites.
4. General migration periods for bald eagles are as follows: spring migration from January 15 to April 30; fall migration from October 1 to December 15.

Peregrine Falcon Guidelines

CURRENTLY OCCUPIED NESTING HABITAT

No currently occupied peregrine falcon nesting eyries have been located in the Rocky Mountain Front area.

1. Should nesting peregrines be discovered, site specific nest management plans should be developed for each nesting territory. References used to develop these plans should be: The Approved Recovery Plan and Guidance from the Montana Peregrine Falcon Working Group.

POTENTIAL NESTING HABITAT

Historical evidence suggests peregrine falcons nested in the Rocky Mountain Front area.

1. Secure specific significant potential nesting and foraging habitat through lease, exchange, easement, cooperative agreements or purchase.
2. Maintain and improve quantity, quality and availability of prey base within a 10 mile radius of potential nesting habitats. Emphasis should be placed on habitat maintenance or enhancement of riparian and wetland habitats.
3. Maintain or enhance avian prey base in the Rocky Mountain Front area.
4. Portions of potential peregrine habitats which were identified on the Rocky Mountain Front (DuBois 1984, Supplementary Maps) should be monitored on an annual basis for peregrine falcon nest territories.

NON-NESTING SEASON

1. Encourage provision of a sufficient and safe food base for migrating and wintering peregrines.
2. Identify key use areas and employ best management practices to maintain or enhance the integrity of these sites.



RAPTORS OF SPECIAL INTEREST OR CONCERN

The golden eagle, Cooper's hawk, long-eared owl, northern pygmy owl, northern saw-whet owl, burrowing owl, northern goshawk, ferruginous hawk, prairie falcon and merlin all occur or may occur in the Rocky Mountain Front area and have been identified (by Flath, MDFWP, 1984) as species of special interest or concern in Montana.

Guidelines for Raptors of Special Interest or Concern

CURRENTLY OCCUPIED NESTING HABITAT

1. Avoid human disturbance within recommended buffer zone area (table 1) during sensitive nesting phases (table 2 and table 3).
2. Monitor threats and changes to nesting territories.

POTENTIAL NESTING HABITATS

1. Maintain or enhance riparian habitats.
2. Maintain or enhance special habitat features, i.e., cliffs, snag areas, etc.
3. Manage coniferous forest so as to maintain segments of old growth timber.

NON-NESTING SEASON

1. Identify key use areas, such as migration corridors, winter roosts, foraging areas, etc.
2. Monitor key use areas for threats or change.

Guidelines for Unique or Special Habitat Features

Unique and/or special habitat features lend diversity to environments otherwise dominated by broad plant communities. These habitat features can play an important role in the enrichment of wildlife diversity and wildlife densities in an area. Such is the case in the Rocky Mountain Front Raptor Study Area (DuBois, 1984), where cliffs, riparian areas and coniferous forest were the most commonly used habitats by nesting raptors, yet collectively these habitats comprised only 15% of the total land base.

1. Management activity involving alteration or disturbance of unique or special habitat features should be carefully evaluated on a case-by-case basis.
2. Management should be directed to protection and/or enhancement of all unique or special habitat features.

ENHANCEMENT ACTIVITIES FOR RAPTORS

The following are suggestions for programs that would have the potential to enhance raptor populations on the Rocky Mountain Front.

1. Implement land management plans that perpetually protect and provide habitat important to raptors and their prey.

2. Install artificial nesting platforms in areas of extensive grasslands to provide nesting structures for golden eagles, red-tailed hawks and ferruginous hawks, in areas where it can be demonstrated that populations of these species will benefit without impacting other special interest species (such as black-footed ferrets and Swainson's hawks) through predation or competition.
3. Encourage planting and maintenance of shelter belts in agricultural areas. Shelter belts have the potential to provide nesting areas for Swainson's hawks, red-tailed hawks, merlins, great horned owls and long-eared owls.
4. Install dikes to retain water on areas that are presently exposed as mud flats on the upper ends of reservoirs which are severely dewatered during the summer (Eureka, Bynum and Nilan Reservoirs). This would greatly enhance waterfowl and shorebird production which would in turn provide a better prey base for prairie falcons and peregrine falcons. This would also reduce blowing dust from these areas. Islands should be constructed in the dike ponds to provide nesting areas for waterfowl.
5. Revegetate clear-cuts and disturbed areas with a diversity of native plants, and encourage reseeding of highly erodible croplands to native vegetation to maintain a diverse prey base.
6. Implement a snag management policy that will provide nesting habitat for cavity-nesting raptors such as American kestrels and saw-whet owls.

The failure of adult raptors to return to the nest, eggs or young after human interference of an unfamiliar nature is both serious and unpredictable. Because of this unpredictability, precautions should always be taken around any occupied nest or potential nesting territory.

Following are general recommended nest buffer zones related to various human activities. These activities and recommended zones are not inclusive, details of terrain, vegetation, type and duration and familiarity of disturbance, specific temperament of individual birds, phase of nesting cycle, etc., all enter into determining the actual needed buffer zone at a given nest site. Preclusion of human activity at a given nest territory should be tempered with as many variables as possible, and on a site specific basis.

Table 1

Activity	Recommended buffer zones
Off-road vehicle use	1/4 mile - 1/2 mile
Camping	1/4 mile - 1/2 mile
Hiking	1/4 mile - 1/2 mile
Rock climbing	1/2 mile - 3/4 mile
Road Construction	1/2 mile - 1 mile
Controlled burning	1 mile - 2 miles
Trail clearing	1/4 mile - 1/2 mile
Building/construction	1/2 mile - 3 miles
Mining/heavy equipment or blasting	1 mile - 3 miles
Logging	1/2 mile - 1 mile
Aircraft flights (low altitude)	1/4 mile - 1 mile

Nesting chronology for most raptors can be divided into 5 phases. The following summarized each phase, general sensitivity to disturbance and comments. This table should be used with table 1 to temper activity and zone buffers.

Table 2

PHASE	ACTIVITY	SENSITIVITY TO DISTURBANCE	COMMENTS
I	Nest building includes courtship behavior	Extremely Sensitive, period most likely to desert.	1. Most critical time period from the standpoint of desertion.
II	Egg laying	Extremely Sensitive, period most likely to desert.	2. Human disturbance of even limited duration may cause desertion, not only of nest sites, but also of long established territories.
III	Incubation	Extremely Sensitive, period most likely to desert.	3. Nest site tenacity is weakest on new territories or when the birds first establish their territories. 4. Flushed birds may puncture, crush or eject eggs from nest. 5. Flushed birds leave eggs unattended. Eggs are susceptible to cooling, loss of moisture, over heating and predation.
IV	Hatching and nestling rearing	Moderately sensitive	1. As hatching/rearing approaches, most birds become tenacious to clutches of eggs. 2. Generally, uncommon to desert a nest after young have hatched.
V	Post fledging	Moderately	3. First half of nestling period, young most susceptible to elements. 4. Flushed birds may trample young or eject them from nest. 5. Unattended nestlings may chill or overheat, are susceptible to predation. 6. Nestlings may miss feedings. May affect overall health of young birds. 7. Premature Fledging - Threat to young prematurely leaving nest due to disturbance.

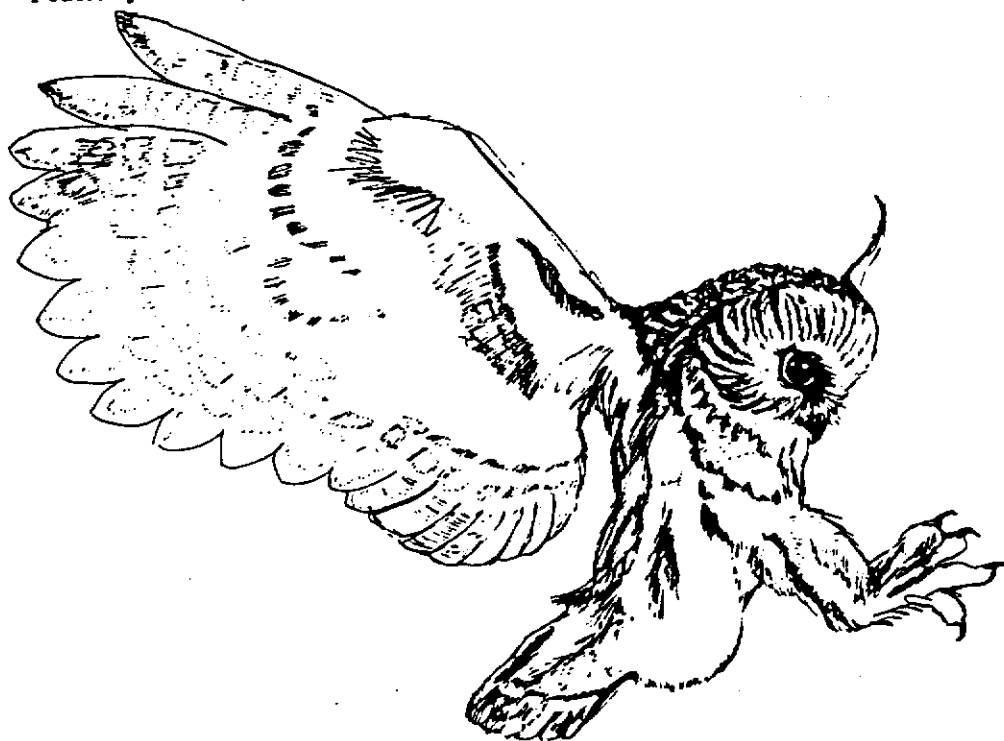
Approximate nesting dates for some raptors that occur in the Rocky Mountain Front, North central Montana.

Table 3

Species	Approximate Dates of Nesting Season
Turkey vulture	April 15 - August 1
* Golden eagle	February 1 - July 30
** Bald eagle	February 15 - August 15
Northern harrier	April 1 - July 15
Sharp-shinned hawk	April 15 - August 15
* Cooper's hawk	April 15 - August 15
* Northern goshawk	April 15 - August 15
Red-tailed hawk	May 1 - September 15
Swainson's hawk	April 1 - July 30
* Ferruginous hawk	May 1 - August 15
American kestrel	April 15 - August 15
* Merlin	March 15 - July 30
* Prairie falcon	April 15 - August 1
** Peregrine falcon	March 1 - August 1
Short-eared owl	March 1 - August 1
Long-eared owl	January 1 - August 1
Great horned owl	March 1 - August 15
Great gray owl	March 1 - July 1
Eastern screech owl	March 1 - July 15
Northern pygmy owl	March 1 - August 30
* Northern saw-whet owl	March 15 - July 15
* Burrowing owl	

*Species of Special Interest or Concern

**Federally Listed Species



Land Use and **Wildlife**
with Emphasis on **Raptors**



Patrick C. Benson
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Prepared for USDA, Forest Service
Intermountain Region

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INTRODUCTION

The multiple use - sustained yield management effort encouraged by the U.S. Forest Service produces various environmental impacts affecting wildlife in both a beneficial and detrimental manner. Of particular interest in this study are the raptorial birds because of their delicate physiological nature and the ability to act as an environmental quality indicator. Because of the wide variety of raptors and their various biological and environmental needs, it becomes important to have specific information that allows for the most productive management of the resources.

The purpose of this plan is threefold, (1) to inform the forest managers of raptor species present on forest lands in the Intermountain Region and their habitat requirements, (2) indicate those land uses which provide or reduce habitat for raptors, and (3) determine measures which can be taken by the land managers to reduce detrimental effects to raptors produced by habitat alterations while still taking full advantage of beneficial practices.

MAJOR PROBLEMS

1. Raptors occur in a large number of environments and utilize a variety of niches within those environments; as a result, generalizations cannot be made as to their habitat requirements.
2. Raptors are often extremely secretive, making it difficult to determine their presence. Therefore, most people know little about them, thus compounding the difficulty of their study.
3. Each species varies in its sensitivity to human activity and therefore requires individual evaluation of the possible effects of man's activity upon its survival.
4. These birds have received various types of pressure from both unconcerned or uneducated individuals and special interest groups. The activities of these groups should be considered in any management scheme devised.

In the interpretation of this plan, the reader must keep in mind that the recommendations contained are a generalized guide and may need some alteration to be most effective. Without the aid of extensive study, it is difficult to ascertain the effects of various land uses on the raptor populations and likewise the effectiveness of all recommendations. Therefore, it is important that the land managers try various recommendations and alter them if a particular site or animal will benefit.

RECREATION

Recreational activities have been divided into five types according to their impact on the environment and the mental and physical stress required for the pursuit of each. The different types may overlap one another with an area providing the needs for more than one type.

Primitive - Activities of this type require a natural undeveloped environment free of pollutants and modern man's mechanization. Packing, mountain climbing, river float trips, and ski touring are all activities considered in this type. This activity type normally has little impact on raptors unless specific individuals are disturbed. Precautions should be taken to avoid disturbance of nesting birds which might be encountered on cliffs suitable for climbing or along forest trails. Other impacts of this type of recreation would normally be minimal.

Consumptive - These activities require a natural or semi-primitive environment for the taking of fish and/or wildlife species, rocks, minerals, edible plants, etc. Hunting, fishing, rock collecting, and berry-picking are a few of the activities considered in this type.

The activity type can produce some undesirable impacts on raptors if not controlled. Along with the obvious disturbance caused by human presence, problems including egg collecting and illegal shooting may occur. These destructive activities are best counteracted by a strong public awareness and education campaign along with enforcement of state and federal laws. Cooperative efforts between local, state, and federal officials are essential.

Passive - Activities of a passive type require a low physical and mental stress and are oriented toward semi-primitive to lightly developed areas. Vehicle camping, pleasure boating, picnicking, and easy hiking are but a few of these activities. Roadside parks, small campgrounds, and boat docks are some of the necessary facilities required for such functions. Some problems arise with these activities including increased numbers of people present with greater amounts of disturbance and a loss of habitat due to construction of such facilities. Intentional harassment of various species by humans may also occur. Although some species may coexist with these activities and show little conflict, it appears that the best plan to take is to avoid regions where high raptor activities occur. Special interest should be directed toward threatened or endangered species when planning for this and the following two types.

Social Learning - Social learning activities are conducted in moderately developed areas where social interaction and group learning experiences can be facilitated. Resort vacationing, organized camping, scouting and church groups, and group tours are included in this type. The effect of this activity might vary depending on when an evaluation is made and how extensive the facility. During development of facilities, impact could be extremely high on wildlife until the animals become accustomed to the increased human activity. Sensitive wildlife species may abandon the area altogether because of the large land areas needed for this activity with a resultant loss of habitat and increased human use. Many raptors can be classified in this category and greatly effected. Raptor needs should be considered in the plan and design of such areas.

Active - This recreation type requires highly developed facilities where large numbers of people can engage in activities that need higher levels of physical participation. These activities include winter sports, downhill skiing and snowmobiling, field sports, and competitive racing of boats or off-road vehicles. The large numbers of people, habitat destruction, and vehicle noise can all constitute a great impact upon wildlife using such areas. Before development of such areas, considerable study and planning should be done to determine the trade-offs involved and their relative importance. Overall, wildlife compatibility is low and may be much lower for raptors.

The most important factor involved in the decision of recreational site placement and facility types is knowledge of the wildlife to be affected by the action and enough study to know how great the impact will be on raptors. This is true of any activity and as much data should be collected as practically possible before taking action. Recommendations concerning recreational uses and raptors are listed below.

1. Restrict operation of off-road vehicles to prevent raptor disturbance.
 - a. Restrict off-road vehicle use in areas containing nesting raptors during nesting and brood-rearing periods (March-July, depending upon species and location). The distance of the restricted area will depend upon topography and surrounding vegetation. In open country, ORV use should be severely restricted or prohibited within one mile of active nests. In timbered forest environments, the distance of the buffer strip could be reduced to one-half mile.

- b. Restrict or prohibit ORV and general public access to areas containing wintering populations of golden and particularly bald eagles from November through March.
2. Require mufflers on off-road vehicles to prevent wildlife disturbance.
3. Restrict climbing of cliffs used by raptors for nesting. Climbing should be restricted to non-nesting and brood-rearing periods on any cliffs containing active nests.
4. Restrict construction of recreational facilities in areas of known raptor nesting. A general wildlife survey of each potential recreational facility should be conducted prior to planning to determine the effects construction and use of each site will have on raptors.
5. Allow for buffer strips between known raptor nests and recreational sites when new facilities are being constructed (for distances see 1-a).
6. Allow construction of recreational facilities only during non-nesting periods.
7. Limit access to areas of high raptor density during nesting periods. In areas where endangered species are present, total restriction of recreational activities is desirable.

GRAZING

Because of the economic importance of grazing, extensive projects have been undertaken to enhance the habitat for this purpose. Many of the techniques used to produce this change in habitat are in direct conflict with raptors and may cause great damage to specific populations, which may already be in a precarious position. Two raptor species which may be directly and adversely affected by range management practices are the ferruginous hawk (*Buteo regalis*) and the burrowing owl (*Speotyto cunicularia*). Much controversy exists as to the status of these two birds, but biologists are in agreement that their populations are quite delicate and that maximum consideration should be afforded these species when range development is planned.

The greatest impact upon raptors due to grazing and range management practices would probably come about from the reduction of raptor prey species habitat. Small birds and mammals are highly sensitive to habitat changes and their numbers can easily be reduced or eliminated from an area if precautions are not taken. Reductions may result in a loss of the necessary food source of many of the birds of prey.

Discussed below are some specific types of activities which may have an effect on raptors and possible actions which may be taken to lessen these effects.

Habitat Alteration and Management

Reduction of foliage unpalatable to livestock through the techniques of chaining, burning, and spraying with chemical defoliants is used on lands administered by the Forest Service. Along with methods of increaser or "noxious plant" control is a reseeding program designed to establish growth of plant species which are highly palatable to livestock.

If properly administered, these techniques can be beneficial to certain raptor populations by providing an increased food base in the form of rodents and lagomorphs using sprayed areas. Golden eagles

(*Aquila chrysaetos*), redtail hawks (*Buteo jamaicensis*), and ferruginous hawks are dependent upon this food source and could be benefited by some changes in the habitat.

Data are available which isolate responses of small mammals to changes from natural vegetation types to more economically desirable species such as crested wheatgrass (*Agropyron cristatum*), intermediate wheatgrass (*A. intermedium*), bluebunch wheatgrass (*A. spicatum*), and others. Several major species of small mammals which are important to raptors and should be considered when designing revegetation projects are the black-tailed jackrabbit (*Lepus californicus*), Townsend's ground squirrel (*Spermophilus townsendii*), and the pocket gopher (*Thomomys* sp.). Other small rodent populations should also be considered when undertaking these projects.

In a study of the use of crested wheatgrass seedings by black-tailed jackrabbits, Westoby and Wagner (1973) found no appreciable loss in use of seeded over untreated areas. This study did, however, show certain patterns of use by the rabbits. It was discovered that approximately 70 percent of the use of the seeding by the rabbits was in a 300 meter band around the perimeter of the altered areas and close enough to the untreated habitat to use the available cover afforded there. Portions of the seeded area that contained islands or peninsulas of cover allowed rabbits to drift further from the edges of the seeding while still having cover available. Those areas where cover was further than 300 meters were used least of all.

Also of concern in this study was the percentage of available forage used by jackrabbits and the possible conflict with livestock. Because of the reluctance of the rabbits to use areas beyond 300 meters (330 yards) from the perimeter of the seeded area, it would appear desirable, from a livestock point-of-view, to eliminate native shrubs from larger areas to maximize the benefit to livestock. Larger seedings would allow livestock a greater area on which there was no competition for forage. Westoby and Wagner's data showed that in those years when the rabbit population was at its peak, less than 10 percent of the available forage was lost to these animals. This use is minimal and indicates little conflict with livestock. Therefore, if smaller seeded tracts can benefit both livestock and wildlife without a great loss to either, this type of planting would be more desirable.

Seedings can be harmed by rabbits if they are made during the peak of the cycle. Planning should be done and attempts made to seed areas when rabbits are at a low population level, thus reducing or eliminating damage.

Seeded areas should also be limited in size allowing rabbits to use them and to still have available cover. This can best be done by planting irregular patches 600 meters (660 yards) or less wide, alternated with natural areas of sage or by providing islands and peninsulas of sagebrush within a seeding.

A study of small mammal response to clearing and seeding of grasses in juniper rangeland conducted by Baker and Frischknecht (1973) indicated changes in rodent numbers depended on techniques used. Windrowing of chained material provided cover for many of the rodent species, concentrating much of the rodent use in or adjacent to these areas. This study also showed a peak preference for these areas two years after seeding with a decline and leveling off of numbers in following years. Various species showed different responses to treatments but the overall effect was an increase in rodent populations for a period of time. Those areas where treatment was in narrow strips provided better habitat for these animals due probably to an increased edge effect. White (1976) has observed a concentration of raptors along these type windrows, probably due to the increased food supply.

Turkowski and Reynolds (1970) found an increase of 1.2 to 4.0 times as many rodents on treated areas as on untreated areas three years after treatment. These data would indicate a high preference

for seeded areas at this point. Although certain rodent species disappeared from the seeded areas, other species would move in as the habitat changed to meet their requirements.

These two studies dealt primarily with the family Cricetidae which includes such animals as deer mice (*Peromyscus maniculatus*) and longtailed voles (*Microtus longicaudus*), and the family Heteromyidae, which includes the Great Basin pocketmouse (*Perognathus parvus*). These animals were found to feed heavily on seeds, small insects, and grasses which were all abundant in seeded areas. These studies, however, spent little time discussing the orders Geomyidae or Sciuridae, which containing, respectively, such animals as pocket gophers and squirrel type rodents including the Townsend's ground squirrel and the Richardson's ground squirrel (*Spermophilus richardsoni*).

Howard and Wolfe (1976), in their study on ferruginous hawks found that birds with nests located in crested wheatgrass-alfalfa habitat had a much higher percentage of northern pocket gopher (57 percent), and Townsend's ground squirrels (20.6 percent), in their diet than those birds nesting in a desert shrub habitat, 0 percent and 4.3 percent, respectively. This study also indicated those birds living in a sagebrush environment had a higher percentage (67.3 percent) of blacktailed jackrabbit in their diet than those in crested wheatgrass habitat (3.4 percent). Howard and Wolfe attribute these differences to relative abundance of individual species. No dimensions were given for the crested wheatgrass seeding so it is impossible to compare these data with those of Westoby and Wagner (1973).

Tietjen, et al. (1967) in a study of the effect of 2,4-D on pocket gophers discovered an initial decline of 80-90 percent of these animals after application. This decrease in gopher numbers accompanied a comparable decrease in the available and preferred food supply - forbs - eliminated by the 2,4-D application. Tests were run to determine toxicity of 2,4-D and results showed that the chemical had no apparent effect on test animals at normal application levels discounting the possibility of gopher mortality due to poisoning. Weimeyer (1976) found similar results when testing toxicity levels in birds.

No migration from the treated areas was noted and it was determined that the decline of pocket gophers was due to a loss of desirable food source. Sampling indicated that other rodent species were apparently not adversely effected by the 2,4-D application.

To this point only the effect of foliage elimination on small mammals has been discussed. Another important food source to certain raptors is small birds.

Best (1972) discusses effects of sagebrush eradication on Brewer's sparrow (*Spizella breweri*) and vesper sparrow (*Pooecetes gramineus*). Results of this study indicate that various degrees of sagebrush eradication effect them differently. If sagebrush was reduced by 50 percent or less there appeared to be little or no effect on either species. Complete elimination of sagebrush in an area, however, resulted in a decrease in the number of Brewer's sparrows. This decline was attributed to a loss in suitable nesting sites and a possible change in available food supply. The vesper sparrow did not appear to be adversely affected by sagebrush eradication, probably because of a more adaptable type behavior.

Olsen (1974) in a study of bird populations in relation to various range habitat types found a great difference in numbers and species using particular vegetative types. Four plots, ranging from a "relatively undisturbed stand of sagebrush" to a crested wheatgrass planting done following removal of shrubs by plowing were studied. The plots showed various sagebrush cover values and plant diversities. A similar diversity of bird life also occurred along with the plants. Table 2 shows the relationship between plant and bird diversity. An interesting pattern of use was observed on plot 4, the crested wheatgrass planting. Horned larks (*Eremophila alpestris*) which used this plot were present only during the cooler portions of the day, seeking the shade of adjacent plots when temperatures increased. Jackrabbits in this area showed a similar pattern of use to that of the horned lark with a retreat to sage covered areas for shade during hotter periods.

Table 2. Relationship between sagebrush cover, number of plant species, and number of bird species in Curlew Valley, Idaho (from Olsen, 1974).

	Sage Cover Values (%)	Numbers of Plant Species	Numbers of Bird Species
Plot 1	12-49	94	6
Plot 2	3-40	25	6
Plot 3	3-16	19	5
Plot 4	•	10	1

- No percentage values were given for this plot. The author stated that sagebrush and saltbush were reinvading but were still quite small. These plants were of little or no value as cover species. This value might well represent 0 percent.

Olsen's data shows a relationship similar to those gathered by Best (1972) indicating a large drop in numbers of Brewer's sparrows when elimination of 50 percent of the sagebrush cover occurs.

Disturbance of nesting habitat caused by range improvement practices is another important consideration when managing for raptors. Two types of nesting sites are of interest when considering these effects, (1) nests in or on the ground or placed in vegetation, (i.e., juniper trees) on an area to be altered, and (2) nests adjacent to treated areas.

Several raptor species are noted for their ground nesting behavior, particularly the ferruginous hawk and the burrowing owl. The ferruginous hawk is known to nest on the ground at the crest of small hills on dirt mounds or boulders which may be raised above the surrounding area by only two or three feet. These birds also will nest in juniper trees or on top of small bushes.

Small mammals serve not only as a food source for the burrowing owl, but also provide burrows in which to nest. Abandoned burrows of prairie dogs, ground squirrels, and particularly in the west, badgers, are used by these birds. Disturbance of habitat which might eliminate these sites can be highly detrimental to these birds.

Howard (1975) found ferruginous hawks to be highly sensitive to human activity during certain periods of the year. They may abandon nesting attempts if even slight disturbance occurs. This sensitivity is probably demonstrated by many other raptors as well. Destruction of young birds may also

occur accidentally if precautions are not taken to avoid active nests when undertaking range improvement programs. Discing and plowing can be particularly harmful to burrowing owls by closing entrances to nest burrows and destroying young or eggs (Renn 1976). It is important to time the implementation of range improvement activities to avoid nesting periods and areas of high raptor density or use. Late summer and fall are the optimum seasons for range improvement practices in areas containing nesting raptors.

From the data presented in the studies on rodent, lagomorph, and small bird populations on areas altered for range improvements, recommendations can be made which will benefit those prey species utilized by raptors and will ultimately benefit the raptors themselves.



BREWER'S SPARROW, *Spizella breweri*

Management Recommendations

1. Plan sagebrush eradication projects and seedings so there will be alternate areas of treated and untreated vegetation. This will allow increased edge, adequate cover, and provide a more diverse food supply.

2. Limit the size of individual strips or patches of altered habitat always leaving natural cover within 300 meters (330 yards) of any point in the area. This can be done by making altered areas no wider than 600 meters (660 yards) or leaving untouched islands or peninsulas of natural cover within each area.
3. Leave about 50 percent of the natural sagebrush cover within a particular altered site to provide sufficient cover for nesting passerine bird species.
4. Remove cover by methods of chaining, railing, or burning rather than using 2,4-D, disking, or plowing techniques; this will provide greater numbers of forbs and cover beneficial to wildlife.
5. Windrow chained or railed material to improve the habitat for nesting and cover areas for small birds, rodents, and lagomorphs.
6. Time seedings to provide an alternate source of prey (i.e., increase in rodent populations) when cycles of rabbits are at a low.
7. Avoid alteration of important areas of high raptor use.
8. Time alterations of habitat to avoid destruction or disturbance of raptor nests or young, selecting late summer and fall for projects.
9. If raptor nests are disturbed, placement of young in nests outside of the altered area should be attempted after consultation with appropriate State fish and game agency personnel.
10. Mixed seedings should be done to provide a more diverse vegetation for small mammal populations upon which raptors are dependent.

Overgrazing

Of importance to raptors as well as most wildlife species is distribution and numbers of livestock animals on the range. Destruction of habitat, loss of cover, and loss of wildlife forage can all occur with the presence of livestock. Habitat changes due to livestock activity can have as great an impact as habitat manipulation by man.

Two particular problems should be considered when discussing overgrazing, (1) poor distribution of livestock using the range, and (2) overuse of range due to excessive numbers of animals present.

Distribution problems usually occur in areas where cattle come to water and remain for long periods of time. Congregating cattle around waterways, marshes, and ponds can cause disturbance of small mammals and birds. Trampling of plants and destruction of a well vegetated streambank used by small mammals and birds for cover and nesting can reduce numbers of these animals. Waterfowl can also be affected adversely by overuse of an area by cattle, primarily through loss of cover for suitable nesting habitat.

A raptor which could be directly affected by congregating cattle around watering areas is the marsh hawk (*Circus cyaneus*). These birds also use areas of dense cover around water for the placement of their nests and rely heavily on such areas for hunting of rodents.

Several possible alternatives can be considered to reduce impact of livestock around these watering areas:

1. Fencing of watering areas for wildlife use allowing livestock to use only certain restricted areas.
2. Provide additional watering areas to reduce congregation of livestock and destruction of wildlife habitat. This alternative should be accompanied without additional increase in the numbers of livestock allowed on the range or the wildlife benefits are lost.
3. Reduce the number of domestic livestock allowed on the range. The various problems of excessive numbers of animals on a particular range and its effects on wildlife species has been discussed extensively. Overgrazing can greatly reduce cover and forage necessary for many wildlife species.

Black and Frischknecht (1971) observed changes in the composition of animals found on plots subjected to various grazing intensities. This study indicated that rodent types changed with grazing intensities and that certain species showed a preference for selected types and densities of cover. Some rodent species showed substantial increases in numbers when grazing was reduced or not allowed.

Phillips (1936) observed a reduction of rodent and lagomorph numbers when range was heavily overgrazed, although some animals showed preference for moderately overgrazed areas. Smith (1940) found that overgrazing reduced numbers of birds present on his study area. Mammal populations varied with the needs of the particular animals. Insect populations, which many of the rodents were dependent upon, favored lightly grazed areas. Monson (1941) found more than double the numbers of small birds on ungrazed plots as on those overgrazed. Monson's study also indicated greater diversity of species in ungrazed areas. In a ten-year study of grazing in woodlands, Dambach (1944) found greater species diversity and numbers of individuals in areas unused by livestock. Olsen (1974) states that loss of nesting cover, a decrease in diversity or density of insect populations, or disturbance by cattle all directly associated with grazing appear to cause reduced diversity and density of passerine birds present on his study area.

Research indicates that overgrazing can be detrimental to wildlife species; reducing the capabilities of rangeland to support diverse and healthy populations of plants and animals. Several alternatives should be considered to reduce competition between livestock and wildlife species. Several are listed below:

1. Reduce numbers of domestic livestock on range.
2. Devise a grazing program which will reduce impacts on the range involved and allow for a period of recovery. A practice of deferred rotation grazing would be desirable to allow wildlife to use areas undisturbed by livestock.
3. Remove livestock completely from range allowing for a return to a natural state and eliminating competition to wildlife. This would be reasonable only where there were extremely high wildlife values (such as threatened and endangered species) that were being impacted because of grazing.
4. In areas of high raptor use, set dates for allowable grazing so that small birds, mammals, and raptors can produce and raise their young before cows are present.

TIMBER MANAGEMENT

Several criteria are necessary before a decision is made to log an area. These criteria are important in determining the impact of the harvest and the necessary steps to lessen its effect on the total environment. They are as follows:

1. Accessibility of the proposed harvest area. This is a determination of the economic and ecological feasibility of getting to the areas to be logged and transporting the harvested trees from those areas. This decision is dependent upon the type of harvest techniques used, terrain, and distance from processing areas or routes to processing areas.
2. Erodibility and slumpage of soils. Those areas to be logged, proposed corridors of travel, and nearby waterways must be considered when problems of erosion and slumpage are studied. Loss of soils, pollution of streams, and road damage due to erosion are a few of the problems faced when logging operations are undertaken and can greatly effect the ecological balance of an area if not properly accounted for.
3. Ability to regenerate. Before the removal of vegetation and construction of roads occurs, an areas' capability to establish new vegetation must be considered and a determination made as to the practicality of habitat change. Factors including soil types, amounts of precipitation, and rodent depredation are a few of the necessary considerations.
4. Effects on esthetics, watershed, and wildlife. Visual impacts, effects on runoff, and wildlife habitat are all important concerns when determining which forest stands can or should be cut. Short-term as well as long-term effects, both detrimental and beneficial, should be evaluated before a decision to harvest a timber stand is made.

When the decision to cut or not to cut is being made, information from all of the forest specialists should be analyzed and weighed to help make that decision one which will benefit the total ecosystem in the greatest possible manner. This concept must be kept in mind when determining the best type of logging operation for a particular area. Both selective cutting and clearcutting have their economic, wildlife, and esthetic benefits and detriments, but if managed properly, the benefits can outweigh potential adverse effects.

A discussion of the various forest management practices and their effect on the forest ecosystem follows. Forest management practices affect raptors in the following ways:

1. Direct harassment to raptors during timber harvesting operations.
2. Increased harassment of raptors resulting from additional access provided by newly constructed logging roads.
3. Direct destruction of habitat (i.e., nest sites and perches) as a result of timber harvest.
4. Change in raptor prey base resulting from different vegetation successional stages created by logging activities. Virtually any forest management practice that results in the change in vegetation of an area will affect the prey base of raptors (small birds, mammals, insects, etc.). This effect can be beneficial or detrimental to raptors and will be discussed further.

Selective Cutting

Selective cutting of timber involves the removal of mature, over-mature, or diseased trees from a forest stand. This method of harvest prevents loss of soils, opens the forest floor to light, increasing understory growth useful for cover and as a food source for many wildlife species, and leaves much of the natural cover present when the operation is completed. Several possible problems concerning wildlife may occur with this type of harvest if precautions are not taken to prevent them.

1. Elimination of snags, both living and dead, and individual large trees important as nesting sites, hunting perches, and roosts may occur if these trees are not marked and an effort made to maintain them. These are important not only to raptors but to many wildlife species.



OSPREY, *Pandion haliaetus*



2. If total harvest is made for a specific type of tree in a mixed forest, or if a harvest is made so as to produce a single aged, single species stand, much of the vegetative overstory will be lost and a monotypic environment may occur which will reduce the numbers and diversity of animal species present in an area.

Clearcutting

Many of the forest stands which are harvested using clearcut operations are diseased or have been infested by insects. Clearcutting is used to eliminate these problem trees and to prevent further infestation of the pests to the surrounding trees while trying to make maximum use of timber products available. The remaining areas involve mature or over-mature stands which have reached or are slightly beyond their maximum wood products potential. There has in the past been much controversy concerning the effects of clearcutting on various wildlife species and subsequently research has been done to assess some of these effects.

The questions which should be asked about clearcuts and their effects are:

1. How extensive should clearcuts be to enhance the habitat for wildlife?
 2. At what stage of forest succession should clearcuts be made to allow the greatest benefits to raptors?
 3. What effect does precommercial and commercial thinning have on forest stands and their wildlife production?
 4. Should snags and pockets of trees be left in clearcuts for wildlife use?
 5. What types of slash disposal are available, and should be used, and what are the effects of each on the ecosystem?
1. How extensive should clearcuts be to enhance the habitat for wildlife?

In the Intermountain Region of the Forest Service, the policy is to maintain the size of clearcuts at less than 40 acres. Most cuts are smaller in size than this and for the purposes of wildlife, this is generally beneficial. Clearcutting reverses the direction of habitat succession, opening areas to sunlight, and allowing additional precipitation to reach soils. This opening of the canopy encourages growth of early successional vegetation which provides habitat for a wide variety of species either formerly not present or present in reduced numbers in the mature forest. Many of those species found in the mature forest, however, do not find suitable habitat in clearcut areas. Each type of environment has its own flora. Various seral stages of plant succession each provides habitat for a specific complement of animal species. Certain species of birds and mammals survive equally well in any of the plant stages while others are dependent upon only one or two. Some animals will use those uncut areas for nesting and cleared areas for hunting or foraging. Overall, the changes in habitat produced by clearcutting results in a more diverse community of animals and plants.

Just as the mature or over-mature forest stand eliminates certain species of wildlife from the community because of lack of certain needs provided there, so does the clearcut. Many animal species fear to venture very far into a clearcut to forage because of the lack of cover and protection provided them. As in the seeded areas of range habitats, an edge along the periphery of clearcuts is used allowing various wildlife the security of the forest cover while providing more diverse foraging areas. For this reason, if

clearcuts can remain small and narrow, they will produce greater benefits for wildlife. These areas are used by many species of raptors for hunting, while the nearby forest provides nesting habitat as well.

Clearcuts which are as small and as narrow as practically possible and patterned into the habitat to provide maximum edge while protecting soils and watersheds are desirable. Making clearcuts in narrow strips can be most desirable for several reasons, (a) increased edge for the area covered, (b) no large expanses of low cover density undesirable to small birds and mammals as well as large species, (c) a narrow, properly placed strip is more easily revegetated to trees by natural processes of seed dispersal, and (d) smaller areas prevent a build-up of wind velocity and thus reduce a loss of soil moisture due to evaporation.

Winn (1976) states that for best benefits to wildlife, clearcuts should be no wider than 5 times the height of the surrounding canopy. Smaller, narrower cuts are the most desirable from a wildlife standpoint, providing the necessary edge needed for many vertebrate species.

2. At what stage of forest succession should clearcuts be made to produce the greatest benefits to raptors?

The most dramatic effect habitat change can have on raptors other than direct displacement is an alteration of the food source on which these birds are dependent. Numerous studies have been conducted involving habitat alteration and forest succession and its effect on the fauna present in the area. As previously mentioned, a diversity of plant communities produces a diversity in faunal species. This concept, if fully understood, can be used to produce a broad spectrum of niches which can benefit the total community by increasing its stability.

Salt (1957), in a study of the avifauna of the Jackson Hole area, found quite varied populations in each vegetative type. As the forest progressed successional, an increase in number of species occurred. This increase was evident in all feeding categories and Salt attributes this to an "increase in complexity of the vegetation."

Odum (1950, 1956) found results similar to Salt and points out that the ecotone or edge effect produced in a mixed forest might be the factor determining the increased diversity of the forest. Kendeigh (1946, 1948), Martin (1960), and Snyder (1950) all found similar correlations with fauna and plant communities - an increase in plant diversity followed by an increase in faunal species. Balda (1975) concludes that ecotones produce a more diverse bird population than do late plant successional stages, because of a greater complexity of vegetation.

Similar relationships to those found with birds were studied with mammals by Gashwiler (1959, 1970). Various mammal species were found in different types of habitat both logged and unlogged and burned and unburned. Movements of these animals occurred as alterations took place.

The important concept to remember when determining when clearcuts should be made in an area is that to produce a diversity in wildlife, a diversity in habitat must first occur. An extensive monotypic over-mature forest stand or a large total clearcut both produce narrow undiversified faunal populations, but both produce habitat which provides the necessary requirements for the animals living there. An ideal situation would be to have the over-mature forest, the clearcut, and every successional stage in between. This can be accomplished by a system of cutting which allows for leaving some timber stands to a point beyond their prime economic value. Although this type of timber management is not considered an economically sound timber practice by many, the importance of the wildlife species dependent upon this habitat must be considered equally as important as the monetary gains sought by the timber harvest.

Environmental conditions of each area to be harvested must be evaluated in order to produce the best habitat for raptors as well as all wildlife. A decision is then made on how best to enhance the area for the various species. It must be determined how important each particular area is to raptors and other species and the losses or gains which will be made by the alteration in habitat. At this point, a sound and logical decision can be made as to how and when to harvest.

3. What effects does precommercial and commercial thinning have on forest stands and their production of raptors and other wildlife species?

The purpose of thinning forests is to eliminate those trees which are not considered prime timber producers, thus reducing competition for those trees of higher quality, and to allow for increased and more rapid growth by the prime trees. Three major effects occur due to this practice: (a) opening of the stand allowing increased light to reach the forest floor; (b) reduction of the forest canopy or density of the canopy, and elimination of tree species undesirable for timber harvest but possibly highly desirable to wildlife; and (c) elimination of cull trees or snags.

- a. Opening of the stand allowing increased sunlight to reach the forest floor will allow an increase in foliage at the ground level and improve the habitat for some small birds using this vegetative layer. Kilgore (1971) found with the reduction of upper forest vegetative layers an increase in ground nesting and feeding bird types occurred while some other types were reduced. Although Kilgore's study did not involve a major reduction of the upper forest canopy, the vegetation removal in his study allowed increased sunlight to reach the forest floor; similar results might be expected with overstory removal by timber thinning techniques.
- b. With the elimination of much of the upper forest canopy by thinning techniques, a similar reduction of the birdlife dependent upon that canopy occurs. An entire group of birds - both passerines and raptors - feed and nest in the upper canopy layer of the forest. With this loss of dense canopy goes a specific habitat type and the faunal necessities it produces. Smith (1973) indicates that a vertical stratification of foliage occurs in various degrees in temperate forests. With this stratification of vegetation comes a similar stratification of faunal groups each with its own distinct requirements for survival. This stratification allows for increased diversity of animal species in a forest with increased numbers of strata. Balda (1969) found definite correlation between bird species and foliage density and height. While some birds did overlap in use of various foliage heights there was a very specific use pattern for each species in each strata which reduced interspecific competition. Karr and Roth (1971) found that bird species diversity is dependent upon foliage height diversity and percent vegetation cover. This study and a similar one by Recher (1969) indicates that a diverse foliage profile is a good indicator of bird species diversity.

These studies indicate that overstory or understory removal can eliminate a great number of the avian and mammalian species which are dependent upon these vegetative types. If this reduction occurs, the raptors and other predators dependent upon the smaller prey species would also be reduced.

- c. The importance of snags, both living and dead, to wildlife of the forest has in recent years received much study both in and out of the Forest Service. Forest management practices have in the past eliminated many of these snags because of concern over fire hazard and insect infestation. Commercial and precommercial thinning has eliminated

many living and dead snags which are beneficial to wildlife along with cull trees which are poor quality timber trees but could be modified to be high quality wildlife snags. Snags will be discussed in more detail in the following sections.

4. Should snags and pockets of trees be left in clearcuts for wildlife habitat?

The importance of snags as nest sites, hunting perches, and a source of food for forest animals has been recognized only in the past few years. The Forest Service has gone from a policy of elimination to enhancement with the discovery that snags are a vital part of the forest ecology. Questions of how many snags are desirable, what types of snags are important, and which animals use snags have been asked and are being answered by Forest Service and other biologists. The California Region of the Forest Service has recognized snag importance to the point of producing a publication entitled, "Snag Management." The importance of snags to raptors falls into three areas, (a) potential prey species using snags as nesting sites is large and diverse, (b) snags are important hunting perches for raptors, and (c) snags represent important nest site structures for raptors in forested areas.

Jackman (1974) indicates that 38 species (40 percent) of the forest birds of Oregon are cavity nesters and use snags regularly as nest sites. These cavity nesters represent several families of birds including some species of raptors. Along with avian species, many small mammals and insects use snags for a food source, nesting, and perching sites. Because of the varied needs provided by the snag, and particularly the snag with cavities, it is an important productive resource to many wildlife species including raptors. Von Hartman (1957), in a study of hole-nesting birds found that insufficient nesting sites could be a limiting factor to the number of nesting passerines. When increased numbers of snag cavities were present, an increase in the hole-nesting birds occurred. Haapanen (1965) in a comparative study of managed and unmanaged forest stands found that when snags and deciduous trees were removed and the stand periodically thinned that the numbers of hole-nesting birds declined while the open nesting birds showed no appreciable change. In a managed pine forest, there was no decrease in open nesters while a 44 percent decrease of cavity nesters occurred. A spruce forest under the same type management showed a 66 percent drop in cavity nesters with only a 5 percent drop in open nesters as compared to the unmanaged state. Similar results might occur in some mammal populations known to use cavities.

Another important factor related to cavities is the rate of success of fledglings. Nice (1957) found that cavity nesters had a 66 percent fledgling success while open nesters had only a 46 percent rate of success. Generally, cavity nesters also have a larger clutch size and young fledge at a later age also improving the rate of survival for these birds.

Snags as hunting perches for raptors are highly beneficial. The importance of these perches is particularly noticeable under two conditions, (1) along open fields, meadows, or clearcuts and (2) in winter months. Many raptors will hunt for rodents from perches overlooking openings in a forest or similar type areas. These sites are of great importance to forest managers particularly because these birds rely on many species which may be detrimental to the vegetative regeneration of cutover areas. In this situation, raptors can provide an important and beneficial control. Bald eagles and ospreys also use these sites for hunting and feeding when overlooking reservoirs, rivers, or streams.

During winter months when food sources for raptors are reduced because of snow cover and mammalian hibernation, snags can provide these birds with an important energy conserving factor. Raptors catching prey while on the wing expend greater amounts of energy than do those hunting from perches. Techniques of hunting which cause birds to use less energy can be important to inexperienced young birds which normally have a poor rate of survival due to reduced hunting success as well as adult birds in particularly harsh winters.

The use of snags as nest sites may be as great a factor affecting raptors as any mentioned in this section. Snags, both living and dead, provide nest sites for many of the large raptors. Ospreys and bald eagles have built large nesting structures in both living and dead trees. It is interesting to note that trees, particularly old Douglas fir which tower over many lodgepole pine, are most often used. This represents a good example of the importance of mixed forests and the need to leave certain types and sizes of trees for wildlife use.

Raptors of many types, particularly small owls, are cavity nesters and are dependent on snags for nesting sites. Jackman (1974) found six raptor species which were almost exclusively cavity nesters and one which used cavities regularly in the Oregon forests. All of these species are almost entirely rodent and insect feeders and are quite beneficial to the forest ecosystem. Whether these populations of raptors are limited by the number of available nesting sites is unknown, but certainly they compete with passerines and other birds and mammals using tree cavities and would displace some of these types resulting in a reduction of successful breeding pairs in the forest. Hammerstrom, Hammerstrom, and Hart (1973) found available nesting sites to be a limiting factor to kestrels (*Falco sparverius*) in their study area. In a 20-year period, only three pairs of these birds fledged young while in the following five years after placement of nesting boxes which produced a similar type cavity to those in some snags, 51 broods of kestrels (sparrow hawks) were raised. Not all of the nesting attempts were successful, some because of competition with other birds and a greater number of boxes might have resulted in more successful production by both raptors and passerines. Woffinden and Mosher (1976) found in a conifer-aspen mixed forest that deciduous as well as coniferous snags were important with many species of mammals and birds using them including the flammulated owl (*Otus flammeolus*).

Types of snags and numbers necessary for raptors and other wildlife are important questions when considering snag management. Gale (1973a) classifies snags into three categories according to age and extent of decay. The categories are "hard," "soft," and "living." Hard snags are tall dead trees which still have numerous branches and show relatively little decay. Soft snags are usually shorter with fewer branches remaining and decay is fairly extensive. Live snags are trees which have some non-living parts such as the crown or numerous branches. All three types are important because they represent various stages of the evolution of snags, each supplying certain needs for wildlife. Gale (1973b) surveyed the species of snags and numbers in various habitat types and the percentage of these used by wildlife. He concludes that "ideally, from the wildlife standpoint, it would be best to leave all snags." Snags have a limited lifespan and when this is reached, a lack of suitable snags may occur. For this reason, it is important to provide new snags by leaving cull trees which may be of poor timber quality but may provide many of the necessities for wildlife. Leaving some large healthy trees would also be desirable both from a wildlife standpoint and for timber stand regeneration, providing a natural seed source.

As in range management, retaining natural vegetation with an altered area can reduce some of the impacts of habitat manipulation due to logging activities. Islands or peninsulas of natural vegetation can increase the amount of edge important to many species of wildlife while helping to return the altered area to its original state through natural seed dispersal. Properly planned for and placed, these islands and peninsulas of cover can act as corridors for wildlife movement providing an important security need for many species, particularly in large harvest units. These unaltered areas of vegetation are not only important to raptors and the species on which they are dependent, but for all wildlife, game, and non-game alike.

Winn (1976), after studying vertebrate use of coniferous forest types, concludes that allowing only the cutting of trees greater than a certain diameter (i.e., greater than 3-1/2 inches) results in a clumping of the remaining vegetation providing a highly beneficial wildlife area. This type of harvest allows for the taking of desired trees while meeting some wildlife requirements.

Meadows should be surrounded by leave areas to prevent damage. Winn (1976) recommends a system of determining a minimum leave distance from logging operations necessary for the protection of these areas. The determination is made by walking into the forest from the edge of the meadow until the meadow cannot be seen, being obscured by trees and other vegetation. At this point, the observer is at the middle point of what should be left around that particular meadow. This type of determination takes into account steepness of terrain and density of vegetation. It should be remembered that this is a minimum distance and any increase would be desirable. Disturbance of these meadows and any waterways should be avoided.

5. What types of slash disposal should be involved and what are the effects on that ecosystem's plant and animal community?

Primarily two types of disposal are used in eliminating undesirable slash, (a) piling and burning, and (b) broadcast burning. Burning of slash in piles requires hand or mechanical piling of material before ignition. This type of disposal is very efficient in that fires burn at a higher temperature and materials are more completely consumed by the fire. Two major complaints come about when the effects of slash burning on wildlife are considered, (a) increased disturbance of soils, by mechanical devices, and (b) soil damage due to high temperature burning.

Mechanical disturbance to the forest floor caused by machines used for piling brush can reduce the resilience of an area by eliminating topsoils from the terrain. Gouging of tractor treads can expose rocks, soils, and parent material which may be unsuitable for production of plant species which are necessary for soil stability and preparation for succeeding plants. Exposure of these soils can cause erosion which can further delay establishment of desirable species and reduce an area's value for wildlife forage and cover. If the damage is extensive, the problem is compounded by a reduction of soil moisture due to a loss of plant material.

Burning of slash in piles increases the detrimental effects to soils by producing a high temperature which destroys soil organisms and results in a sterile environment for plants to grow. Ahlgren (1966), in a study of small mammals and reforestation following prescribed burning, states that where surface temperatures were higher during fires, frequency of many plants was reduced. The re-establishment of a succession of plant species in as short a time as possible allows for increased stability of soils and reduces the adverse effects to wildlife species. Eddleman (1972) writes "a three- to five-year period is usually necessary for grasses and other native plants to become re-established on mechanically disturbed areas. More than twice as much time is needed for re-establishment on intensely burned areas. From the standpoint of the native understory species, light soil disturbance and light burns, such as are associated with broadcast burning, are desirable."

The technique of broadcast burning allows slash to burn at a slower, less intense rate, reducing damage to soils due to high temperature and mechanical disturbance. This lower temperature burn has several particularly advantageous effects on small mammals and birds in relation to regeneration of plant species, (1) soils and their various components are less damaged by the lower temperatures involved with broadcast burns thus allowing a more rapid plant regeneration, (2) when using broadcast burning techniques, some areas are lightly burned and some missed completely allowing these animals areas of refuge from the fire, and (3) light burning, unlike higher temperature burns does not destroy as many of the seeds of various native plant hastening the regeneration of cover species. Ahlgren and Ahlgren (1965) discovered that soil microorganisms and their respiratory rate were also reduced by fire; the higher the temperature, the greater the reduction.

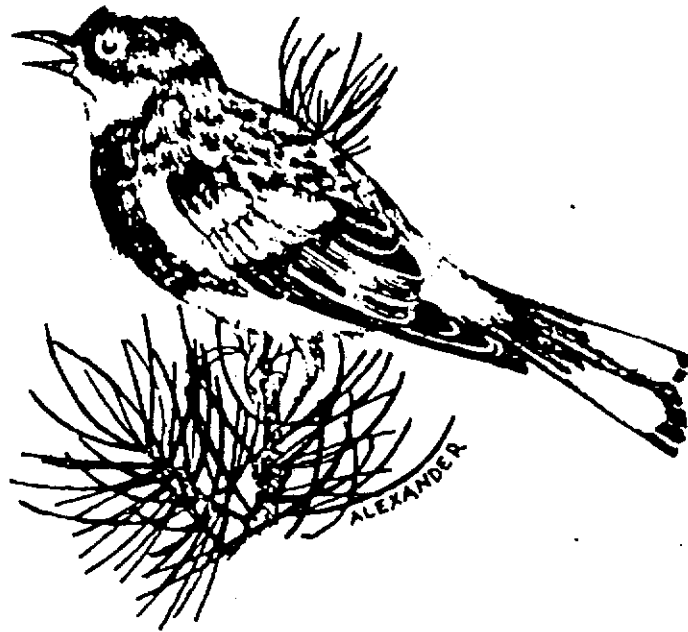
These organisms are of great importance to establishing plants in the breakdown of organic material into a usable food source. A reduction of these microorganisms can slow the re-establishment process considerably as plants cannot gain the nutrients needed for growth.

Below are some guidelines to best reduce impacts to raptors and wildlife in general due to logging activity.

1. Make clearcuts long and narrow with undulating edges. For best wildlife use, clearcuts should be no wider than 5 times the height of the surrounding forest canopy.
2. Leave pockets of vegetation in clearcut areas in the form of islands or peninsulas to provide corridors for movement and refuge areas for wildlife.
3. Design timber programs to provide the widest diversity of vegetation, allowing some forest plots to grow beyond their maximum productive age while cutting others to provide various stages of regenerating vegetation. This practice will produce the greatest habitat for wildlife diversity.
4. Avoid overstory removal which eliminates avian species dependent upon this vegetation layer.
5. Manage for snags. Leave the largest number of snags possible within clearcut areas. Snags are important to raptors and other wildlife species as feeding areas, hunting perches, and for nesting. A minimum of 2 snags/acre should be left for optimum wildlife benefits and cull trees should be left standing after logging operations to provide a continuing snag source for future wildlife use.
6. Strips of forest vegetation should remain as a buffer around meadow and stream areas when clearcut logging methods are used. Undisturbed meadows and stream banks are highly beneficial to small mammals and birds.
7. Avoid mechanical disturbance in clearcut areas and allow natural vegetational succession to occur. Natural vegetation provides important habitat for the small birds and mammals upon which raptors are dependent.
8. Broadcast burn rather than piling slash to reduce high temperature burns which are destructive to soil organisms and small mammals.

MINING, GEOTHERMAL, OIL, AND GAS

Mineral extraction has received increased attention recently as societies' needs for additional sources of energy and chemical fertilizers have increased. Phosphate and geothermal resources are found throughout the forest lands. Extensive exploration and extraction have begun with an increase in activities to continue. Exploration for oil and gas resources on the forest has increased in recent years; such activities provide for increased conflicts with wildlife. With increased activity, destruction and disturbance of wildlife habitat will occur, causing displacement of numerous wildlife species including raptors and prey species upon which they depend. Before mining or drilling activities begin, certain steps should be taken to evaluate the impacts on wildlife in an area as well as the remaining ecological values. A determination can then be made as to what measures can be taken to reduce or eliminate these effects. Decisions should also be made as to what forms of mitigation can be undertaken to compensate for the losses involved.



YELLOW-RUMPED WARBLER, *Dendroica coronata*

The effects of extraction activities on raptors fall into three categories: (1) direct displacement; (2) lowering of habitat quality; and (3) intolerable levels of human activity. The activities which cause wildlife problems are from three sources: (a) transportation activities; (b) extraction activities; and (c) processing activities. Not all mineral exploration activities encompass all of these problems on or near the forest so individual problems will be discussed under specific headings. Transportation is, however, an activity which concerns all types of mineral extraction and will be discussed in an overall sense. The problems discussed concerning mining roads can be transposed to timber problems as well as other activities on the forest.

Transportation

Two types of transportation are used for hauling people or minerals to and from mining areas, (1) railroads and (2) roads and highways. The problems of these two systems are similar and will be discussed together.

With the construction of roads or railroads comes a general loss of feeding, hunting, foraging, and territorial sites for many species including raptors and the prey species. Oxley and Carmody (1974) observed a reluctance to cross roads by small mammals when the road reached a certain dimension. Data from this study indicates that roads can be an effective barrier against dispersal of small forest mammals. Diamond (1973) also found roads to restrict movements of some small birds.

Slumpage and soil erosion, causing a loss in soil and water quality, are other detrimental effects caused by additional new transportation systems within the forest. Road beds poorly fitted to the surrounding waterways and soils can be washed out or cause an increase in levels of particulate matter in streams and rivers effecting the total biological system.

Chemical pollutants from automobile emissions settling onto soils and plants adjacent to highways and roads have reached extremely high levels in some areas and have increased with additional traffic. Lead has been found in large concentrations next to highways and roads. Most lead settles out in the first 35 meters (38.5 yards) from the road (Smith 1971) with high concentrations as far as 250 meters (275 yards) away. Nickel, another additive used in gasolines as well as cadmium and zinc used in tires and lubricants have also been found in higher concentrations next to roads and highways (Lagerwerff and Specht 1970). All of these chemicals have been found in soils and vegetation and can be lethal to vertebrates. A build-up of levels of chemicals can occur within the food chain which can effect some of the higher predators, including the kestrel and the barn owl (*Tyto alba*) both of which often use roadsides as hunting areas. With a more highly developed road system, not only will areas be exposed to greater numbers of haul trucks, but also a larger volume of private autos which will add to the level of concentrations. Restriction of the number of vehicles using these roads would reduce the concentrations. Below are some suggestions for reducing the effects of transportation systems to wildlife.

1. Limit the size of haul road to the smallest needed for the purpose. Minimum size will reduce the speed of vehicles using these roads and prevent many wildlife mortalities.
2. Fit roads into the terrain following natural contours to prevent damage to hillsides and surrounding waterways due to slumpage and erosion.
3. Limit the straight stretches of roads to reduce the maximum speed attainable. Straight stretches should be limited to less than 100 yards in length. This practice also allows roads to fit into the terrain more easily.
4. Limit access to haul roads to prevent heavy public use. This practice will reduce chemical pollutants in each area and also the possibility of illegal shooting of raptors.
5. Close roads and reseed road beds when operations are completed. This practice will allow a return to the natural state and prevent the disturbance caused by extensive public use.

Extraction

Each type of mineral extraction has unique impacts upon the environment but all involve a certain amount of disturbance of soil and vegetation. The types of soil disturbance range from the removal of vegetation and the leveling of an area for an oil or gas drilling pad to the massive removal of overburden and minerals from an open pit phosphate mine. The wildlife impacts involved vary as greatly as the activities and each individual site should be evaluated independently to assess the extent of the impact. Where extensive overburden removal has occurred, a large-scale reclamation program should be implemented. Soil stabilization is an important first step in this rehabilitation and a reseeding program using various natural plant types should be encouraged as soon as possible after mining activities have ceased. Where possible, topsoil should be saved and returned to the disturbed site after backfilling has occurred. When soil stability has been obtained, a program to return natural tree types to the area should be started. Planting should be made which will allow for openings in the canopy vegetation at maturity with as much edge produced as possible. During the period of reclamation, activities which are potentially damaging to developing plants should be excluded from the area (i.e., grazing).

Contouring of the land should be done to return the habitat to as close to the original condition as possible.

Phosphate Mining

The effects of phosphate mining on the forest are already being felt. The various problems associated with the mining need to be dealt with. Disruption of vegetation and soil has previously been discussed, but the question has arisen as to what use high walls left after mining activities might have for nesting raptors and whether they should be left for this purpose. Because of the extended nature, in terms of time of the impacts caused by this type of mineral extraction, it is difficult to assess the potential usefulness of these highwalls as nest sites. It is important to realize that the areas involved have maintained healthy populations of many types of raptors in the past without these structures and therefore their impact would be most probably minimal. Only a few such structures should be left, if any, as the return to as natural a habitat as possible will be more important to the birds and the environment in general.

Runoff from mining areas is another problem which could effect the general ecology of an area and eventually the raptors and the prey upon which they depend. State water quality standards should be adhered to in mining areas in order to prevent affecting the surrounding habitat.

Geothermal Power

With the ever increasing need for clean productive sources of power, exploration into the field of geothermal resources has increased. Several areas of high geothermal activity with many areas of interest are being found within the boundaries of the Intermountain Region. This resource on the Caribou National Forest has been studied extensively by the Division of Ecological Services of the U.S. Fish and Wildlife Service. Guidelines have been written by this agency which will reduce the ecological impacts upon the forest. For this reason, extensive guidelines will not be outlined in this paper as the Fish and Wildlife program is excellent and should be consulted before a geothermal production is undertaken. A general outline of some of the problems of geothermal power is, however, included below. All of these impacts would potentially affect raptors by causing a general degradation of the environment.

Environmental impacts from geothermal activity can come in several forms including, (1) air quality and climatic effects, (2) liquid emissions, (3) noise, (4) erosion, and (5) land subsidence. Each of these problems will be discussed in greater detail below.

1. Air Quality and Climatic Effects.

Environmental impacts due to emissions into the air come in two forms, (a) non-condensable gases including H_2S , NH_4 , and CH_4 and (b) localized climatic effects. Although levels of non-condensable gases are much lower than would be encountered with coal-fire plants, the high incidence of weather inversions within the region causes a greater concentrating effect in the area which intensifies the problem. With these inversions, contaminants may reach levels high above those in an area with different weather patterns.

The effect that steam from wells will have on the local environment, particularly the climate, is difficult to estimate. Dry-steam or flashed-steam generating plants of 1,000 MW capacity would evaporate 30-35 million gallons of vapor per day (Jones and Stokes Associates, Inc., 1975). Local temperature inversions would compound the effects of this significant amount of water vapor which would un-

doubtedly impact the vegetational and wildlife patterns of the area. Standards should be set and measures taken to reduce both chemical emissions and water vapor from geothermal wells. Rigorous monitoring should be enforced to ensure compliance.

2. Liquid Emissions.

The liquid emissions from previous geothermal wells have contained high levels of various chemicals including sodium, calcium, potassium, magnesium, chlorine, lithium, boron, and fluorine. Many of these chemicals or salt compounds of these chemicals can be toxic to both vegetation and wildlife. An additional problem is thermal pollution caused by water temperatures of 300-600°F. If not properly disposed of, these waters can alter the biota of local lakes, rivers, and streams. Holding ponds can be used to cool geothermal waters adequately but have proven unsuitable due to the increasing salt concentrations which occur as evaporation takes place. ReInjection of water into its original reservoir is the only ecologically sound alternative, preventing any potential chemical or thermal pollution.

3. Noise.

High levels of noise accompany geothermal activities due to the extreme pressure of the steam and waters used. Potentially this source of disturbance can be harmful to not only nesting raptors but other forms of wildlife as well. Muffler systems have proven to be useful in reducing this problem and should be required on all facilities.

4. Erosion.

The steep terrain in many areas of the Region has the potential of being highly erodible if subjected to the increased activities necessary for development of geothermal resources. Because of the large expanses of land used in geothermal production (12 square miles for 1,000 MW at Geysers, California; Bowen 1975), disturbance of soil and the resulting lowering of water quality will cause a general degradation of habitat in the area affecting all forms of soil, vegetation, and wildlife. Well sites should be chosen after having considered the potential erosion problems while avoiding those which are unstable or otherwise unsuitable (i.e., 30 percent slope or greater). Standards should be set by the Forest Service and enforced to prevent these problems.

5. Land Subsidence.

Soil subsidence has proven to be a problem with geothermal development and requires reinjection of fluids for its prevention. This reinjection is necessary to return subsurface pressures to predrilling levels. The problems of subsidence need additional study before extensive geothermal development continues.

Oil and Gas

Disturbance of soils and vegetation is one of the greatest environmental detriments of oil and gas development. Drill pads, roads, and adjacent areas create a loss of vegetation important to small birds and mammals. Revegetation programs should be implemented after drilling activities have ceased. Guidelines controlling geothermal drilling and exploration should be followed for oil and gas development.

Processing Activities

Phosphate resources are the only concern in this section as oil and gas processing is done away from the area and geothermal processing is included in its development.

Processing of phosphate ores can create water and air pollution problems. State air and water quality standards should be adhered to and a stringent monitoring program implemented to eliminate this problem and to avoid detrimental effects upon wildlife of the area.



AMERICAN KESTREL, *Falco sparverius*

DESCRIPTION OF COMMON DIURNAL RAPTORS

The following is a brief description of some of the diurnal raptor species common in the Intermountain Region.

Bald Eagle

The bald eagle is found in the Region year-round although the nesting population is minor when compared to other raptors or the bald eagle wintering population. Both summer and winter populations are dependent primarily upon the rivers and lakes for fishing. Significant changes in diet occur in the winter if waters of the area freeze over. Carrion such as winter killed deer and elk or crippled water fowl are utilized. Eagles also kill rabbits and various species of water fowl for food. Nesting generally occurs near the top of large trees, however, cliffs are occasionally used.

The bald eagle is a large bird, having a wingspan of 6-1/2 - 8 feet. Adults show the characteristic white head and tail. Immature birds lack the white on the head and tail, showing some white on the underside of the wings. (See pages 72 and 75 in Peterson Field Guide.)

Golden Eagle

This bird is found throughout the Region year-round. Although it is more visible in open areas, this bird can be seen in various habitats. Because of the bird's adaptability this species will feed upon a wide variety of prey allowing the bird to be very successful. The golden eagle will nest in trees as well as on cliffs which further allows the bird great flexibility in the areas which it can inhabit. This species may begin courtship activities as early as January.

The golden eagle is similar in size to the bald eagle with a wingspan of 6-1/3 - 7-2/3 feet. Adult plumage, which is usually acquired at four years of age consists of an evenly dark color. Look for wash of gold on hind neck. Immature birds show white at base of wing primaries and white tail bordered by a dark band. (See pages 72 and 75 in Peterson Field Guide.)

Osprey

The osprey, or fish hawk, is confined to areas associated with rivers and lakes as the diet consists of nearly 100 percent live fish. Dead fish are only taken when fresh. Nests are built in the tops of large trees near water. The male carries fish to the female and young until fledging occurs.

This fish-eating bird has a wingspan of 4-1/2 - 6 feet and is best identified in flight by the crook in its wings. (See pages 76 and 83 in Peterson Field Guide.) The bird is brown-black above and white below with a white head having a broad black cheek patch.

Red-tailed Hawk

This bird is common throughout the Intermountain Region, living both in the forested areas as well as grassland habitats. As with many raptors, this bird seems to prefer nesting along waterways probably due to the greater numbers and diversity of prey in these areas. Rodents and rabbits are primary sources of food though small birds are also taken. Wintering populations are much smaller than summer as many of the juvenile birds disperse.

This large hawk, which has a 4 - 4-1/2-foot wingspan, generally shows a light breast with broad bands of streaking across belly. This species exhibits much variation in color; many times the rusty, upper side of the tail is the best identifying characteristic. (See pages 66, 82, and 83 in Peterson Field Guide.)

Rough-legged Hawk

This bird is a winter resident in the more open areas of the Region. Feeding primarily upon small mammals, rabbits, and occasional birds, these raptors are better suited to open areas and can often be seen hovering over open fields, hunting. They are also commonly seen perched on telephone poles.

The rough-leg is recognized by its large size, having a 4 - 4-1/2-foot wingspan, black belly, and conspicuous black patch at "wrist." Though two color phases do occur, all birds generally have white on the base of the tail with a dark terminal band. (See pages 66, 82, and 83 in Peterson Field Guide.)

American Kestrel (Sparrow Hawk)

This bird is probably the most common and widespread raptor of the Intermountain Region. Feeding on insects, rodents, and even occasionally upon small birds, the kestrel is an extremely adaptable bird. Nesting throughout the Region, these birds will often use hollow trees as nesting sites. In the fall, large pre-migration concentrations of these birds can be observed in some areas. During the winter, most of these birds have left the area due to the harsh conditions.

The sparrow hawk is the smallest of the falcons having a 1-3/4 - 2-foot wingspan. This species is commonly seen hovering on rapidly beating wings while hunting. (See pages 67 and 74 in Peterson Field Guide.)

Accipiters

The goshawk, Cooper's hawk, and sharp-shinned hawk are all primarily forest dwellers, feeding heavily upon birds and taking some rodents. These birds are all found in the Region and will often nest close to streams in conifers or aspens.

These three species are characterized by long tails and short, rounded wings. Typical flight is several short, quick beats and a glide. The goshawk is the largest of the three species, having a wingspan of 3-1/2 - 4 feet, followed in size by the Cooper's hawk with a 2-1/4 - 3-foot wingspan and sharp-shinned hawk with a 2-foot wingspan. (See pages 63, 64, and 67 in Peterson Field Guide.)

Ferruginous Hawk

The ferruginous hawk is a large hawk of the desert or prairie. It will nest on old deserted buildings and windmills as well as hillsides, dirt mounds, and juniper trees, which are their most common nest site. This bird feeds heavily upon rodents and lagomorphs, hunting in the sage-grassland areas. (See pages 66, 70, 82, and 83 in Peterson Field Guide.)

Light and dark color phases are seen in ferruginous hawks. Both phases have a white or near white tail and a white patch on the underside of the wings. The remaining feathers are brown in the dark phase. The light phase has all white underparts with the exception of a V formed by the reddish brown legs held against the body in flight. It is the largest American buteo, having a wingspan of 4-2/3 feet.

Turkey Vulture

The turkey vulture is commonly seen on warm, summer days circling over the more open areas of the Region. It is a scavenger, eating the flesh of dead animals, thereby quickening decomposition and preventing the spread of disease. Cliffs are common nesting sites though trees are sometimes utilized.

This bird is nearly eagle size with a 6-foot wingspan. A good field identification feature is the two-toned blackish wings, the front part being dark, hind part contrastingly lighter. The species characteristically soars with wings slightly above horizontal while rocking and tilting unsteadily. (See pages 61 and 75 in Peterson Field Guide.)

Prairie Falcon

Areas within the Intermountain Region support year-round resident as well as migrant prairie falcons. Preferred habitat consists of desert and agricultural areas near cliffs. The composition of the diet varies with the locality. It feeds primarily on birds, though mammals, reptiles, and occasionally insects are also eaten. Nesting is commonly in depressions on cliff ledges or faces.

This nearly crow-sized bird has the typical long-pointed wings and quick, pigeon-like wingbeats of a falcon. Look for black "wing pits" on the underside where the wings join the body. (See pages 74 and 77 in Peterson Field Guide.)

Peregrine Falcon

This endangered species is rarely seen, although some resident, as well as migrating, birds occur within the boundaries of the Region. Peregrine falcons are usually found near bodies of water or marshes. Nearly 95 percent of the diet consists of various bird species. Nests are simply depressions on bare rock ledges of cliffs.

Peregrines can be distinguished from prairie falcons by the bold facial marks and overall darker color. A conspicuous vertical "mustache" below the eyes is also a diagnostic characteristic. Wingspan of the peregrine falcon ranges from 25 to 40 inches. (See pages 67, 74, and 78 in Peterson Field Guide.)

Marsh Hawk

This slim, long-tailed hawk with a conspicuous white rump patch can commonly be seen gliding low over lowlands and marshes. It is found throughout most of the Region. Two-thirds of the diet consists of small mammals although birds, amphibians, reptiles, and some insects are also taken. Nests consisting of sticks and grasses are located on the ground or in low vegetation.

Coloration varies from very light gray in breeding males to the dark reddish brown of the young. The white rump patch is the distinctive feature which can be easily seen when the marsh hawk is in flight. When gliding, its wingspan measures 42 to 54 inches. The wings are held above horizontal in a V shape. (See pages 67, 73, and 74 in Peterson Field Guide.)

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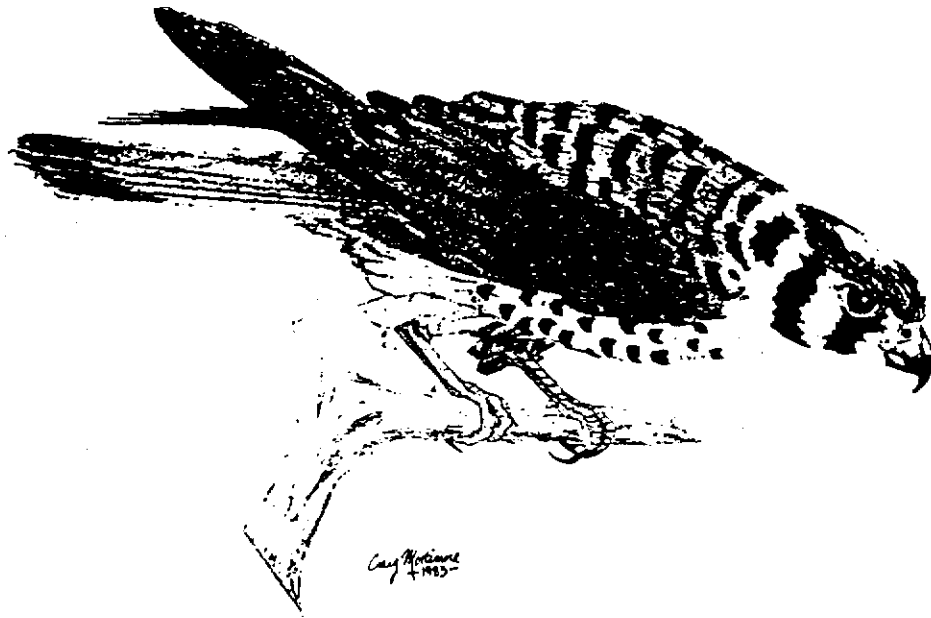
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**"Your Wildlife Heritage"
Raptor Series**

American Kestrel



Nevada Dept. of Wildlife

THE AMERICAN KESTREL

(*Falco sparverius*)

The American kestrel is the most common of our North American falcons. European colonists incorrectly called this small falcon a "sparrow hawk," one of the names by which the kestrel is still known. The kestrel is one of the more familiar raptors, or birds of prey, and is highly visible when perched on power poles, transmission lines, and roadside trees. They are also often observed hovering on rapidly beating wings while searching for mice and insects.

The kestrel is about nine to twelve inches in length, or slightly larger than a robin, with narrow, pointed wings. The American kestrel is the only species of falcon in which the sexes are as distinctly different in juvenile birds as they are in the adults. The plumage, or feathers, of the male is strikingly more colorful than that of the female. The male's head has a blue-gray crown encircling a chestnut colored patch. Black stripes below and behind the eyes contrast sharply with the white throat and cheek patches. The back and tail are a bright rust color, the wings are blue-gray, and the breast is light with black spotting. The female has less color variation than the male, being more uniformly rust colored with buffy-streaked underparts. Her head is similar to the male's but with more subdued coloring. These distinct color characteristics make the kestrel the most colorful of all North American raptors.

As with most raptors, there is a marked size difference between the sexes, with male kestrels in Nevada weighing approximately 2½ to 3½ ounces and females 3½ to 4½ ounces.

Kestrels can be found throughout Nevada; however, highest population densities, both breeding and wintering, are located near agricultural areas or streams and rivers where they can feed on an abundant prey base and utilize large trees for nesting.

Because of the kestrel's diet, it is usually considered one of the more beneficial birds to man. The grasshoppers, crickets, beetles and other insects that it consumes are often injurious to man's crops, comfort and economic interests. Mice and other small rodents are also major food items and kestrels often take these animals near farm buildings and agricultural crop land. Like the majority of predators, the kestrel is an opportunistic hunter and while they generally utilize those prey species

which are most plentiful and available such as small rodents and insects, they have been known to dine on such food items as lizards, small birds and bats.

The reproductive cycle for Nevada's kestrels extends from early April through July with a prolonged courtship period prior to actual nesting. During courtship a male establishes a nesting territory, which is defended against other males. To attract a potential mate and maintain territorial boundaries, the male performs spectacular aerial displays and loud vocalizations. Pair bond formation and nest site selection also occur during the courtship period.

Kestrels prefer to nest in tree cavities excavated by large woodpeckers in many areas of Nevada; however, where such nest sites are not available, they readily utilize crevices in cliffs, old buildings, and even large buildings in the center of metropolitan areas. Man-made nest boxes are also utilized by kestrels when they are properly constructed and placed.

After a nest site is selected, the female will typically lay four or five lightly spotted eggs. Incubation duties are shared by both parents and the eggs hatch in about twenty-eight days. Young kestrels will remain in the nest for approximately twenty-five days and are entirely dependent upon food provided by their parents. Nestlings continue to be fed by their parents until feather development is complete and they become accomplished flyers and hunters.

Although the American kestrel is currently an abundant species, there are numerous land use practices that could adversely affect the population. For example, old trees, such as cottonwoods and aspen that are dead or dying, are required in many areas for successful nesting. Nesting cavities excavated by woodpeckers are seldom present in younger, more vigorous trees. The increased demand for firewood in recent years has reduced the number of the trees which are most often used by woodpeckers.

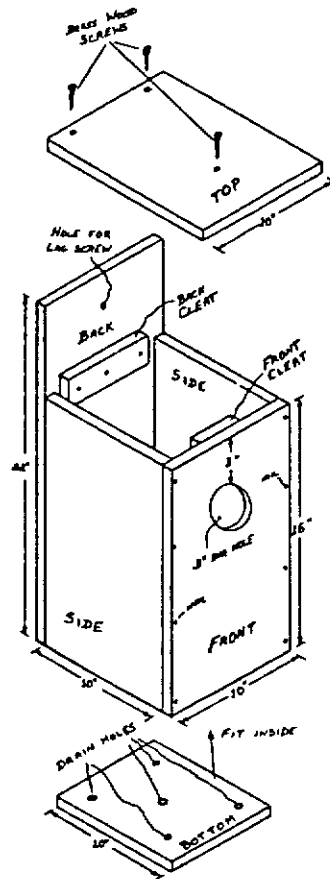
The use of pesticides for insect control can also adversely affect kestrel populations. Accumulation of pesticide residues in the kestrel and its eggs can result in lower reproductive success, and in extreme cases, the death of the falcon.

The Department of Wildlife continually monitors raptor populations for distribution, trend, reproductive success and condition of required habitats. Through these survey efforts we will continue to be aware of changes that may affect these sensitive birds.

All raptors, including kestrels, are protected by state and federal law and it is important to understand that these predatory birds play an important role in maintaining a balanced environment.

If we are to continue to enjoy the many varieties of wildlife found in Nevada, we must all become aware of their needs and the roles they perform in nature. Only through cooperative efforts on the part of many diverse interests and groups will we maintain our wildlife resources.

Kestrel populations appear to be doing well today, and with our help and continued understanding we can insure that this beautiful raptor remains a part of our wildlife heritage.



KESTREL NEST BOX

It is best to leave the wood natural. Do not paint or spray with wood preservatives. No entrance perch is required by kestrels and a perch will attract starlings. Kestrels generally nest about 20 feet from the ground and seem to prefer an easterly exposure.

Since kestrels do not construct a nest, two to three inches of coarse sawdust must be placed in the bottom of the box. Kestrels scrape a shallow nesting depression in the accumulated litter normally found in natural cavities.

When the box is finished attach it securely to the supporting structure with a lag screw.

Nest box illustration taken from the Wildlife Management Techniques Manual, The Wildlife Society, 1980.

Cover art by Craig Mortimore

The AMERICAN KESTREL is a PROTECTED bird.

NEVADA DEPARTMENT OF WILDLIFE
P.O. Box 10678 • Reno, Nevada 89520

Barn Owls in Nebraska



Nebraska Game and Parks Commission
Eugene T. Mahoney, Director



Barn Owl

ALIASES: Monkey-faced owl, spirit owl, ghost owl.

OCCUPATION: Rodent destroyer, works only at night.

ADDRESS: State of Nebraska, frequents barns, old farm buildings, silos, dirt banks.

DESCRIPTION: Weight about 1 pound; 18 inches tall; heart-shaped face; last seen wearing white and rusty brown feathers.

WANTED: For their own protection and restoration.

INTRODUCTION

Distributed worldwide, the barn owl (*Tyto alba*) is an uncommon, but local breeder in Nebraska. Nesting records here have shown breeding in at least seven counties with most reports from the southern half of the state. Since the breeding population of the barn owl in Nebraska is small and apparently declining, man's assistance is required to prevent the barn owl from becoming endangered or threatened.

DESCRIPTION

The unique shape and color of the barn owl make it easy to distinguish. Adult birds are about 18 inches high and are noted for their white heart-shaped face, small dark eyes, long legs and feathered feet. Colors vary, but brown and white predominate. The head and upper parts are a buff or rust brown with fine markings of white, gray and black. The tail is buff above with four dark bands. Feathers of the facial disc are white with a brown tinge around the eyes. Underparts are white with buff shadings and marked with brown to black flecks.

HABITS AND HABITAT

Barn owls prefer habitat which is primarily open country with intermixed grasslands, meadows, pastures, open woodlands and cropland. In these areas the barn owl can capture the prey it prefers. Hunting is predominantly nocturnal, although owls will hunt at dusk when feeding young. The primary prey taken are small rodents. Mice, rats, voles and other rodents make up 95 to 98% of a barn owl's diet. This preference for rodents that are high injurious to man and his crops makes them extremely valuable to landowners from an economic standpoint. Food is obtained by the bird sweeping across fields until prey is pinpointed by sound. The owl then drops down and catches

the prey by pinning it to the ground.

The barn owl regurgitates compact waste pellets containing the fur, bones, feathers, and other undigestible material of their prey. Undigested material from three to six rodents may be contained in each pellet. From two to three pellets are cast by the individual owl during a 24-hour period. Digestion is rapid, and an individual owl will almost always eat at least half its own weight in prey nightly. Young in the nest are even more voracious, requiring their own weight or more in food every day. Anyone who doubts the content of a barn owl diet should examine some pellets collected at a nest. It is a most educational experience.

Barn owls nest in a variety of places. Nest sites include old buildings, barns, hollow trees, stream or canal banks, rock cliffs and underground burrows. No effort is made to build or line the nest. The female lays a clutch, which varies in size from four to seven eggs. The pure white eggs are laid at two to three-day intervals. Incubation by the female begins with the first egg and lasts 27 to 34 days. Young owlets vary in size and are tended and fed by both parents. Young owls acquire adult plumage in 3 to 7 weeks

and leave the nest after 60 days. Young barn owls are independent in about 10 weeks. If undisturbed, barn owls will return to the same nesting site year after year.

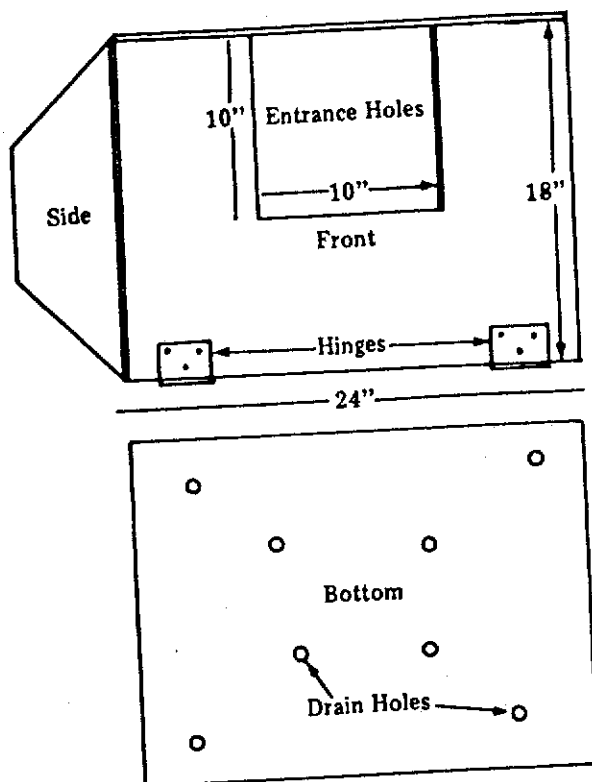
MANAGEMENT

Barn owls will quickly utilize new nest sites, so there is potential to maintain or increase breeding populations through placement of artificial nest boxes. Nest boxes can be used to increase populations in areas where prey and habitat are available but natural nest sites are lacking. Since this owl is tolerant of limited human disturbance, it can be attracted to areas other birds of prey will ignore.

The recommended nest box is 24 inches square, 18 inches high and contains a 10-inch x 10-inch door in the front panel (see diagram). Boxes are easily constructed of readily available materials. Those built to the recommended size require a 4 x 8-foot piece of 5/8-inch plywood, a pair of hinges, two hook latches, and stain for waterproofing the outside. It costs under \$15 to build one box. The front of the box is hinged to facilitate cleaning, which should be done annually.



Boxes can be placed in old barns, silos, or other farm buildings where there is inside access for the birds, protection from predators, and little disturbance. Boxes should be placed only in areas where there is a small breeding or transient population and where proper habitat occurs.

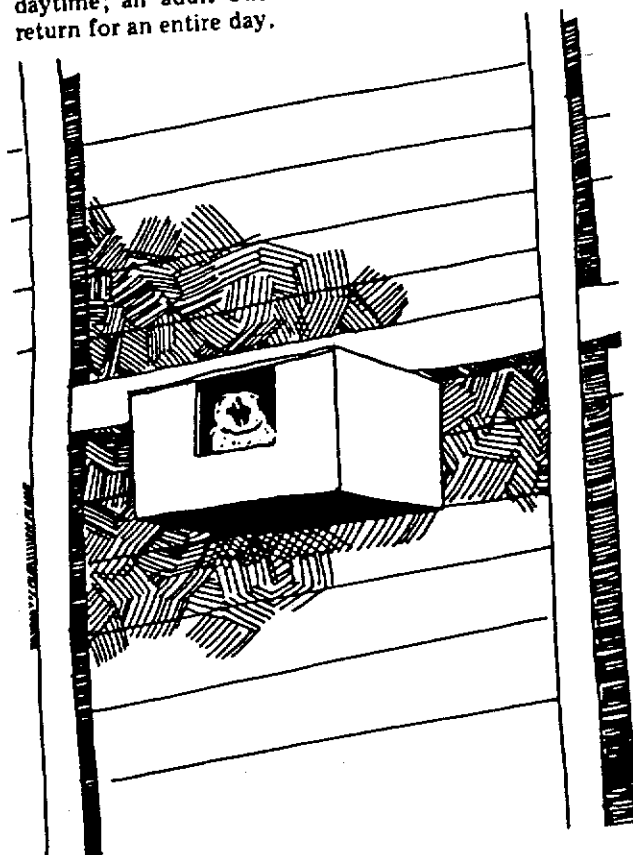


Nest boxes in silos should be placed 30 to 35 feet from the ground, but at least 10 feet from the silo top. If silo size does not permit this, the distance of the box from the ground should be two-thirds of the silo height. Boxes can be placed in the stairwell or hung over the top with wire or metal straps. Barn owl boxes in buildings should be located so the birds have easy access to and from the building's interior. A window, hole, or ventilation shaft will give owls unhampered movement. Open implement sheds and other buildings without enclosing walls are not suitable for barn owl nesting.

To avoid potential secondary poisoning of barn owls, it is recommended that rodenticides not be used in the area of the nest from April 1 to October 1. Barn owls are exceptionally valuable in natural rodent control. They are better than cats. Adults may stockpile as many as 50 rodents in preparation for

arrival of their chicks. A pair of owls was once observed bringing 21 rodents (including 16 mice, 1 rat, 3 gophers, and 1 squirrel) to their nest within 25 minutes. Studies in California have shown that an individual adult barn owl destroys pocket gophers to the value of \$20 to \$30 annually and far more than that in meadow mice.

Nest boxes should be monitored annually to determine occupancy and production of young. However, once a barn owl is observed near a box in the spring, it should not be closely examined until young can be heard calling. Disturbing a nest where eggs are being laid or incubated may prompt desertion. Close observation of the young during the first two or three weeks following hatching should not be made in the daytime; an adult owl flushed in daylight may not return for an entire day.

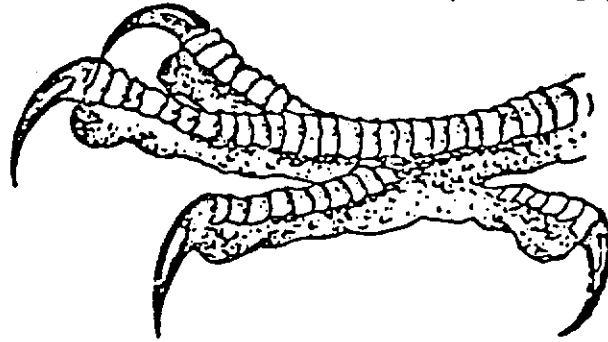


If you would like to be part of the effort in restoring this highly beneficial and interesting species or have knowledge of the location of nesting barn owls, contact the Nebraska Game and Parks Commission, Wildlife Division, 2200 North 33rd Street, Lincoln, Nebraska 68503.

HOW TO HANDLE AN INJURED RAPTOR (BIRD OF PREY)

Be aware of the following facts:

- *Under Federal and State law it is **ILLEGAL** for any person to injure or possess a bird of prey.
- *A raptor's feet and talons are its means of defense.
- *An injured raptor requires immediate specialized care. Any delay reduces the bird's chance for recovery.
- *Most veterinarians have neither special facilities nor the practical experience to properly handle an injured raptor.



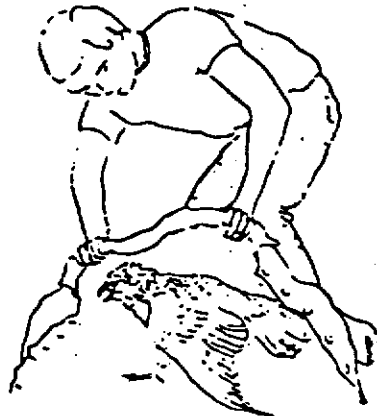
The method of rescue that can be adapted to handle most circumstances is the

"COVER COMPLETELY TECHNIQUE"

A TOWEL, BLANKET, JACKET or any other handy **LIGHTWEIGHT** item (large enough to cover the entire bird) can be used.

PROCEED AS FOLLOWS:

- 1) Note the geographic location where the bird was found. This information will be necessary when the bird is ready for release.
- 2) Approach the bird from the rear if possible. If the bird is alert and can follow your movements, anticipate that it will struggle when first covered.
- 3) When close enough, carefully place the jacket over the bird. Make sure to cover the bird completely.



4) Quickly restrain the bird under the covering. Usually you end up with a covering full of talons, but at least you know where they are.

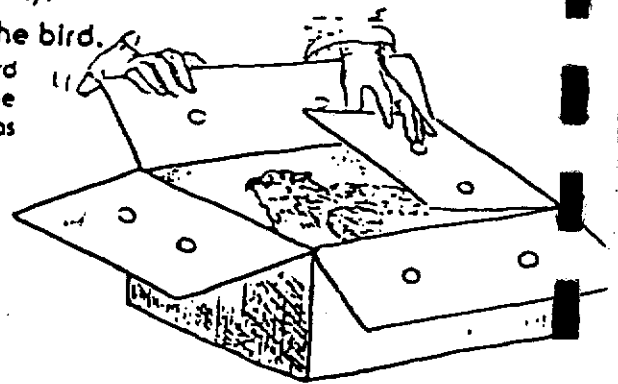
5) As the bird calms down, gather the covering together, being careful to get the bird's wings folded against the body.

6) If required, the covering can be made into a sack using a bootlace.

EXTREME CARE must be used when the bird is transported in this manner. If the day is warm or the covering is made of tightly woven material, the bird can rapidly overheat. The bird should be transferred to a more suitable enclosure at the first opportunity.

A **CARDBOARD BOX** is an ideal way to safely transport the bird.

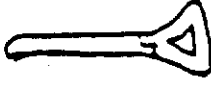
Stop at a nearby house or business and obtain a cardboard box. This box should be **WELL VENTILATED** and just large enough to allow the bird some movement, but not so large as to allow the bird to thrash around inside.



IF YOU FIND AN INJURED RAPTOR call:

and the raptor will receive prompt care from an experienced rehabilitator.

The text and illustrations of this leaflet provided courtesy of the New Jersey Raptor Association, Millington, NJ.

Description	Bones Found in Barn Owl Pellets	Number Found
	Rodent Skull	
	Incisor or Front Tooth	
	Mandible or Lower Jaw	
	Pelvic Girdle or Hip	
	Femur or Thigh	
	Tibia and Fibula or Lower Leg	
	Vertebrae or Backbone	
	Humerus or Upper Arm	



The lower jaw of a mouse, showing the long, curving front teeth and the rather knobby cheek teeth

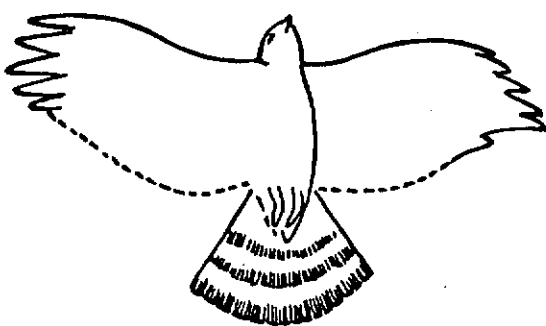
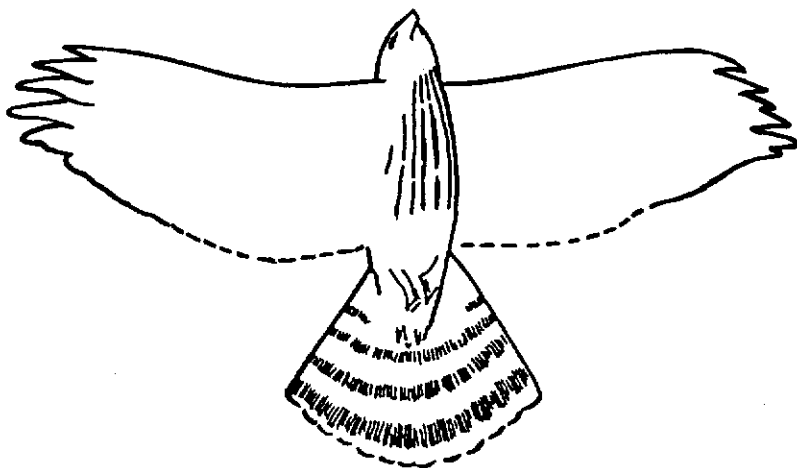
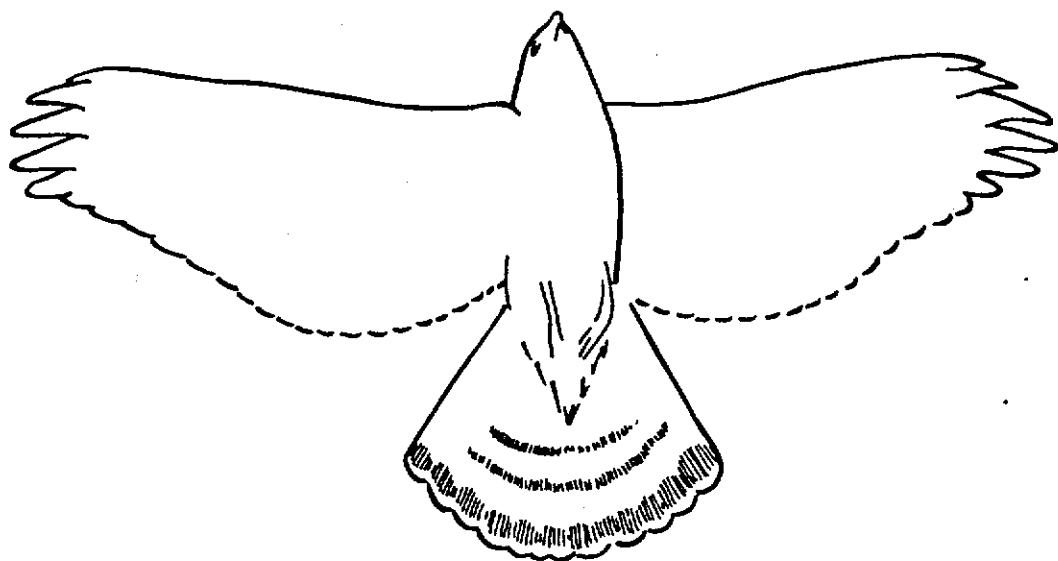


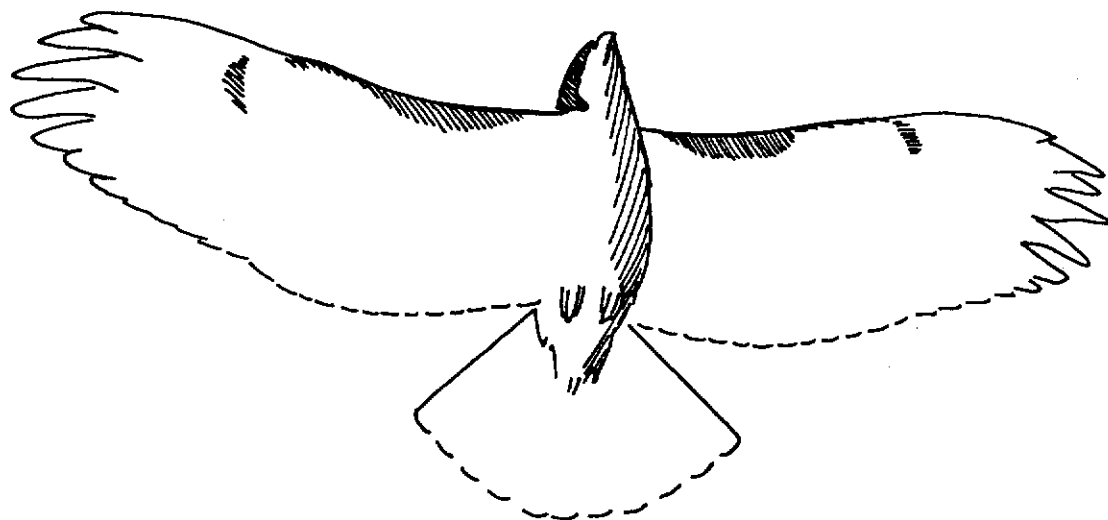
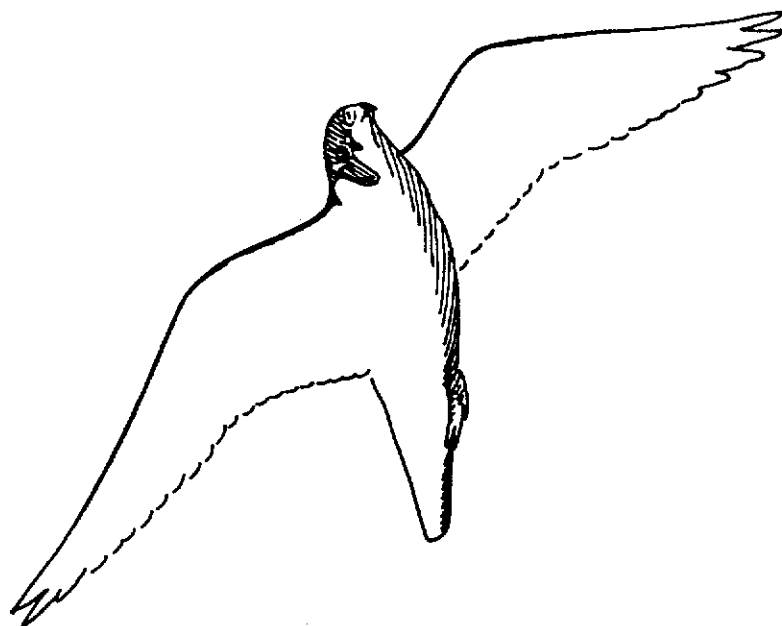
The lower jaw of a shrew, showing the small pointed teeth which it uses to cut up insects and other small animals.



The lower jaw of a vole, showing the rather long, columnar cheek teeth which distinguish this animal from a mouse.



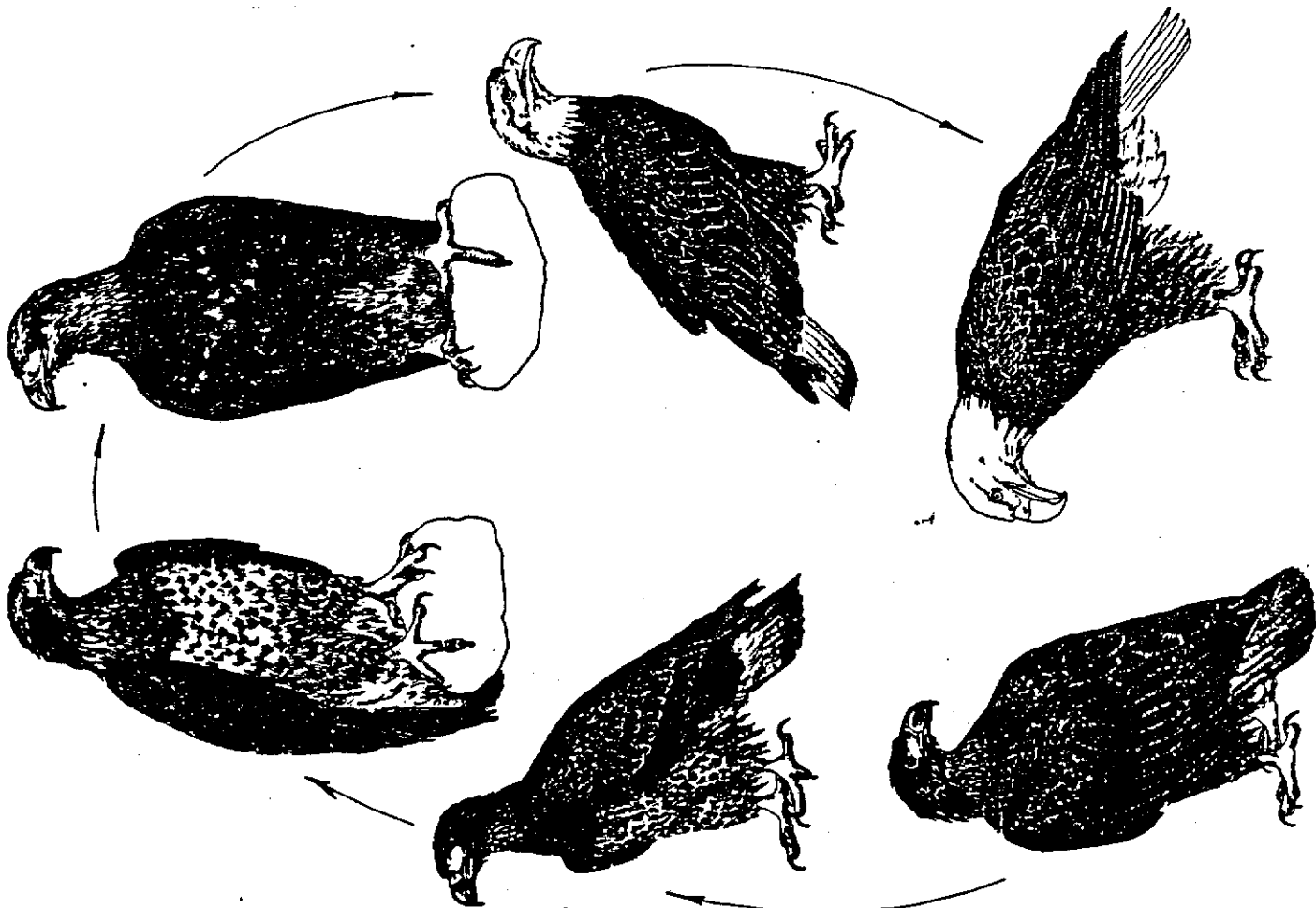




Descriptions of juvenile, subadult, and adult plumages of the bald eagle.*

Feature	Juvenile plumages			Subadult plumages			Adult plumage
	A	B	C	D	E		
Eye	Dark brown	Brown	Light brown	Cream	Dull yellow		Yellowish white
Beak and cere	Black and gray	Black and gray	Black, gray, and some yellow	Gray and yellow	Dull yellow		Yellow
Head	Dark brown to black	Brown	Brown to light brown	Gray and light brown	Dirty white		White
Lower breast	Dark brown	Brown	Usually mottled gray	Usually brown with some gray	Dark brown		Dark brown
Under-sides of wings	Dark brown, black, and gray	Dark brown, gray mottling especially at wing pit	Brown, much gray mottling especially at wing pit	Brown, some gray mottling especially at wing pit	Dark brown with some gray mottling		Dark brown
Tail	Black with gray near vane	Black with gray near vane	Black with gray intermixed	Gray with black	Dirty white		White

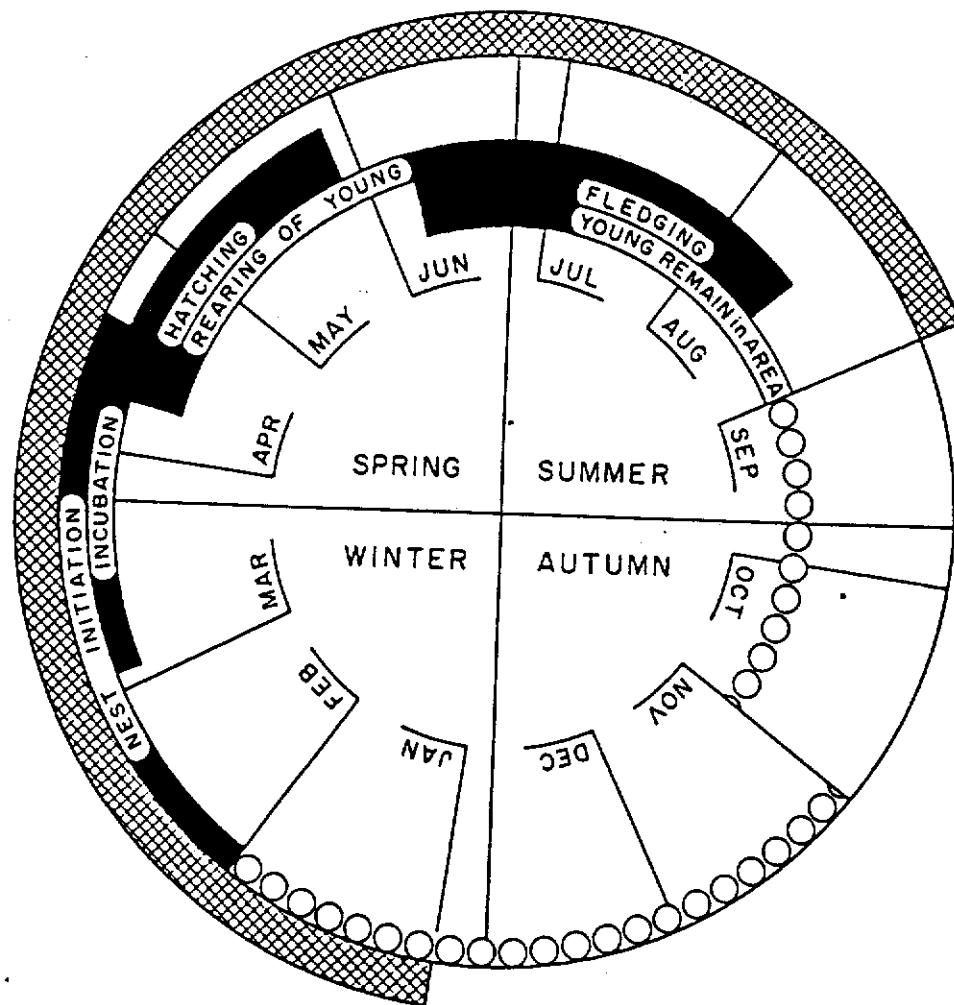
*The relation of plumage types to age is shown in Figure 3.6.



Juvenile plumages A and B (lower left and middle left); subadult plumages C, D, and E (upper left, upper right, and middle right); and adult plumage (lower right).

Age	Plumages A and B				
	1	2	3	4	5
0	Juvenile	1st Molt	2nd Molt	3rd Molt	4th Molt
1					
2					
3					
4					
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8					
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from; Stalmaster, M.V. 1987. The bald eagle. Universe Books, New York, NY.



- ○ ○ - Time not covered by fieldwork for this study but during which eagle activity has been observed at nest sites.
- ▨ - Time when human activities near occupied nest sites are most likely to affect breeding success.

FIGURE 2. Breeding chronology of Bald Eagles in Oregon, 1978-1982.

BREEDING RATES OF RAPTORS
Nestling and Fledging periods

Example: Golden Eagle

about 1-2 days



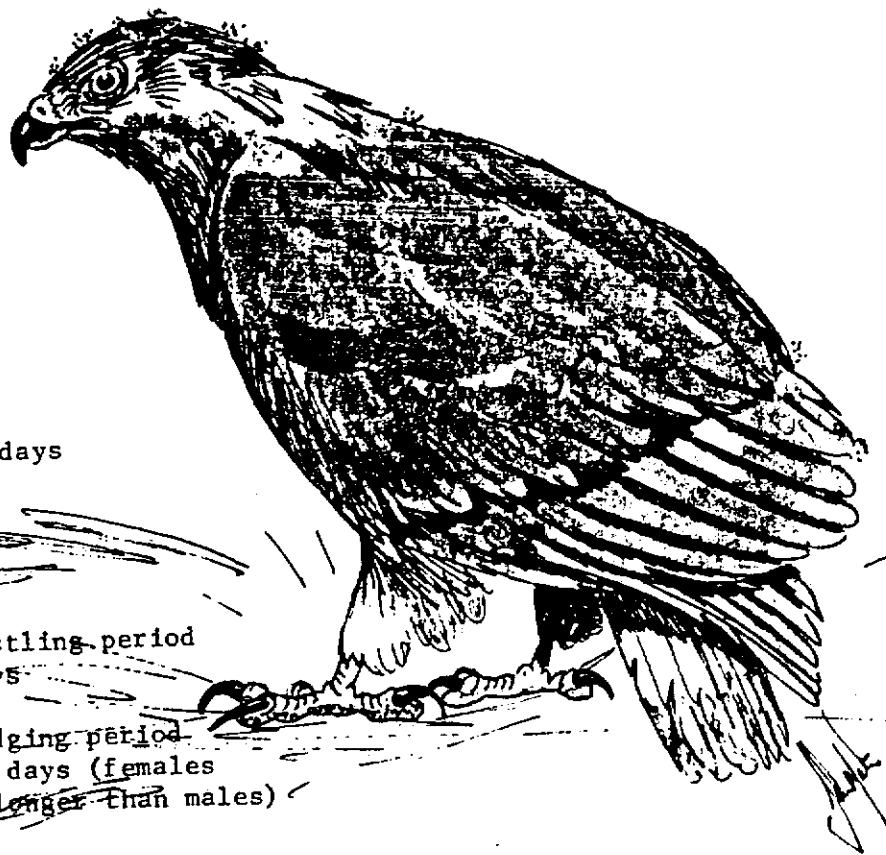
about 25-30 days

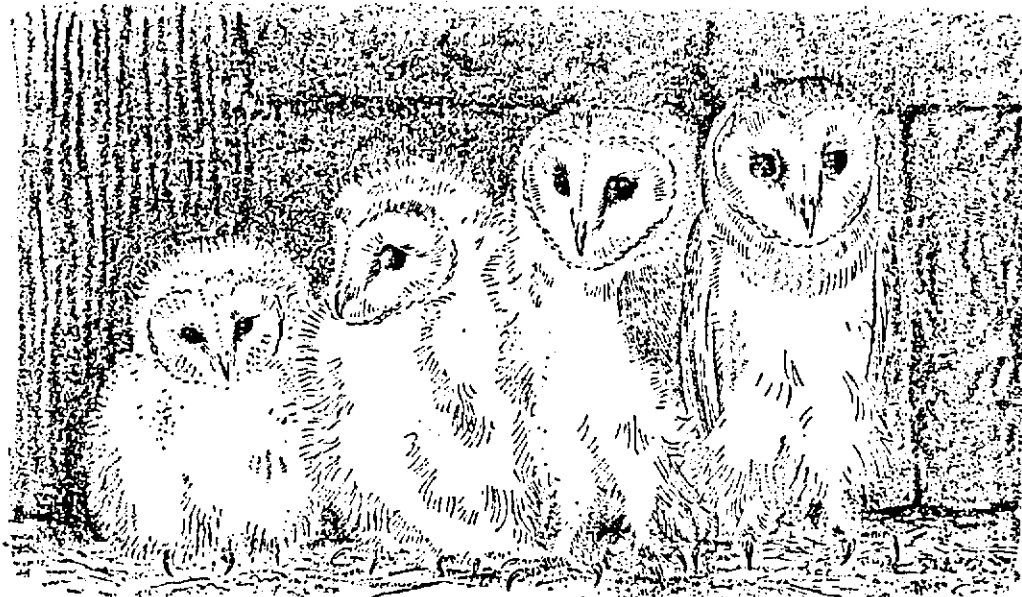


about 55 days

total nestling period
65-77 days

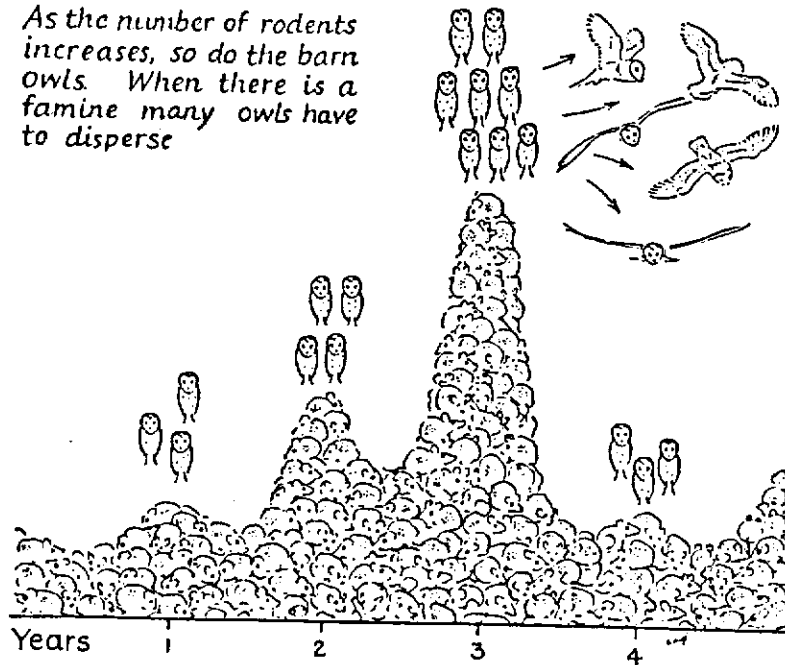
post-fledging period
about 84 days (females
usually longer than males)



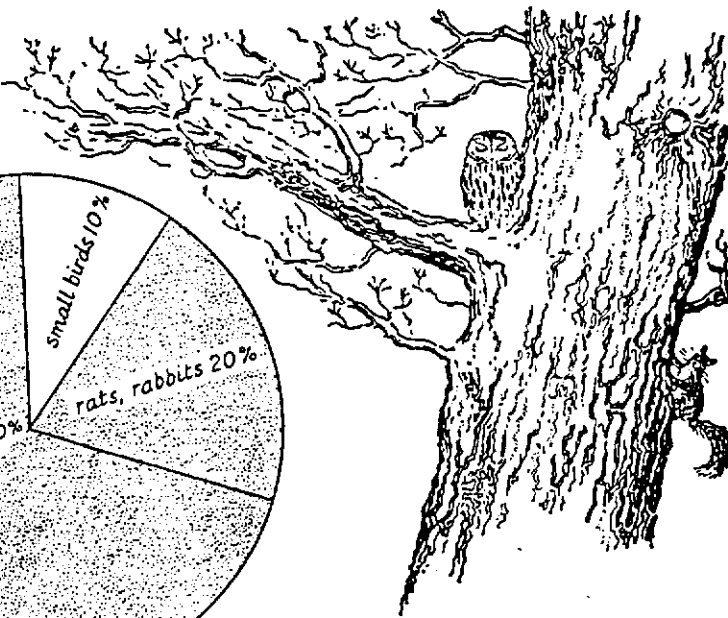
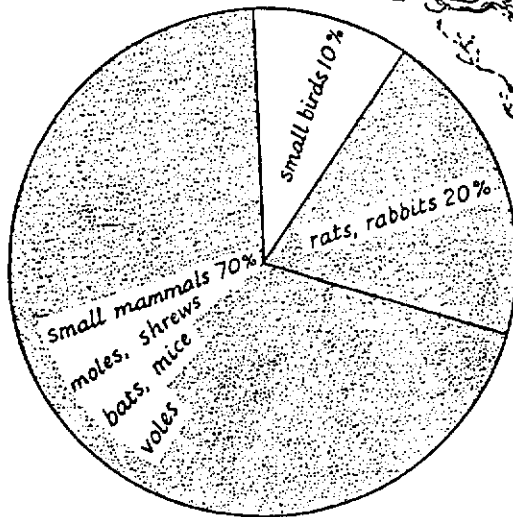


Young barn owls showing difference in age between the first and last to be hatched

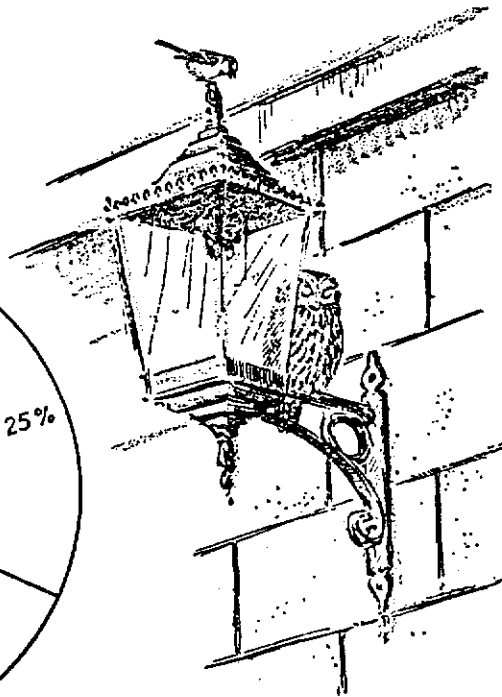
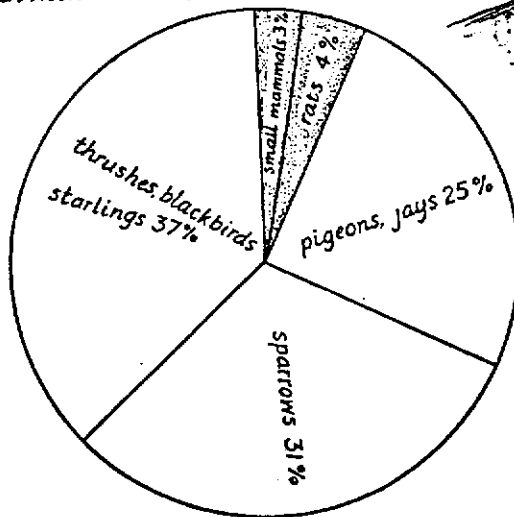
As the number of rodents increases, so do the barn owls. When there is a famine many owls have to disperse



Proportions of food taken by tawny owl in rural area on the outskirts of London



Proportions of food taken by tawny owl in Holland Park, London



WHAT HAWKS EAT

FERRUGINOUS ROUGH-LEG



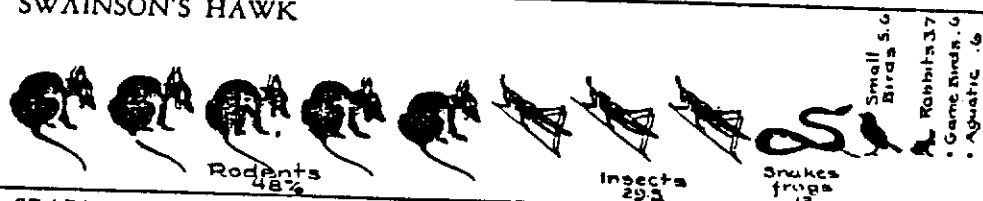
AMERICAN ROUGH-LEG



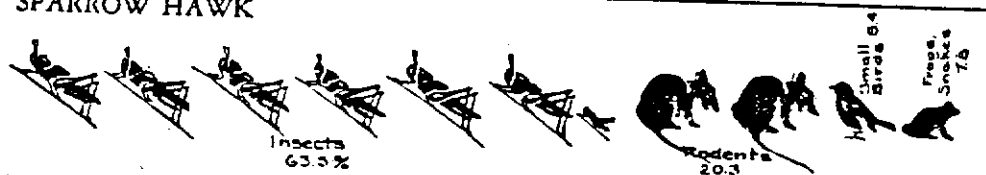
WESTERN RED-TAIL



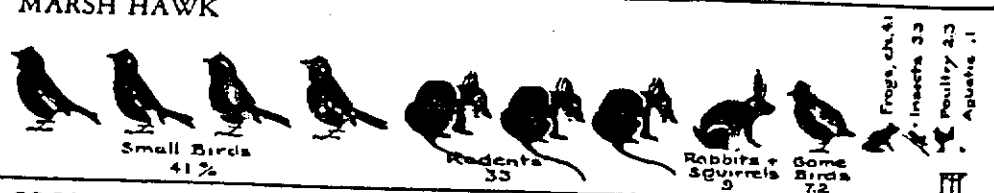
SWAINSON'S HAWK



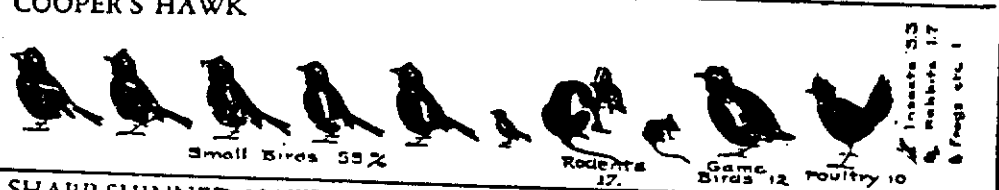
SPARROW HAWK



MARSH HAWK



COOPER'S HAWK

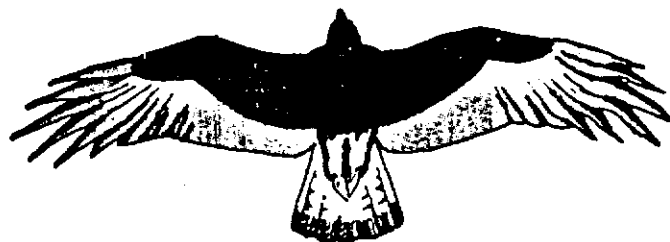


SHARP-SHINNED HAWK

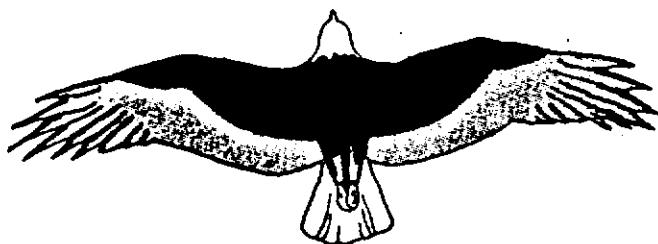




ADULT GOLDEN EAGLE



JUVENILE GOLDEN EAGLE



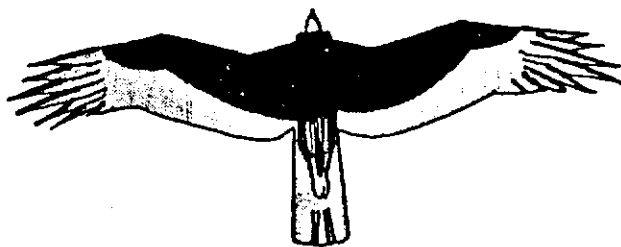
ADULT BALD EAGLE



JUVENILE BALD EAGLE

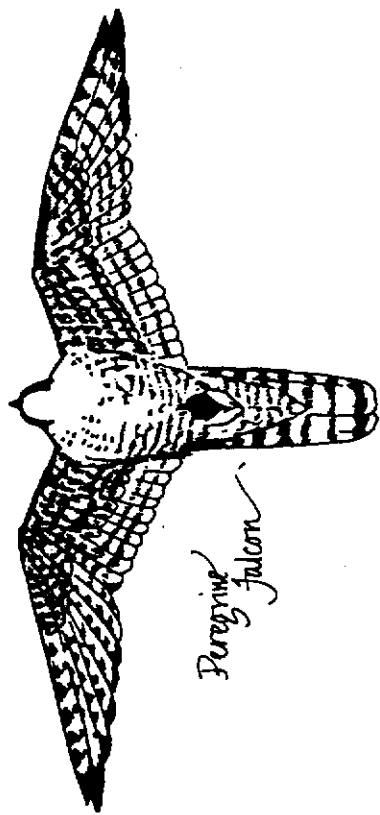


BLACK VULTURE

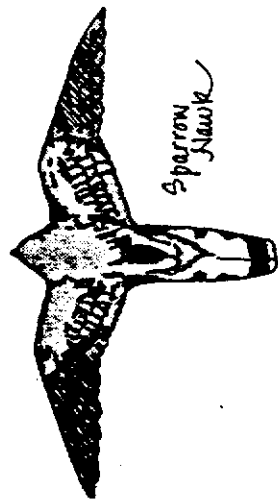


TURKEY VULTURE

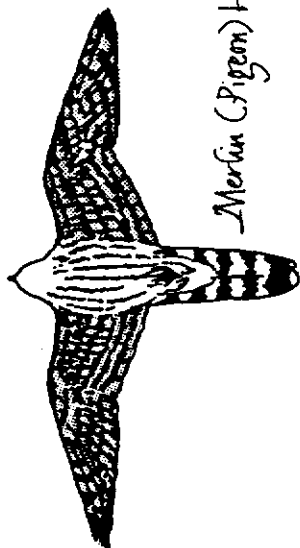
Flight silhouettes of the golden eagle (*Aquila chrysaetos*), the bald eagle (*Haliaeetus leucocephalus*), the black vulture (*Coragyps atratus*), and the turkey vulture (*Cathartes aura*).



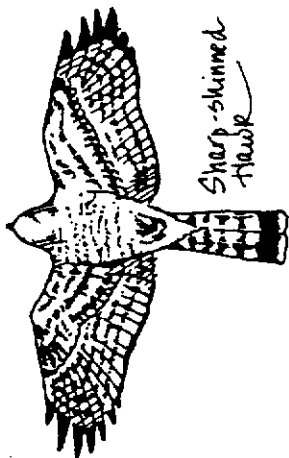
Peregrine Falcon



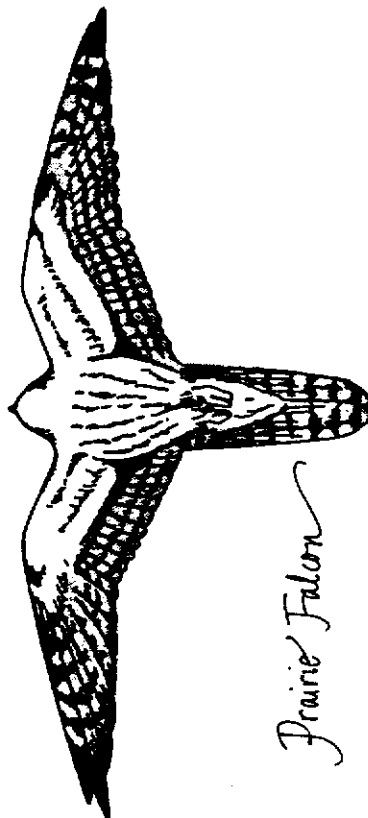
Sparrow Hawk



Merlin (Pigeon) Hawk



Sharp-shinned Hawk

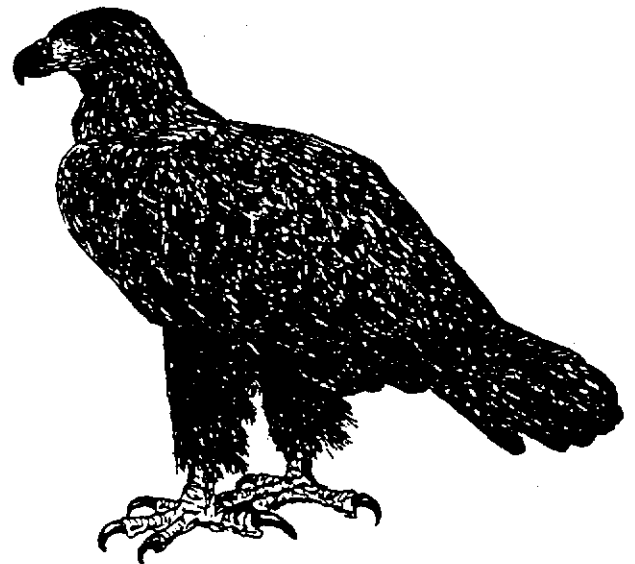


Prairie Falcon

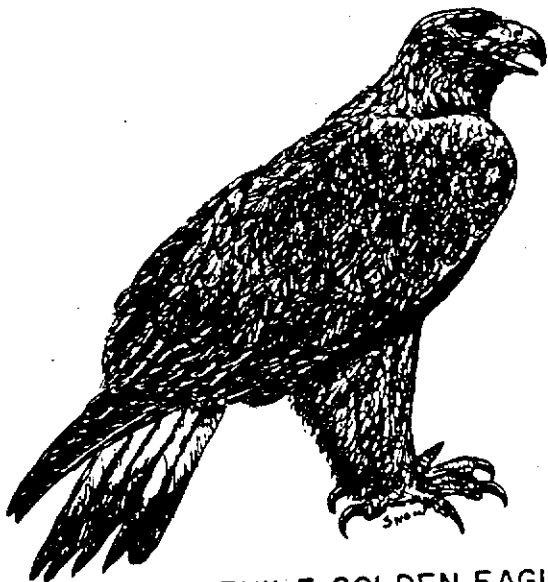
Figure 2: Flight Silhouettes



ADULT GOLDEN EAGLE

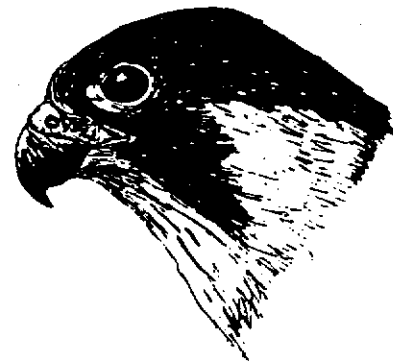
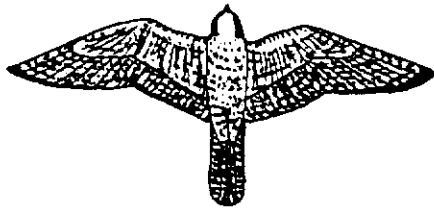


JUVENILE BALD EAGLE

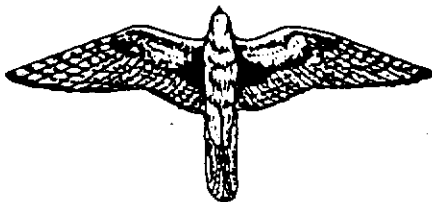


JUVENILE GOLDEN EAGLE

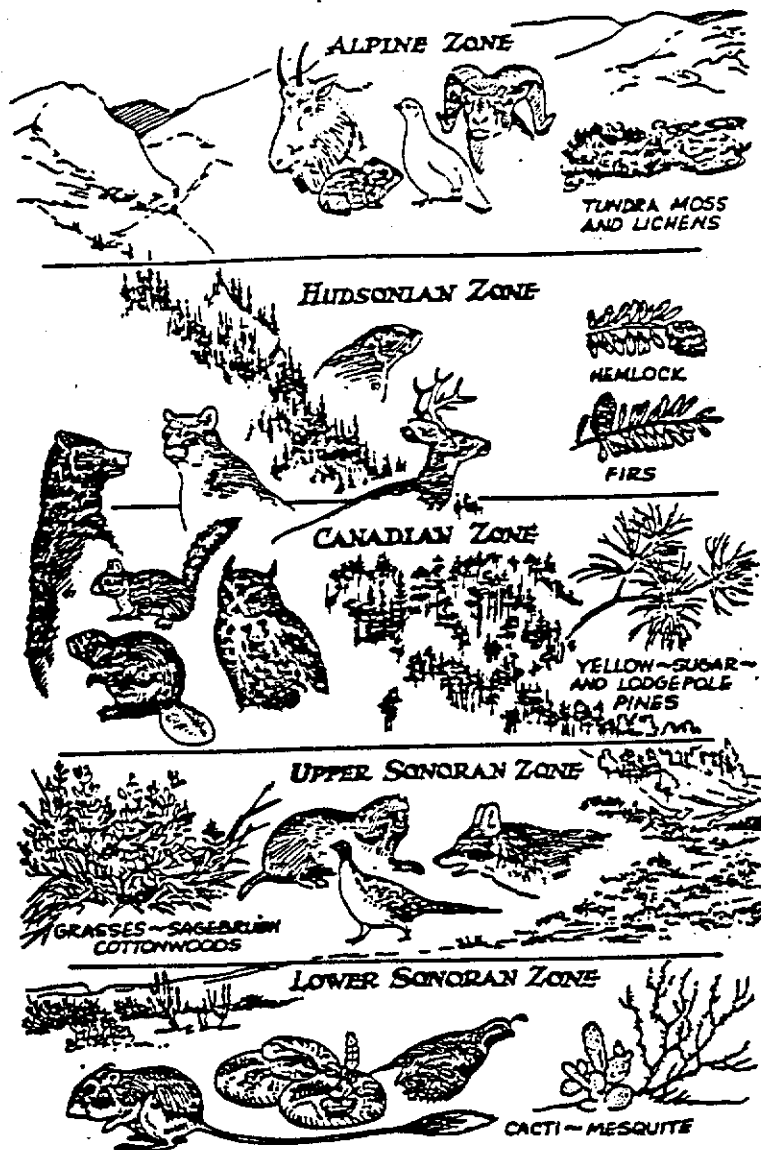
Figure 2. Adult and juvenile golden eagle (*Aquila chrysaetos*) and a juvenile bald eagle (*Haliaeetus leucocephalus*).



peregrine falcon



prairie falcon



LIFE ZONES

First proposed by C. Hart Merriam in 1894 as a method to predict the distribution of plant and animal species. Now disproven for the most part, but applies to areas of the west and southwest United States.

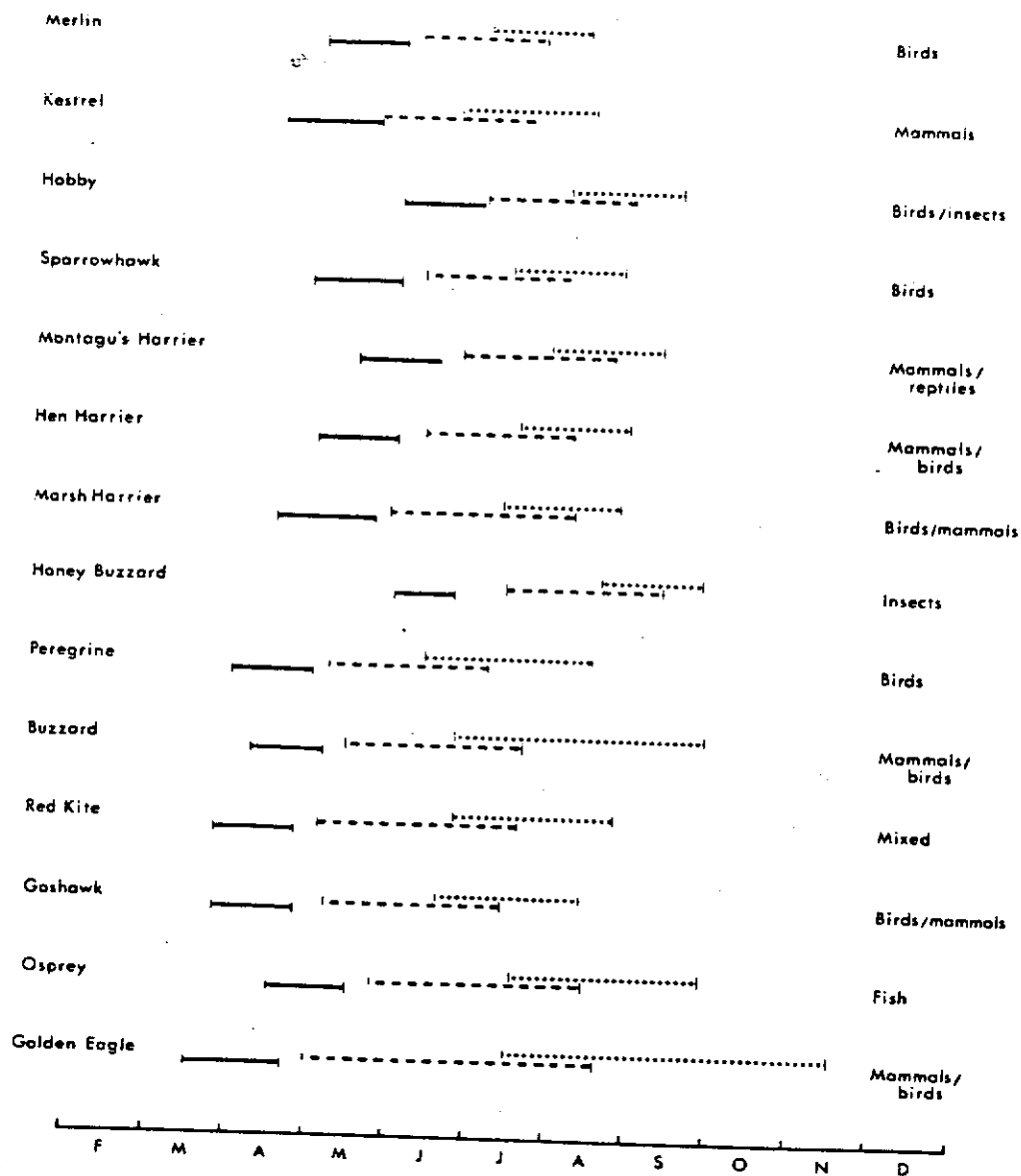
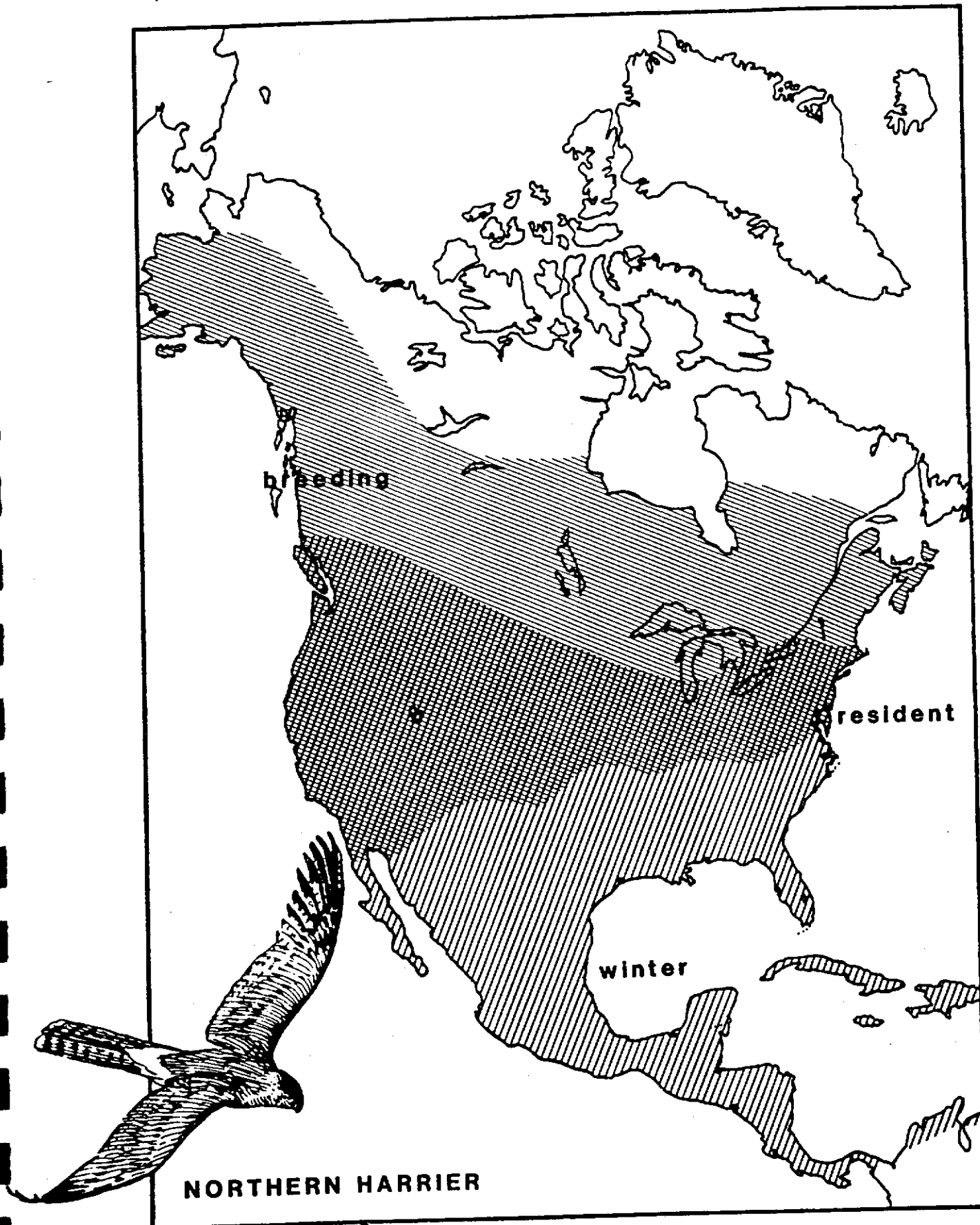
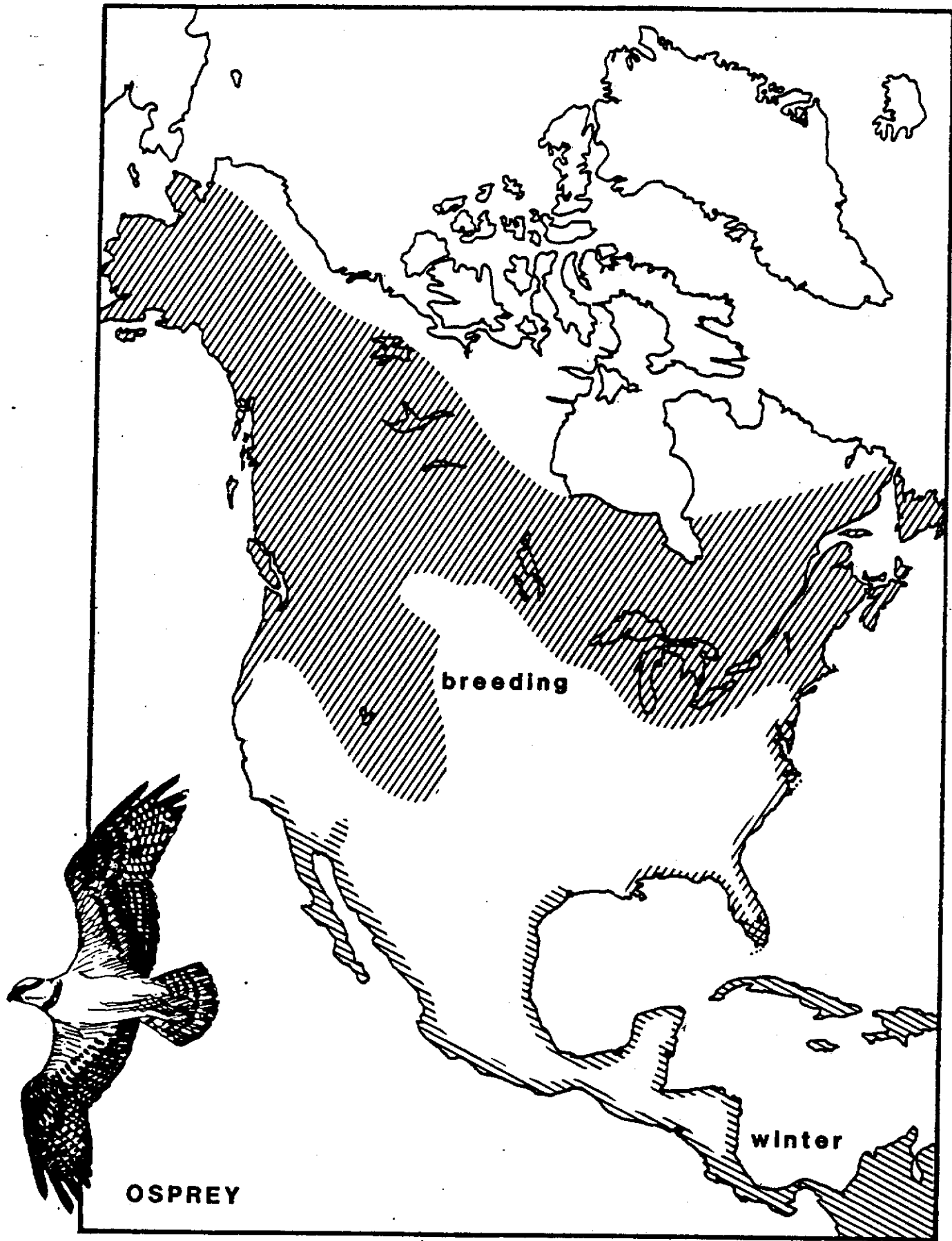


Figure 13. Breeding seasons of raptors in Britain. Species are arranged approximately in order of body-size, and for each species, the lower continuous line shows the period when clutches are started, the middle broken line shows the period when young are in nests, and the upper dotted line shows the period when flying young are fed by parents. The main trend is for large species to begin earlier and have longer breeding seasons than smaller ones, but among species of similar size, timing is also related to diet, shown on the right.







ROUGH-LEGGED HAWK

A. Eyes directed forward, large head with facial disk formed by feathers. -Order Strigiformes (Owls). (See figure 1.)

1. Owl with white, heart shaped face and dark eyes. -Family Tytonidae Barn Owl.

1a. Lacking white, heart shaped face, all other owls. -Family Strigidae-2

2. Size small, wingspread not over 22 inches, length not over 11 inches. -3

3. With ear tufts. -4 (See figure 2.)

4. Eyes dark - Flammulated Owl.

4a. Eyes yellow - Screech Owl.

3a. Without ear tufts. -4 (See figure 3.)

4. Legs long, sparsely feathered, found in open country on or near ground -Burrowing Owl.

4a. Legs not long, well feathered, found in forests. -

5. Tail longer than folded wings, black patch on hind neck. -Pygmy Owl.

5a. Tail not longer than folded wings. - Saw-whet Owl.

2a. Size large, wingspread over 22 inches, length greater than 11 inches. -3

3. With conspicuous ear tufts. -4

4. Wingspread over 52 inches, ear tufts widely separated. - Great Horned Owl.

4a. Wingspread less than 40 inches, ear tufts not widely separated. - Long-eared Owl.

3a. Lacking conspicuous ear tufts. -4

4. Eyes yellow -5

5. Wingspread greater than 54 inches, length greater than 20 inches, color white. - Snowy Owl.

5a. Wingspread less than 42 inches, length less than 17 inches, color brown. - Short-eared Owl.

4a. Eyes dark, puffy round head, heavily barred and spotted underparts. - Spotted Owl.

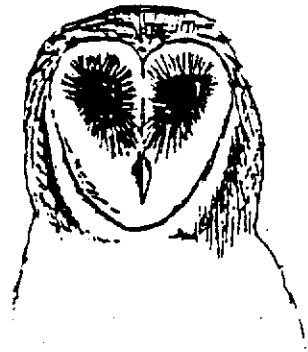


Figure 1



Figure 2

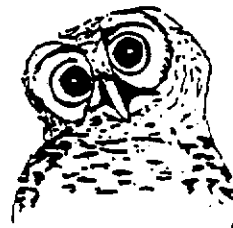


Figure 3



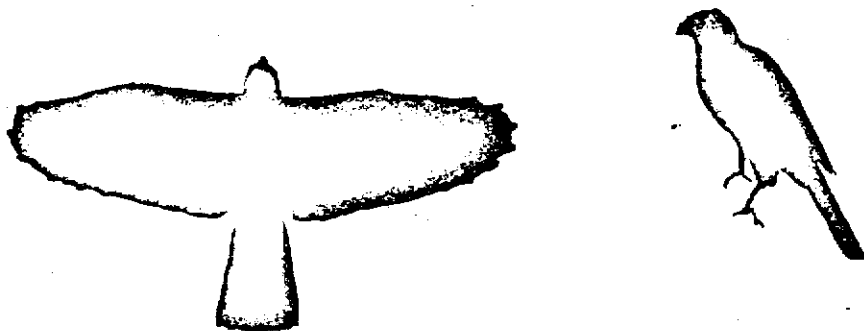
Figure 4



Figure 5

MAJOR GROUPS OF RAPTORS

ACCIPITERS



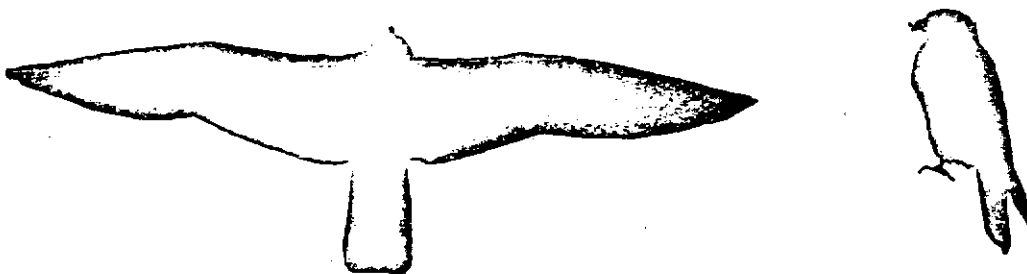
Small to large raptors with long tails and short, rounded wings which afford quick flight and high maneuverability adapting these birds to hunting in a forested habitat. Typical flight in the open is several short flaps and a sail. The long tail extends far beyond the folded wings in the sitting bird.

BUTEOS



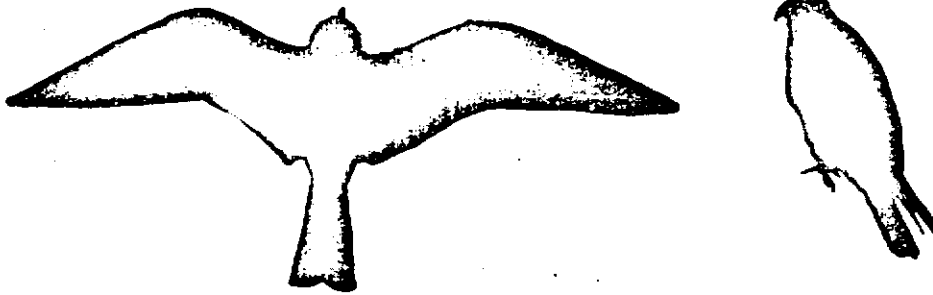
Medium to large raptors with broad wings, robust bodies and relatively short, wide rounded tails. These hawks typically hunt by soaring in wide circles high in the air or by sitting on a high perch. Buteo species range from forested habitats to open country.

FALCONS



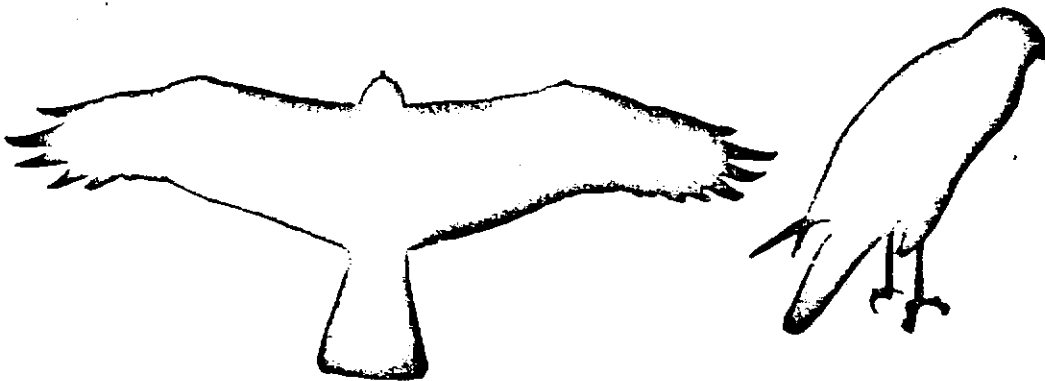
Small to medium sized raptors with long, pointed wings, large heads and long tails, Their streamlined appearance and rapid wingstrokes adapt these birds to pursuing prey in open to semi-open country. Kestrels also will hover when hunting.

KITES



Small raptors with long pointed or rounded wings, long tails and moderately sized heads (smaller than falcons). Kites are capable of graceful soaring as well as swift direct flight. While hunting, some kites hover in mid-air.

HARRIER



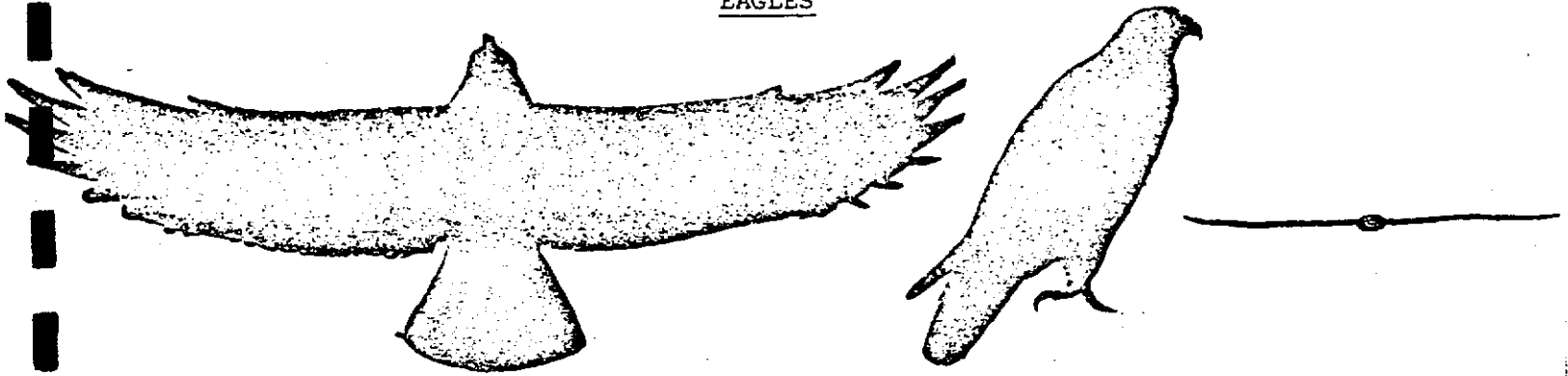
A medium sized raptor with long, rounded wings and long tail. Harriers hunt by low coursing back and forth over marshes or wet meadows. In their low buoyant flight, the wings are held high above the body as they move swiftly only 10-15 feet off the ground.

OSPREY



A large eagle-like raptor which frequents large bodies of water. Ospreys display a distinct crook in each wing which is discernable from great distances. Ospreys hunt water areas by slowly flapping, then hovering. Spectacular dives are made into the water in pursuing fish.

EAGLES



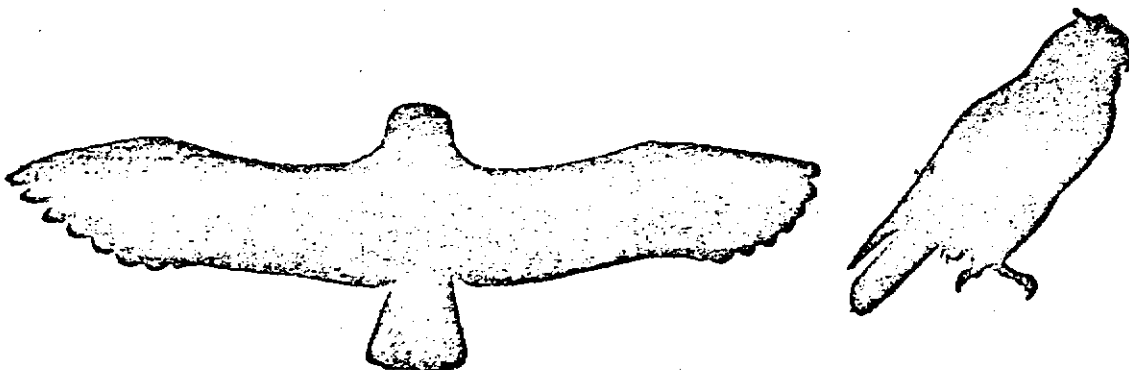
Very large soaring raptors with very long, broad wings. Both golden and bald eagles fly with their wings held horizontal which distinguishes them from ospreys and turkey vultures. Eagles have notably heavier bills than buteos.

VULTURES



Large, long-winged soaring raptors. The unfeathered heads of vultures give them a "headless" silhouette. While soaring, turkey vultures hold their wings above the body in a dihedral or "V" and rarely flap but rather tilt back and forth with the wind currents. Black vultures, however, hold their wings horizontal and flap rapidly and deeply three to six times, alternating this with soaring.

OWLS



Large headed, short necked, night active raptors. Owls have very large fixed eyes and striking facial "disks." Noiseless flight is characteristic to owls and aids them in securing prey at night.



