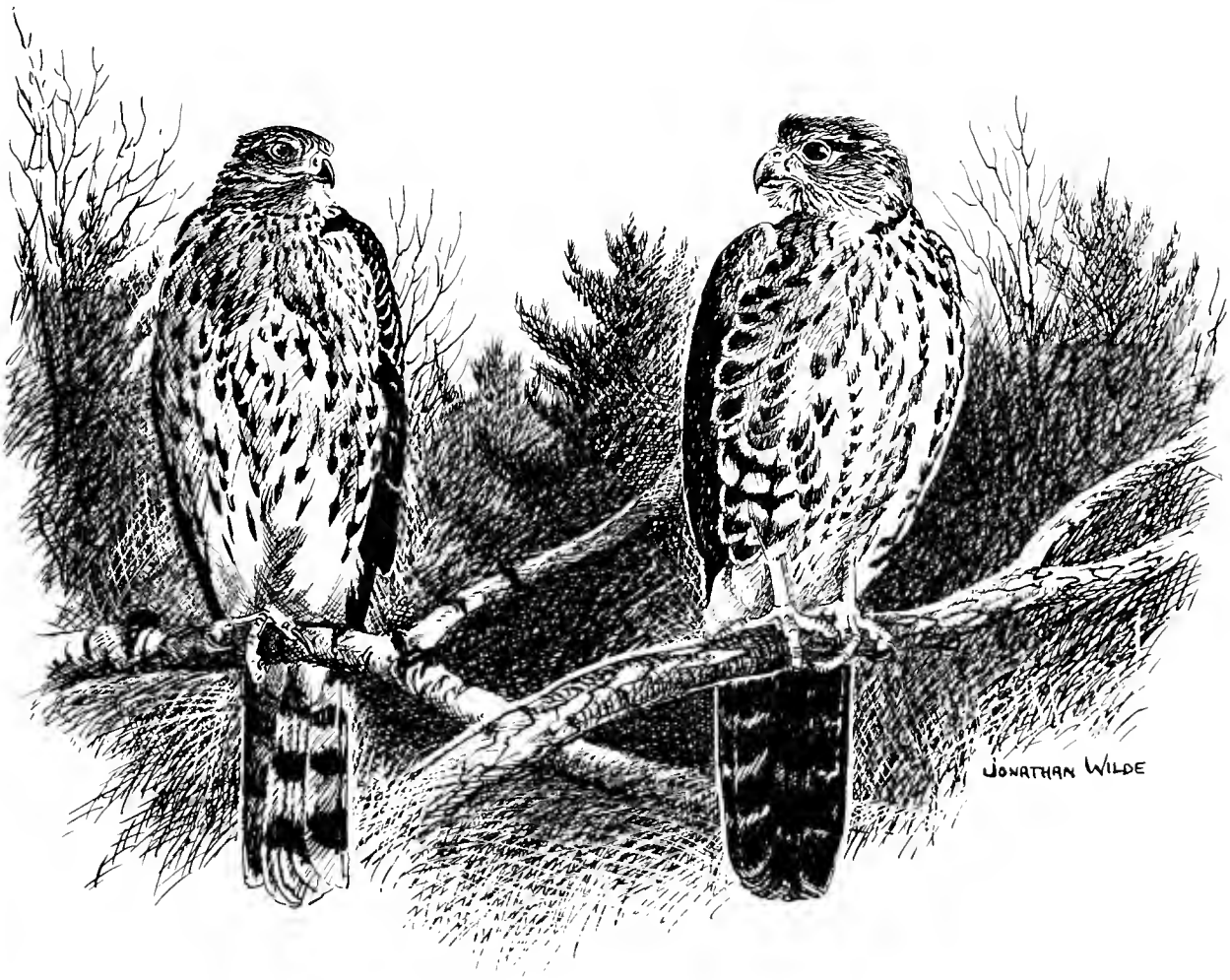
STATUS REPORTS ON TWELVE RAPTORS



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By David L. Evans

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Status Reports on Twelve Raptors

by

David L. Evans[1]

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

Abstract

This report presents the distribution, ecology, management, and status of 12 species of raptors, compiled largely from the literature, and an extensive bibliography on each species. Earlier declines in the bald eagle (*Haliaeetus leucocephalis*), Cooper's hawk (*Accipiter cooperi*), merlin (*Falco columbarius*), osprey (*Pandion haliaetus carolinensis*), peregrine falcon (*Falco peregrinus*), and the sharp-shinned hawk (*Accipiter striatus velox*) appear to have ended with restrictions on organochlorine biocide use, and most populations appear to be recovering. However, continued use of organochlorine biocides in South and Central America has the potential of negating this positive trend.

Depletion of fisheries due to acid rain may pose a future threat to bald eagle and osprey populations in some regions. Loss of essential habitat has affected declines in the caracara (*Caracara cheriway*) and western burrowing owl (*Athene cunicularia hypugaea*) and the disappearance of the northern aplomado falcon (*Falco femoralis septentrionalis*) from the southern United States. Most populations of the ferruginous hawk (*Buteo regalis*), marsh hawk (*Circus cyaneus hudsonius*), and prairie falcon (*Falco mexicanus*) appear stable; habitat loss is the most critical factor in population changes.

Introduction

This report presents a general overview of status, distribution, ecology, and management of 12 species of raptors suffering population declines or with inconclusive evidence concerning population changes. Establishing population estimates for raptors is difficult; logistical problems usually preclude efforts to assess reproduction and recruitment on a wide scale and the solitary nature of most raptor species defies adequate assessment of mortality rates. The bulk of present-day knowledge concerning population variables has come from intensive nesting studies on relatively small, often widely separated, areas. In a few species, concentrations of wintering birds offer additional insights into factors affecting population stability. For many species, migration counts at various migration concentration points provide the only economically feasible information available on population trends. Unfortunately, variation in weather patterns contributes to wide fluctuations in yearly counts and only long-term analyses may discern meaningful trends.

The following compilation, including selected references, is intended as a beginning reference point for those interested in raptor biology and may be of use to a diverse assortment of agencies in formulating policy decisions which may affect various facets of raptor ecology. The reports were compiled largely from the literature through mid-1977. Additional references were added, as available, through 1979. Emphasis was placed on North American studies; foreign references were included when pertinent. For purposes of brevity and conciseness, phrases or sentences with implied subjects rather than complete sentences are used in many of the descriptions. Scientific names for species are given on the following list. See Appendix for captive diet and development.

Common Name	Scientific Name
American kestrel	*Falco sparverius*
Arctic ground squirrel	*Spermophilus parryii*
Badger	*Taxidea taxus*
Barn owl	*Tyto alba*
Black-tailed jackrabbit	*Lepus californicus*
Bobcat	*Felis rufus*
Brown jay	*Psilorhinus morio*
Coyote	*Canis latrans*

[1]Present address: 2928 Greysolon Road, Duluth, Minnesota 55812.

Golden eagle	*Aquila chrysaetos*
Gopher turtle	*Gopherus polyphemus*
Great horned owl	*Bubo virginianus*
Horned lark	*Eremophila alpestris*
Kangaroo rat	*Dipodomys*
Northern pocket gopher	*Thomomys talpoides*
Opossum	*Didelphis marsupialis*
Prairie chicken	*Tympanuchus* spp.
Prairie dog	*Cynomys* spp.
Raccoon	*Procyon lotor*
Red fox	*Vulpes vulpes*
Red-tailed hawk	*Buteo jamaicensis*
Richardson's ground squirrel	*Spermophilus richardsonii*
Ringtail	*Bassariscus astutus*
Robin	*Turdus migratorius*
Rock dove	*Columba livia*
Rough-legged hawk	*Buteo lagopus*
Short-eared owl	*Asio flammeus*
Spruce budworm	*Choristoneura fumiferana*
Striped skunk	*Mephitis mephitis*
Swainson's hawk	*Buteo swainsoni*
Swift fox	*Vulpes velox*
Thirteen-lined ground squirrel	*Spermophilus tridecemlineatus*
Timber wolf	*Canis lupus lycaon*
Townsend's ground squirrel	*Spermophilus townsendii*
White-necked raven	*Corvus cryptoleucus*
White-tailed jackrabbit	*Lepus townsendii*

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Raptors

Bald Eagle (*Haliaeetus leucocephalus* Linnaeus)

Status: Endangered in the conterminous 48 States, except those populations in Washington, Oregon, Minnesota, Wisconsin, and Michigan where it is Threatened (U.S. Fish and Wildlife Service [USFWS] 1978). Primary threat is habitat loss; most populations appear to be recovering from earlier reproductive difficulties associated with organochlorine contamination.

Original Discovery and Description:

Southern bald eagle (*H. l. leucocephalus* Linnaeus).—*Falco leucocephalus* Linnaeus, Syst. Nat., ed. 12, vol. 1, 1766, p. 124. Based on The Bald Eagle *Aquila capite alba* Catesby, Carolina, vol. 1, p. 1 (in America, Europa = South Carolina). American Ornithologists' Union [AOU] 1957.

Northern bald eagle (*H. l. alascanus* Townsend).—*Haliaeetus leucocephalus alascanus*: C. H. Townsend, Proc. Biol. Soc. Washington, 11, no. 34, June 9, 1897, p. 145 (Unalaska, Aleutian Islands). AOU 1957; Mengel 1953.

Background: *H. l. alascanus* is identical in appearance and slightly larger than *H. l. leucocephalus*. Aspects of reproduction, other than chronological differences related to climate and respective latitude, are the same. Formerly, 40° N latitude was arbitrarily designated as dividing the breeding ranges of *alascanus* and *leucocephalus* (AOU 1957; USFWS 1976). Members of both subspecies wander freely into the other's breeding range during nonbreeding periods, resulting in considerable confusion in identification (Dunstan 1973; Postupalsky 1976*a*). As a result of these identification problems, a proposal was made to put the entire species (*Haliaeetus leucocephalus*) on the Endangered List (USFWS 1976). The proposal was finalized 14 February 1978 (USFWS 1978).

As the national emblem of the United States, the bald eagle plays an important part in the symbolism and culture of our nation. As a top predator in the food chain, it has suffered serious declines as a result of environmental pollution. It also has been extirpated from large portions of its historic range as a result of habitat loss and human encroachment.

Status Determination: The southern bald eagle was listed as Endangered by the U.S. Department of the Interior (USFWS 1973). The entire population of the bald eagle (*H. leucocephalus*) in the conterminous 48 States is now listed as Endangered, except for those populations in Washington, Oregon, Minnesota, Wisconsin, and Michigan which are listed as Threatened (USFWS 1978).

The southern bald eagle is listed as Endangered by the International Union for Conservation of Nature and Natural Resources (1966). Godfrey (1970) lists the northern bald eagle as Endangered in Canada.

Description: A large fish-eating eagle with long, broad wings and a large, strong bill. Adults are light to chocolate brown with white head and tail. Eyes, beak, legs, and feet are yellow. Tarsi are feathered half way to the feet. Immatures are brownish-black to light mottled tan with whitish underwing linings. Eyes are brownish and beak is black; legs and feet are dull yellow (Brown and Amadon 1968; Friedmann 1950).

Juvenile and subadult plumages exhibit considerable variation: relations between the various observed plumages and specific age classes are not precisely known. Generally the body becomes lighter colored with successive plumages until the fourth or fifth year, after which the typical adult plumage is attained (Southern 1964, 1967; Brown and Amadon 1968).

The large, bulky nests are unique and are used in locating bald eagle territories during air and ground searches (Mathisen 1968*c*).

See Bent (1937), Friedmann (1950), Brown and Amadon (1968), Snow (1973), or birding guides for characteristics for identification of parts or products.

Distribution:

Southern bald eagle.—Historically, this species bred from northern California south to both coasts of Baja California, central Arizona, New Mexico (formerly western Nevada and southern Utah), and from northern Texas, Oklahoma, Missouri (formerly Nebraska and Iowa), southern Illinois, western Kentucky, and Virginia south to the Gulf Coast and Florida. During the nonbreeding season (March–October) some birds wandered northward to northern Illinois, southern Michigan, New York, Connecticut, Maine, New Brunswick, Nova Scotia, Prince Edward Island, and southern Quebec (AOU 1957).

Florida remains the center of abundance with an estimated 250–300 pairs (USFWS 1973). There are a few nests in Louisiana and Texas, 30–50 pairs in California (Thelander 1973), and about 10–15 pairs in Arizona (Rubink and Podborny 1976). In 1973, a pair built a nest in Nebraska on the Missouri River, the first known nesting in the 1900's. The pair deserted before laying eggs (Lock and Schuckman 1973). See Tilt and Ruos (1976) for a more complete assessment of bald eagle distribution south of Canada.

Northern bald eagle.—Formerly bred from Bering Island, the Aleutian Islands, northwestern Alaska, Mackenzie, Manitoba, central Ontario, southeastern Quebec, Labrador, and coasts of Newfoundland south to southern Oregon, Idaho, Wyoming, Colorado, South Dakota, Minnesota, Wisconsin, Michigan, Ohio, Pennsylvania, New Jersey, and Maryland. Winters from Alaska, northern Mackenzie, southern Ontario, Quebec, and southern Nova Scotia south to the southern United States (AOU 1957; Dunstan 1973; Postupalsky 1976*a*). Although scattered reports of nesting bald eagles in the middle United States exist for the 1800's and early 1900's they are now gone and their relationship to *leucocephalus* and *alascanus* is unknown. As a result, 40° N latitude has been selected as an arbitrary dividing line between the two subspecies (AOU 1957; USFWS 1976). Considering the lack of readily apparent differences between the two subspecies, even this may be superfluous (Brown and Amadon 1968:289).

Centers of abundance remain in Maine, the Chesapeake Bay area, Upper Peninsula of Michigan, northern Wisconsin, and Minnesota, northern Idaho, Oregon, Washington, and Alaska, Saskatchewan, Manitoba, and northern Ontario (Sprunt et al. 1973). Habitat loss, human disturbance, and environmental contaminants have been instrumental in declines in these areas. See Tilt and Ruos (1976) for a more complete assessment of bald eagle distribution south of Canada.

Habitat: Bald eagle habitat is closely associated with relatively large bodies of water which provide an abundant source of food, primarily fish.

In Alaska and Canada, where human disturbance is slight, bald eagle habitat is composed of a narrow strip of land along lakeshores and rivers which provide trees for nesting, fishing, and loafing (Hensel and Troyer 1964; Robards and King 1966; King et al. 1972; Gerrard et al. 1975). Human disturbance, and to some extent habitat loss, appear to be responsible for the considerable decrease in shoreline nesting observed in more populated areas (Whitfield et al. 1974). The mean distance of bald eagle nests from water was 201 m in Canada (Gerrard et al. 1975) and 329 m in Alaska (Corr 1974); nests in Florida averaged 1.06 km from water, apparently in response to human disturbance (McEwan and Hirth 1979).

Winter habitat of the bald eagle is less closely associated with water than summer habitat. Although most wintering eagles depend primarily on fish, a considerably wider prey base is utilized, including jack rabbits, crippled waterfowl, and carrion. Major concentrations of wintering bald eagles occur near wildlife refuges, dams, and other areas with open water (Spencer 1976). About half of the bald eagles wintering in the conterminous States occur in the Mississippi, Missouri, Wisconsin, Platte, and Arkansas river valleys (Steenhof 1978). Recent work in the western United States, including the Great Plains, indicates a considerable number of wintering eagles there (Edwards 1969; Platt 1976; Spencer 1976). Communal roosting is prevalent in wintering bald eagles; roosts are selected primarily for protection from the wind (Steenhof 1978) and may be as far as 25 km from feeding areas (Swisher 1964).

Decreasing numbers of large nesting trees in suitable nesting areas and areas that are not disturbed by human

activities during the early stages of nesting appear to be the most critical aspect of habitat loss. Recreational use of lakes and extensive shoreline development have reduced feeding habitat. Acid rain threatens to reduce lake fisheries. Lakes with high sensitivity to acid rain are generally found in northern California, Oregon, Washington, northern Idaho, Montana, northeastern Minnesota, northern Wisconsin and Michigan, and east of the Appalachians (U.S. Environmental Protection Agency 1979).

Feeding Habits: Bald eagles are primarily fish eaters; however, they are opportunistic and will utilize avian and mammalian prey and carrion if readily available, especially in the nonbreeding season (Herrick 1934; Bent 1937; Murie 1940; Broley 1952; Tate and Postupalsky 1965; Southern 1966; Retfalvi 1970; Hehnke 1973; Dunstan and Harper 1975; Ofelt 1975). In some coastal areas, birds and reptiles form an important part of the diet (Ogden 1975; personal observation in Maine).

The birds usually hunt from perches adjacent to water but they also hunt while in flight. Live, dying, or dead fish are taken from the water with the feet or from shallow water with the beak and carried to the nest or a feeding perch. Fish or other prey too heavy to lift are dragged to shore with a heavy rowing motion of the wings (Campbell 1969; Edscorn 1973). Occasionally fish are purloined from hapless ospreys or other fish-eating birds (Brown and Amadon 1968; Grubb 1971; Ogden 1975).

The diet varies considerably with geographic area and season. Wintering northern bald eagles utilize a much wider prey base (Southern 1963, 1964; Platt 1976; Spencer 1976). Little is known about food habits of nonbreeding southern bald eagles.

In captive breeding experiments whole fish and a variety of whole animals (e.g., chickens, rats, mice) were fed; a diet partially consisting of a commercial food (Zupreem and Nebraska Brand Birds of Prey Diet) has been used during the nonbreeding season (Maestrelli and Wiemeyer 1975; see Appendix).

Reproduction and Development: Eagle nests are characteristically large, ranging from a minimum of 1 m in width and depth to 5 m deep and 3 m across; size and shape are determined partly by the supporting branches. Nests are usually in live trees, the species depending on its propensity for large, strong branches or forks for nest support, and height above the canopy (Mathisen 1969*a*; Frenzel et al. *in* Madsen 1973; Gerrard et al. 1975). In the Aleutians, coastal areas, Arizona, and other regions where suitable nest trees are scarce, nests are placed on ridges, cliffs, and on seastacks (Troyer and Hensel 1965; Sherrod and White 1975; Rubink and Podborny 1976). Ground-nesting has been recorded on an island near Yellowknife, Northwest Territories (Bromley and Trauger 1974).

Initiation of egg-laying appears to vary with temperature, which in turn generally varies with latitude, beginning as early as November and continuing through mid-January in Florida (Broley 1947). In Arizona incubation was first observed on 14 February (Rubink and Podborny 1976). In Wisconsin, the earliest estimated egg-laying occurred in late February; most clutches are completed by 1 April (C. R. Sindelar, Jr., personal communication). The Aleutians and Pacific Coast are warmed by the Davidson and "Japanese" currents (Nelson and Myres 1975) and breeding is initiated considerably earlier than at corresponding latitudes in the interior (Retfalvi 1965; Sherrod and White 1975).

Bald eagles engage in courtship flights consisting of the pair soaring together for long periods of time at great heights. Occasionally they will lock talons and somersault downward several hundred feet (Brown and Amadon 1968). Two or three eggs are typically laid, although four-egg clutches have been recorded (Herrick 1932). Incubation lasts about 35 days (Herrick 1934).

Newly hatched young are covered with white or gray down which is replaced by thicker gray down at 2–3 weeks; first feathers appear at 4–5 weeks. Fledging occurs at 10–12 weeks and the young are dependent upon the parents for several more weeks (Brown and Amadon 1968). Frenzel (*in* Madsen 1973:29) stated that about 80% of fledgling eagles in their Minnesota study spent some time on the ground before becoming proficient at flying. They appeared to be fed normally by the parents even though they were on the ground.

Bald eagles are believed to reach sexual maturity at 5 or 6 years of age (Sherrod et al. 1976). Little is known about longevity and length of sexual activity; however, a dead bald eagle was recently recovered on an island in western Lake Erie that was 27 years old. (L. Van Camp, personal communication). Captive bald eagles have reached 50 years of age (Snow 1973). Sherrod et al. (1976) estimated adult mortality at 5.4% per year and a collective mortality of subadult birds before breeding age to be 90% or more on Amchitka Island, Alaska.

Diseases and Parasites: A variety of diseases and parasites have been reported in the bald eagle, including avian cholera (Locke et al. 1972; Rosen 1972), aspergillosis (Coon and Locke 1968), and an enteric bacterial pathogen, *Edwardsiella tarda* (White et al. 1973), infestations of helminth parasites (Kocan and Locke 1974), and others (Coon et al. 1970). None occur frequently nor are considered limiting factors.

Predators and Other Mortality Factors: Occasionally raccoons, bobcats, crows, and under unusual circumstances gulls, prey on eggs and small young, forcing the adults away from the nest (see Fyfe and Olendorff 1976).

Severe weather may have serious effects on reproduction. The Florida hurricane in October 1944 resulted in widespread nesting failures in the subsequent breeding season (Broley 1947). Severe storms, especially in the

North, may result in temporary nest abandonment, causing destruction of eggs or young.

Persistent pesticides also lower productivity. The relation between organochlorines (notably DDE) and eggshell thinning is now well established (Hickey and Anderson 1968; Hickey 1969; Krantz et al. 1970; Wiemeyer et al. 1972). DDE interferes with normal calcium metabolism, resulting in thin-shelled eggs which cannot withstand normal incubation. Populations reaching 17–20% eggshell thinning exhibit severe reproductive difficulties and resulting declines (Anderson and Hickey 1972). Dieldrin, PCB's, and mercury have been linked to embryonic and early chick mortality (Anonymous 1970; Wiemeyer et al. 1972). High concentrations of dieldrin and DDT are known to result in outright deaths of bald eagles (Chura and Stewart 1967). Of 153 eagles analyzed between 1964 and 1970 almost 10% of the deaths were attributed to dieldrin poisoning (Belisle et al. 1972).

Illegal shooting remains the greatest single known source of bald eagle mortality. Roughly half of all recorded bald eagle deaths are a direct result of shooting. Other causes of mortality include impact injuries (usually with powerlines or towers), electrocution, trapping injuries (eagles caught in "sight bait" sets for furbearers), automobile or train accidents, and poisoning from contaminated coyotes or other carcasses (Coon et al. 1970; Mulhern et al. 1970; Belisle et al. 1972; Sprunt 1972).

Population Level:

Southern bald eagle. – Reduced populations in Florida due to loss of habitat and effects of DDE. Current reproduction appears adequate for maintenance of the remaining population, although productivity in southern Florida is lower than in central and northern Florida (Nesbitt et al. 1975). Populations on the Georgia-Carolina coast, Gulf Coast, Arizona, and lower California have decreased significantly and are suffering low reproductivity (Tilt and Ruos 1976).

Northern bald eagle. – Alaskan populations, estimated at 35,000 to 40,000 nesting pairs, appear to be doing well. In the conterminous 48 States, substantial reduction of populations occurred before 1950, primarily due to human disturbance and habitat loss. Since then, pesticide contamination has further reduced populations, especially those in coastal areas and on the Great Lakes shores. Populations nesting on interior lakes west of Lake Erie appear to be reproducing at an adequate rate and may be increasing slowly (Postupalsky 1978*b*; C. R. Sindelar, personal communication). Populations east of western Lake Erie are experiencing poor reproduction, especially in northern Ohio. Maine appears to have very poor reproduction as a result of spruce budworm control programs and is currently one of the most endangered populations. However, reproduction in 1976 showed a slight upturn (Tilt and Ruos 1976).

Thaeker (1971) estimated that over 130 bald eagles are held for research purposes and by zoos. Captive propagation at the Patuxent Wildlife Research Center, Laurel, Maryland, resulted in 12 young raised from 1973 to 1977 plus 1 young raised from three captive-produced eggs placed in eagle nests in the wild in 1977. It appears technically possible to augment wild populations with captive-produced offspring (Maestrelli and Wiemeyer 1975; S. Wiemeyer, personal communication).

Reasons for Current Status: Conversion of habitat to agricultural and industrial uses, habitat loss from logging, recreational utilization of lakes and lakeshores and concomitant human disturbance have effected a slow, long-term decline that began not long after the arrival of white men on the continent. These declines were probably accelerated in the late 1800's and early 1900's during the heyday of lumbering. Recent emphasis on recreational development represents an increasing threat to bald eagle habitat (Sprunt 1969; Weekes 1975*a*).

Illegal shooting remains the single most frequent cause of death of recovered bald eagles even though they are completely protected by the Bald Eagle Protection Act (16 USC 668–668d). Habitat protective provisions were extended to the northern bald eagle upon enactment of the proposal to place the entire species on the Endangered List.

Recent large-scale declines in reproduction have resulted from biocide pollutants, notably DDE. The most vulnerable populations are those nesting on the shores of the Great Lakes and in the northeastern United States. All populations, except in Alaska, appear to have suffered declines from environmental contaminants; the magnitude in any one area appears to be relative to the contaminant level in that area. The Florida population appears to be midway in the spectrum of productivity of bald eagles, whereas Wisconsin interior lakes and Alaska are among the highest and Maine and the Great Lakes shores are the lowest (Sprunt et al. 1973).

Recovery Team: Information concerning recovery teams and recovery plans in progress may be obtained from the Office of Endangered Species, U.S. Fish and Wildlife Service, 1000 Glebe Road, Arlington, VA 22203.

Management Activities: Specific habitat management plans are being used on U.S. Forest Service lands and by various States. Cooperative agreements with landowners of nesting territories are being implemented by the Florida Audubon Society and in Wisconsin and Maine (USFWS 1973; Madsen 1973; U.S. Forest Service Manual, Title 2600, Wildlife Management).

Modification of powerlines to substantially decrease electrocution is being carried out, especially in the western States where electrocution is a greater mortality factor than in the East (Marshall 1940; U.S. Department of Agriculture 1972; Miller et al. 1975).

Cooperative efforts between Federal, State, and private individuals are under way to assess yearly produc-

tion and status of bald eagles. Additional studies are being done on food habits, post-fledgling movements, and wintering (see bibliography for specific studies). The National Wildlife Federation is compiling a bald eagle data bank on research efforts around the country.

Bald eagles are protected by the Bald Eagle Protection Act of 1940 and by the Endangered Species Act of 1973. Public information programs, notably a promotional public relations program sponsored by the Chippewa National Forest (Minnesota) and Hunt & Wesson Foods to buy bald eagle habitat, have been very successful (Mathisen *in* Madsen 1973:43–44). Eagle Valley Environmentalists, P.O. Box 155, Apple River, Illinois 61001, sponsor an annual meeting of bald eagle researchers and the public. Topics cover a wide range of bald eagle biology and focus on winter ecology.

Migration counts are maintained at various hawkwatches around the country (see Newsletter of Hawk Migration Association of North America). The Raptor Information Center of the National Wildlife Federation conducts an annual midwinter bald eagle census in cooperation with the U.S. Fish and Wildlife Service.

From 1977 through 1979, 18 captive-produced young from the Patuxent Wildlife Research Center fledged in the wild, introduced by a variety of techniques including transplanting young to active nests and hacking young at artificial platforms. Eggs suspected of being thin-shelled were collected during these operations and were incubated at Patuxent; four hatched and the young were returned to active nests in the wild (S. N. Wiemeyer, personal communication). New York has been foremost in reintroduction research involving hacking young at artificial sites. Since 1976, all 15 young released fledged successfully and several birds returned to the area in subsequent years (P. Nye, personal communication).

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Burrowing Owl (*Athene cunicularia* Molina)

Status:

Western burrowing owl. – Severe declines, especially those populations dependent upon prairie dogs and other persecuted small mammals for nesting burrows.

Florida burrowing owl. – Increasing.

Original Discovery and Description:

Western burrowing owl (*Athene cunicularia hypugaea* Bonaparte). – *Strix hypugaea* Bonaparte, Am. Ornithol. vol. 1, 1825, p. 72 (note). (Western United States – Plains of the Platte River.) American Ornithologists' Union 1957.

Florida burrowing owl (*Athene cunicularia floridana* Ridgway). – *Speotyto cunicularia* var. *floridana* Ridgway, Am. Sportsman, 4, no. 14 (n.s. no. 40), July 4, 1874, p. 216. (16 miles east of Sarasota Bay, Manatee County, Florida.) AOU 1957.

Background: Although the Florida burrowing owl and the western burrowing owl are somewhat similar in appearance, the wide separation of their ranges makes confusion unlikely. In 1976, the burrowing owl was placed in the genus *Athene* (AOU 1976). It formerly was placed in a separate genus *Speotyto*.

The burrowing owl is a small diurnal, crepuscular, and noeturnal owl, unique in its underground semicolonial nesting behavior.

Status Determination: Listed as "Status – Undetermined" by the U.S. Fish and Wildlife Service (1973). Has been on the Blue List, an "early warning" list of species exhibiting potentially serious declines, since 1971 (see December issues of American Birds, 1971 to present).

Description: A small owl with relatively long legs and a short stubby tail. Adults are brown above with buff to buffy white spots, underparts buffy barred narrowly with dark brown. Juveniles are similar to adults, unstreaked to moderately streaked and light to brownish buff below, and have a wing stripe (buffy as opposed to the brown middle secondary coverts of adults). Adult plumage is attained in August or September. Florida burrowing owls tend to be darker in color overall than the western burrowing owl (W. D. Courser, personal communication).

Burrowing owls are somewhat atypical among raptors in that they do not exhibit reverse size dimorphism; males

average slightly larger than females. Identification of sex of adults is usually possible during the breeding season. Males have less barring on the breast and usually have faded plumage from being in the sun more than the incubating females; males are light gray-brown and females darker chocolate brown. Plumage color differences disappear after the postnuptial molt in late summer. Behavioral differences (i.e., female remaining very close to the nest burrow and males conspicuously hunting and providing food) aid sexing of breeding pairs. Solitary owls are often difficult to sex (Butts 1973; Thomsen 1971).

The presence of debris, cow or horse dung, droppings, molted feathers, and owl pellets containing primarily insect remains at the mouth of a burrow indicate nesting activity (Butts 1973). In urban situations, grass divots and other material replace dung as nesting material.

See Bent (1938), Grossman and Hamlet (1964), and birding guides for characteristics for identification of parts of products.

Distribution: Breeds in prairie regions west of a line from northwestern Louisiana north to western Manitoba. Winters in the southern parts of its range south to western Panama (Butts 1973; AOU 1957). The Florida burrowing owl is resident, occupying the prairies of central and southern Florida; the prehistoric range, however, was apparently somewhat greater (Ligon 1963; AOU 1957).

Range discontinuities probably have been widened by extensive prairie dog extermination on the Great Plains (Butts 1973). The population in Florida expanded as land was cleared for the cattle industry (Ligon 1963); burrowing owls are now within 48 km of the Georgia border and are breeding on the Florida Keys (Courser 1976*a*, 1979).

Habitat: Burrowing owls inhabit non-forested plains, grasslands, and deserts (Butts 1973). Urban environments meeting habitat requirements may be utilized (Thomsen 1971; Coulombe 1971). They are largely "dependent upon various digging mammals for nesting burrows" (Thomsen 1971) in the West.

Burrows play a dominant role in the ecology of the burrowing owl. In addition to nesting, they are used throughout the year for roosting and escape. Burrows of prairie dogs, various species of ground squirrels and kangaroo rats (depending on local abundance), and, occasionally, abandoned burrows of badger, coyote, and swift fox may be used. Digging of their own burrows appears to be infrequent in the West (Butts 1973; Thomsen 1971; Martin 1973*b*). In Florida up to 60% of the burrows are dug by the owls; gopher turtle holes are the other main source of burrows used (W. D. Courser, personal communicaton). Burrows utilized by owls are invariably in areas of short vegetation (Butts 1973; Thomsen 1971). Nesting burrows typically slant downward at a 15° angle and usually have a turn within 1 m (Butts 1973).

When the young owlets (about 2 weeks old) come to the mouth of the burrow they use nearby auxiliary burrows and usually use two or three different burrows in succession before they fledge. After fledging they occupy individual burrows at random in the vicinity. Owls in the northern parts of their winter range are primarily nocturnal, as opposed to diurnal and crepuscular in the summer, and spend the daytime in burrows (Butts 1976). In Florida and the southern parts of the winter range, owls can usually be seen during the daytime (W. D. Courser, personal communication).

Critical Habitat: Poisoning of prairie dog towns, with which colonies of western burrowing owls are often associated, substantially reduces burrowing owl populations. Burrow habitat in abandoned prairie dog towns becomes unsuitable for burrowing owls within 1–3 years (Butts 1973).

Feeding Habits: Feeds primarily on arthropods and small mammals. Small reptiles, amphibians, and birds are infrequent in the diet. Invertebrate forms, when available, are most frequently taken, although in some areas the diet appears to be more varied (Longhurst 1942; Best 1969; Coulombe 1971; Thomsen 1971; Butts 1973; Smith and Murphy 1973*b*; W. D. Courser, personal communication).

Ground foraging, in a manner similar to robins, occurs most frequently. Foraging from observation perches and from a hovering position also occurs extensively. Flycatching behavior has been noted infrequently (Thomsen 1971; Butts 1973). W. D. Courser (personal communication) observed owls feeding on insects attracted to lighted areas.

In the summer arthropods are very prominent in the diet. Small mammals are eaten more frequently in the winter in the United States. In the summer, burrowing owls are primarily diurnal but become essentially nocturnal in the winter months (Butts 1973). Owls wintering in central America are likely to have arthropod prey available and may retain diurnal feeding schedules.

Reproduction and Development: Courtship and pair formation occur in March and April in most areas (Grant 1965; Best 1969; Butts 1973) but may begin as early as late December in California (Thomsen 1971) and Florida (W. D. Courser, personal communication). Burrow selection occurs primarily at dusk and during the night (Thomsen 1971). Nesting material, consisting primarily of organic debris and dried manure of cattle, horse, or other species, is carried to the burrow entrance; litter is often used as nesting material in areas of human inhabitation (W. D. Courser, personal communication). Dirt and debris are scraped out of the burrow with the feet; occasionally the beak and wings are also used. The tunnel is usually 18–22 cm wide by 15–19 cm high with a larger nest chamber at the end. Owl-dug burrows in Florida are 15–20 cm wide by 10–13 cm high (W. D. Courser, personal communication). When the nesting burrow has

been suitably modified, the nesting material is distributed throughout the burrow (Walker 1952; Thomsen 1971; Butts 1973).

Pair formation is initiated by unpaired males (Thomsen 1971). Paired birds engage in ritualistic behavior, displaying white facial and throat patches, leading to copulation, which occurs most frequently at dusk and after dark (Martin 1973*b*; W. D. Courser, personal communication). Nest site selection begins after pair formation; the males gather and distribute most of the nesting material. Average clutch size is 6.48 for both subspecies (Murray 1976). One brood is raised per year; renesting will occur if the clutch is destroyed early in incubation. Incubation, which lasts 28–29 days, is done entirely by the female (Coulombe 1971; Thomsen 1971). The male provides all food during incubation and the early nestling stage. The female assists in foraging when the young reach 3–4 weeks of age (Martin 1973*b*). Most feeding occurs at dawn and dusk, continuing until midnight (Grant 1965, Thomsen 1971; W. D. Courser, personal communication).

When hatched, the young are covered with white, fuzzy down. They begin feathering out at 2 weeks, when they are also first observed at the burrow entrance. The young run and forage by 4 weeks of age and are capable of sustained flight by 6 weeks (Butts 1973). Owl families often switch burrows every 10–15 days when the young are 3–4 weeks old (Butts 1973) and remain as a loose-knit group until early fall when the young begin to disperse to nearby burrows (Thomsen 1971).

Burrowing owls begin breeding when 1 year old (Thomsen 1971; K. O. Butts, personal communication). Life span is uncertain; the oldest recorded age is 8 years and 8 months (Kennard 1975).

Diseases and Parasites: Fleas, lice, and ants are occasionally found on birds or in burrows; related mortality appears to be insignificant (Thomsen 1971). Examination of about 30 birds failed to reveal any indication of blood parasites (see Greiner and Kocan 1977; W. D. Courser, personal communication).

Predators and Other Mortality Factors: Badgers, coyotes, domestic dogs and cats, snakes, and bobcats are the most important predators of eggs and young owlets (Butts 1973; Martin 1973*b*). Older nestlings and adults may be taken by large raptors (Martin 1973*b*).

Shooting and roadway mortality are most important for owls over seven weeks old (Butts 1973). Food may be a limiting factor during brood rearing (Thomsen 1971; Butts 1973). Because of the relatively low position of the burrowing owl on the food chain, pesticide-related reproductive difficulties are probably insignificant. Poison-related deaths, especially in areas of prairie dog extermination, may be an important mortality factor (Butts 1973). Nesting failure may be caused by flash flooding, burrow destruction by agricultural operations, and fumigation and sealing of the burrow (Butts 1973). Persecution by ranchers has been a problem in Florida (Nicholson 1954).

Population Level: Estimates of the current burrowing owl population are lacking, other than on relatively restricted study areas (Coulombe 1971; Thomsen 1971; Butts 1973). Substantial declines have coincided with extensive extermination of burrowing rodents, especially prairie dogs, with which burrowing owls are intimately associated (Butts 1973). In areas where burrowing owls are associated with less persecuted species, they do not appear to be declining (Thomsen 1971). The Florida population is expanding in conjunction with land cleared for the cattle industry and is roughly estimated at about 1,000 pairs (W. D. Courser, personal communication).

Thacker (1971) estimated roughly 77 burrowing owls held by zoos or for research.

Reasons for Current Status: The primary factor attributable to burrowing owl declines is the widespread elimination of burrowing rodents, notably prairie dogs and various species of ground squirrels. As an example, prairie dog towns in Oklahoma declined from millions of acres in historic times to just 9,522 acres in 1968. Prairie dog towns poisoned during Butts' (1973) study showed an essentially complete elimination of burrowing owls, as burrows became unsuitable for owls within 1–3 years even in the absence of cultivation.

Illegal shooting may be responsible for substantial mortality in some areas, accounting for 10 of 15 deaths in one study (Butts 1973). Other studies, however, did not mention shooting as a source of mortality (Coulombe 1971; Thomsen 1971; Martin 1973*b*).

Management Activities: Butts (1973) suggests establishing "refuge" prairie dog towns in areas where poisoning is widespread, and limiting poisoning operations with treated grain to January and February (in areas where most owls migrate from the breeding range).

Collins and Landry (1977) described artificial nesting burrows that were widely accepted. This new technique may prove valuable for preservation and rehabilitation of existing range, and possibly for reintroduction to former range.

Burrowing owls are protected by the United States–Mexico Migratory Bird Treaty of 10 March 1972.

Little emphasis is placed on breeding burrowing owls at this time.

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Caracara (*Caracara cheriway* Jacquin)

Status: Peripheral—Rare; declines in the United States are thought to be related to habitat loss.

Original Discovery and Description: *Caracara cheriway audubonii: Polyborus audubonii* Cassin, Proc. Acad. Nat.

Sci. Philadelphia, 17, no. 1., Jan.–Mar. (Aug. 7), 1865, p. 2 (Florida). American Ornithologists' Union 1957. Listed as *Polyborus plancus* in Brown and Amadon (1968) and as *Polyborus cheriway audubonii* in Friedmann (1950).

Background: The caracara is a specialized carrion-eating hawk of open or semi-open country and spends much of its time on the ground scavenging. Its distribution is limited to the extreme southern United States, continuing south through Mexico, where it becomes common. It is the national bird of Mexico and is called the Mexican eagle there (Brown and Amadon 1968). The Guadalupe caracara (*Caracara lutosa*) inhabited Guadalupe Island and Baja California. Now extinct; was last reported in 1903 (AOU 1957, 1973).

Status Determination: Listed as Status Undetermined by the U.S. Fish and Wildlife Service (1973). Has been on the Blue List, an "early warning" list of species exhibiting potentially serious declines, since 1971 (see December issues of American Birds, 1971 to present).

C. c. audubonii in Florida is listed as threatened by the Florida Commission on Rare and Endangered Plants and Animals and the Florida Game and Fresh Water Fish Commission.

Description: A large caracara with a crest, elongate neck, large hooked beak, and long legs. Sides of head and chin bare with scattered bristles. Bill is whitish becoming bluish at the base. Eyes are brown. Wingspread is about 120 cm (Brown and Amadon 1968). Adults are blackish on the crown, wings, lower back, and upper abdomen. The lower part of the head, throat, lower abdomen, and under tail coverts are white, sometimes tinged with yellow; breast and upper back whitish, heavily barred with black. Tail is white with narrow dark bars and a broad subterminal band. Prominent white wing patches are revealed in flight. Facial skin is reddish, and turns yellow when excited. Legs are yellow (Layne 1976). Color pattern of juveniles is similar, but is brownish and buffy; the breast and upper back are streaked instead of barred. Facial skin is pinkish, turning gray when excited. Legs are gray (Layne 1976).

Wing chord of males 360–382 mm, tail 186–203 mm; wing chord of females 382–400 mm, tail 202–228 mm (Oberholser 1974).

See Friedmann (1950), Brown and Amadon (1968), Oberholser (1974), and birding guides for charaeteristics for identification of parts or products.

Distribution: Baja California, southern Arizona, New Mexico, and Texas south through Mexico. Central Florida south to Cuba and the Isle of Pines (AOU 1957).

Arizona.—Resident in small numbers on the Papago Indian Reservation, casual east to Santa Cruz Valley, west to Gila Bend and extreme southeastern Yuma County. Old records extend to Santa Cruz and Salt River valleys, Oracle, and Yuma (Phillips et al. 1964).

New Mexico.—Extremely rare in New Mexico. Periodic presence may be confined to the Rio Grande Valley, also has occurred in southwestern New Mexico (Ligon 1961).

Texas.—Fairly common to uncommon in south Texas brush country and on coast north to about 29°N; uncommon to scarce and somewhat irregular in central portions from San Antonio and Gonzales north to Waco and Navarro County, scarce and irregular northwest to Johnson County and on the upper coast. Formerly bred on Edwards Plateau, eastern Concho County. May have bred in Brewster County, 10 miles north of Terlingua. Wanders northward irregularly to Coleman, Baylor, and Grayson counties; casual straggler to northern Panhandle and eastern Trans Pecos (Oberholser 1974).

Louisiana.—Decidedly rare permanent resident, one or two pairs nesting in Cameron Parish, where the majority of sightings have been reported (Lowery 1974).

Florida.—The bulk of the population is in the south-central prairie region. Casual records in recent years from as far north as Alachum (Gainesville), Duval (Jacksonville), and Nassau (Fernondiva) counties and as far south as the lower Florida keys (Monroe County). Preliminary analysis of a survey covering 1973–76 gives a minimum estimate of the population of about 350–400 individuals (J. N. Layne, personal communication).

Habitat: The caracara inhabits arid prairies and grasslands, and open desert brushland, usually at lower elevations (Brown and Amadon 1968; Oberholser 1974).

Caracaras are known to nest in clumps of live oak, cacti, and in cabbage palms in Florida (Brown and Amadon 1968). Porter and White (1977) reported that declines may be related to clearing of chaparral brushlands.

Little is known, but there appear to be no major seasonal or stage of life cycle differences in habitat use (Brown and Amadon 1968; Oberholser 1974).

Critical Habitat: Declines in some areas are thought to be assoeiated with habitat loss resulting from clearing of chaparral brushlands (Porter and White 1977).

Feeding Habits: The caracara is both a scavenger and a predator. It spends much time on the ground searching for insects, grubs, and worms, and pursues reptiles, amphibians, birds, and small mammals. Also robs bird nests and may force other birds (raptors, gulls, pelicans) to give up their food. Often feeds on carrion, although it is thought to be more interested in the associated insect larvae (Glazener 1964; Grossman and Hamlet 1964; Brown and Amadon 1968; Batten 1969; Oberholser 1974).

Flies at moderate altitude searching for carrion or prey. Also flies close to the ground, similar to marsh hawks. Spends much time on the ground searching for

prey (Oberholser 1974).

Larger groups of up to 10 birds are seen in the nonbreeding season. This may be associated with carrion feeding habits (Oberholser 1974).

Reproduction and Development: Caracaras typically begin breeding in December to February in Florida and slightly later in the western United States (Brown and Amadon 1968; Batten 1969). Nests have been found in cabbage palms in Texas (Smith 1910) and in Florida (Brown and Amadon 1968), elsewhere in low bushes or trees 1.5–15.3 m high (Oberholser 1974). The nest, which is often reused, is made of sticks and sometimes lined with dry dung, trash, or pieces of hide or bone (Brown and Amadon 1968; Batten 1969).

Little is known about courtship behavior. Batten (1969) stated that they utter a cackling call during the breeding season during which the head is thrown back, nearly touching the shoulders. Males sometimes fight in the air (Brown and Amadon 1968). Two or three eggs, rarely four, are laid. Both parents take part in incubation, which is about 30 days (Layne 1976). There is some evidence that two broods are occasionally raised (Brown and Amadon 1968). The fledgling period lasts about 2 months, during which the young are fed primarily fresh meat by both parents (Brown and Amadon 1968; Batten 1969).

Brown and Amadon (1968:133) reported a caracara in captivity over 30 years old.

Predators and Other Mortality Factors: Detailed studies on natural predators are lacking. Pesticide contamination is not known to be a factor; food habits of caracaras do not indicate that they would be affected by organochlorine-induced eggshell thinning. In some livestock-producing areas in South America, caracaras attack young lambs and are severely persecuted (Grossman and Hamlet 1964). Layne (1976) also reported persecution of caracaras in Florida for supposed predation of young livestock. In earlier years, large numbers of caracaras were apparently destroyed in vulture trapping operations in Florida (Layne 1976).

Population Level:

Arizona.—Probably never was common (Phillips et al. 1964). Nested in small numbers on the Papago Indian Reservation, where the last known nesting records for Arizona occurred in 1960 (Levy 1961; Porter and White 1977).

New Mexico.—Extremely rare. One known nesting occurred in 1953, in the Rio Grande Valley at Bellen, south of Albuquerque (Ligon 1961).

Texas.—Fairly common to uncommon in the south Texas brush country. Populations appear to have declined substantially in the last two decades. On the Welder Wildlife Refuge breeding pairs have declined from 35 in the 1950's to 1 or 2 pairs in 1978 (Porter and White 1977). The largest annual Christmas Bird Counts in Texas averaged 28.6 in the 1950's, 7.8 in the 1960's (Oberholser 1974), and 6.5 from 1970 to 1975 (Christmas Bird Count, American Birds—April issues).

Louisiana.—Always has been very rare (Lowery 1974).

Florida.—Available evidence indicates a long-term decline. Heinzman (1970) estimated 100 birds remaining. J. N. Layne (personal communication), in a more extensive survey, estimated 350–400 remaining.

Thacker (1971) estimated 55 caracaras held in zoos. Breeding has been attempted in zoos (recorded in International Zoo Yearbook 15:333) but breeding potential is unknown.

Reasons for Current Status: Habitat loss is thought to be the major factor in caracara declines in the western United States (Porter and White 1977) and in Florida (Layne 1976).

In some areas of South America shooting takes a considerable number; the extinction of the Guadalupe caracara was caused primarily by shooting. This does not appear to be a major factor in U.S. declines, although Layne (1976) reported some persecution in Florida.

Vulture trapping in Florida may have contributed to the decline of caracaras. Highway mortality may also be a factor. Predator control operations (poison baits) in the West may also contribute to mortality (Layne, personal communication).

Management Activities: The Florida Environmental Endangered Lands Program recently acquired an extensive parcel of land in Osceola County, Florida, citing preservation of caracara habitat as one of the reasons for its acquisition.

A. R. Phillips, Apartodo Postal 370, San Nicholas de los Garza, Nuevo Leon, Mexico, is studying caracara populations in Mexico. J. N. Layne, Archbold Biological Station, Route 2, Box 180, Lake Placid, Florida 33852, is studying the population in Florida.

Caracara are protected under the United States–Mexico Migratory Bird Treaty of 10 March 1972.

Caracaras are monitored by Christmas Bird Counts, Texas wildlife refuges (Welder Wildlife Refuge, Laguna Atascosa National Wildlife Refuge), Archbold Biological Station, Lake Placid, Florida, and roadside wading bird and raptor counts in south-central Florida.

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Cooper's Hawk
(*Accipiter cooperi* Bonaparte)

Status: Has suffered severe declines in all areas except the western United States. Primary threats include use of organochlorine biocides in Central and South America, which results in contamination of prey species, and habitat loss.

Original Discovery and Description: *Falco Cooperii* Bonaparte, Am. Ornithol., vol. 2, 1828, p. 1, plate 10, fig. 1 (near Bordentown, New Jersey). American Ornithologists' Union 1957.

Background: No close relatives occur in North America; the Cooper's hawk is easily confused with the sharp-shinned hawk which, although smaller, is very similar in appearance. Immature plumages of Cooper's hawk and the goshawk are also very similar (Wattel 1973; Brown and Amadon 1968).

Medium-sized woodland hawk preying chiefly on medium-sized birds and small diurnal mammals. Considerable declines occurring in recent years are attributed to organochlorine pesticides (Snyder et al. 1973).

Status Determination: Has been on the Blue List, an "early warning" list of species exhibiting potentially serious declines, since 1971 (see December issues of American Birds, 1971 to present).

Description: A medium-sized accipiter, characterized by long legs, long tail, and short rounded wings. Adults dark bluish gray above, underparts white, broadly barred with rufous or cinnamon, usually more rufous on the flanks. Tail relatively long and crossed with three or four dark bands. Legs and feet yellow, claws and beak black. Females slightly browner above. Iris yellow-orange to deep red. Juveniles brownish above, underparts cream with dark brown streaks on the breast and variously patterned on thighs and abdomen. Iris pale yellow; tail, legs, and feet same as adult. Adult plumage attained when 1 year old (Henny and Wight 1972).

Cooper's hawks exhibit considerable sexual dimorphism; females average 1.5–1.6 times heavier than males. Iris color becomes progressively redder with age: pale yellow in the first year, yellowish orange to reddish orange in the second, and deep red by the third or fourth year. Eyes of males appear to change faster and also attain darker red color than females. Variation in intensity and rate of color change precludes establishing precise relations between age and eye color (Snyder and Snyder 1974*a*; Roberts 1967).

Breeding Cooper's hawks characteristically use "plucking posts" ("butcher block"), where they deplume and

partially dismember prey before taking it to the nest. These areas, with feathers and other body parts strewn about, are a good indication of nearby nesting activity (Brown and Amadon 1968).

See Friedmann (1950), Brown and Amadon (1968), Wattel (1973), and birding guides for characteristics for identification of parts and products.

Distribution: Breeds in southern Canada and the United States south to Mexico. Winters in central and southern United States south to Costa Rica (AOU 1957).

Habitat: Inhabits various types of mixed and deciduous forest and open woodland including small woodlots, riparian woodlands in dry country, open arid pinon woodland, and forested mountainous regions.

Not as restricted to conifer habitat as the sharp-shinned hawk; often nests in deciduous forest. Nests are usually near natural or man-made clearings (Meng 1951; Hennessey 1978) and in proximity to water (Hennessey 1978; Reynolds 1978). In Oregon, Cooper's hawks nested in 50- to 80-year-old, dense, even-aged conifer stands (Reynolds 1978).

During migration and in winter Cooper's hawk occurs in almost any type of habitat containing trees or shrubs.

Feeding Habits: Feeds primarily on medium-sized birds such as thrushes, jays, starlings, and quail. Smaller birds and larger birds up to the size of adult ruffed grouse are also taken. Takes more non-avian prey than the sharp-shinned hawk, including mammals up to the size of rabbits and occasionally reptiles and amphibians. In the eastern United States, the diet consists of 82% birds and 18% mammals (Meng 1959; Storer 1966; Wattel 1973), whereas in the Southwest up to half the diet is small mammals and lizards (Snyder et al. 1973). Mean weight of prey was calculated as 37.6 and 50.7 g for males and females, respectively (Storer 1966).

Typically accipitrine, Cooper's hawk still hunts from inconspicuous perches and takes its prey by surprise; characteristic searching flights utilize available cover for concealment. Occasionally it pursues animals on the ground, running with considerable speed.

Reproduction and Development: Nesting begins in early to late spring depending on latitude and, to some extent, weather. The nest site is selected by the male which does most of the building. The nest is constructed of sticks and twigs and is lined with flakes of bark (Meng 1951).

Little is known about mate selection; however, courtship behavior (the male flying around the female with outspread under tail coverts) has been observed (Mockford 1951). Copulation occurs several times a day during nest-building and egg-laying. From three to five eggs are usually laid; there is some evidence that clutch size is a function of habitat quality (Snyder and Snyder 1973). Average clutch size in the eastern United States is 4.18, with no apparent change from pre-pesticide times (Henny and Wight 1972). Eggs are incubated for 35–36 days (Meng 1951; Brown and Amadon 1968), primarily by the female. The male provides all the food and incubates for short periods while the female is eating until the young are 2–3 weeks old.

The young are covered with white down when hatched and begin feathering out at 2–3 weeks of age. The male provides most of the food for the first 2 weeks, bringing the prey almost completely plucked (Meng 1951). The female feeds and broods the young. For a typical nest containing four young, the adults brought an average of 6.3 prey animals per day to the nest for 6 weeks (Meng 1951). Fledging occurs at about 27–30 days for males and 30–34 days for females; young are dependent on the parents for as long as 7 weeks (R. T. Reynolds, personal communication), often returning to the nest for feeding (Meng 1951).

Cooper's hawks usually attain sexual maturity at 2 years of age. However, nesting of 1-year-old birds has been recorded (Meng 1951; Hemphill 1966); Henny and Wight (1972) estimate that 19% of 1-year-old Cooper's hawks attempt to breed. The life-span of Cooper's hawks is unknown. Although Meng (1951) estimates that 20 years may be attained, the maximum recorded life-span in the wild is 8 years (Henny and Wight 1972).

Henny and Wight (1972) estimated immature mortality to be 82.5% and the average annual adult mortality to be 44.0% for the period 1925–40. From 1941 to 1947 they estimated immature and annual adult mortality to be 77.8 and 34.0%, respectively.

Diseases and Parasites: The most frequently encountered parasites are the nest screwworm fly (Calliphoridae), louse fly (Hippoboscidae), and the chewing bird louse (Mallophaga); mortality from any of these is very rare. Diseases include trichomoniasis, coccidiosis, and aspergillosis. None appear to be limiting factors (Meng 1951).

Predators and Other Mortality Factors: Predation is limited largely to the nesting season; adults may be taken by other raptors or large mammals under unusual circumstances. Raccoon predation may be frequent in some areas, causing up to 50% nesting failure (Meng 1951). Crows, jays, and other typical nest predators will eat eggs if the adults are forced away from the nest. Great horned owls may prey on nestlings and recently fledged young; however, Cooper's hawks will renest if eggs are destroyed early in incubation.

Severe weather may affect Cooper's hawks. Schriver (1969) attributed declines in western Pennsylvania to severe winter weather in early 1960. Persistent organochlorine pesticides cause eggshell thinning as well as outright death of young (Snyder et al. 1973). Populations reaching 15–17% shell thinning have serious reproductive difficulties (Hickey and Anderson 1968). The effects of persistent pesticides are magnified in the longer food

chains. Therefore, raptors feeding on birds or fish are more affected than those feeding on small mammals, which, in general, have relatively short food chains (cf. Snyder et al. 1973). PCB's and heavy metals (mercury, lead) may also contribute to embryonic and early nestling mortality. Shooting pressure appears to have declined slowly since 1940 (Henny and Wight 1972).

Population Level: Cooper's hawk suffered severe declines in all parts of its range except the western regions. In the northeastern United States, Peterson (1969) estimated that the population was less than 10% of its former migration count numbers. Hackman and Henny (1971), observing fall migration trends, reported annual declines of 13% between 1951 and 1961 at White Marsh, Maryland. Robbins (1974) reported similar declines from all fall migration indices and all but western Christmas Bird Counts. Henny and Wight (1972), using reproductive data and mortality rates derived from banding records, estimated an annual rate of decline of 13.5% between 1941 and 1945. Before that, substantially greater shooting pressure resulted in even greater rates of decline. After 1948, concomitant with widespread use of DDT and a 24.4% drop in the reproductive rate, annual declines reached 25% (Henny and Wight 1972). Even this may be a gross underestimate as nest failures were apparently not considered (cf. Postupalsky 1974:138). Since 1968, reproduction in the northeastern United States has approached that of pre-DDT levels (Braun et al. 1977). In the Southwest, Cooper's hawk population appeared to be stable up to 1971 (Snyder et al. 1973). There the diet is only 50% birds, resulting in less pesticide contamination. DDE residues in eggs collected in Arizona, New Mexico, and Oregon are considerably less than in eggs from Pennsylvania and New York (Snyder et al. 1973). Reproduction appeared normal in the coast range of California and Mexico from 1971–1975 (Walton 1975).

Thacker (1971) estimated seven Cooper's hawks held in zoos. An additional number, probably less than 100, are held for falconry purposes. Robert Ulbricht (personal communication), Hudson, Wisconsin, has successfully bred Cooper's hawks.

Reasons for Current Status: Intensive forest management, particularly in western coniferous forests, results in large blocks of monotypic habitat, thus reducing potential and active nest sites as well as substantial reduction of prey species (R. T. Reynolds, personal communication).

Where the species is much reduced, falconers may have a negative effect; some States (e.g., Wisconsin) have banned the taking of Cooper's hawks for falconry purposes.

Nest predation by raccoons may contribute to reduced productivity. In New York, almost half the nests observed failed because of raccoon predation (Meng 1951). Raccoon guards placed on nest trees (Meng 1951) and precautions taken during nesting studies (Fyfe and Olendorff 1976) greatly decreased raccoon predation.

Illegal shooting was primarily responsible for early declines. Cooper's hawk was particularly persecuted because of its depredations on poultry. Henny and Wight (1972) estimated that shooting mortality of first-year birds was 28–47% for 1929–40, 15–24% for 1941–45, and 12–21% for 1946–57. With recent improvements in legislation, law enforcement, increasing public awareness, and changes in human activities and poultry management, current illegal shooting mortality is probably somewhat less than the estimates for 1946–57.

Organochlorine pesticides, notably DDE, are primarily responsible for the accelerated declines observed since 1947. Henny and Wight (1972) estimated that the annual rate of decline increased from 13.5 to 25% after the introduction and widespread use of DDT. Egg breakage in Arizona and New Mexico, where the population appears stable, occurred in at least 11 and possibly 15 of 60 clutches; DDE concentrations ranged from 1.86 μg/mL (12.1 ppm dry weight) in fertile eggs to 6.05 μg/mL (59.0 ppm dry weight) for broken eggs and were correlated with eggshell thinning of 3.0 and 15.7%, respectively (Snyder et al. 1973). Eggs from Pennsylvania and New York carried considerably higher DDE levels ranging from 6.12 to 9.17 μg/mL. It appears that DDE levels above 3–4 μg/mL results in frequent egg breakage and serious declines in productivity (Snyder et al. 1973).

Management Activities: Protection includes elimination of hawk shooting at migration concentration points, and public awareness campaigns by Audubon Society, private individuals, and law enforcement officials. Cooper's hawks are protected under the United States–Mexico Migratory Bird Treaty of 10 March 1972.

Cooper's hawks are monitored by autumn hawk counts; the Hawk Migration Association of North America (HMANA) is establishing standard procedures of observation and reporting at the various hawkwatches in the United States (J. HMANA 1(1):1-2).

Cooper's hawks have been successfully bred in captivity.

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Ferruginous Hawk (*Buteo regalis* Gray)

Status: Stable or declining slowly; habitat loss poses a serious threat. Wide fluctuations in productivity associated with cyclic prey species.

Original Discovery and Description: *Archibuteo regalis* G. R. Gray, Gen. Birds. Vol. 1, pt. 1, May 1844, plate vi (no locality given = Real del Monte, Hidalgo, Mexico). American Ornithologists' Union 1957.

Background: No close relatives occur in North America. The ferruginous hawk is the largest of the North American buteos. It occupies a relatively restricted range in the arid western plains region.

Status Determination: Status Undetermined (U.S. Fish and Wildlife Service 1973). Endangered in Oregon (Oregon State University Agricultural Experiment Station 1969). On the Blue List, an "early warning" list of species exhibiting potentially serious declines, since 1971 (see December issue of American Birds 1971 to present).

Description: The largest of the North American buteos, with broad rounded wings; commonly observed soaring. Adults are brownish above with cinnamon rufous feather edgings. Whitish below except for the thighs which are rusty-brown with heavy black barring. The tail is whitish to silvery, sometimes with cinnamon or reddish coloration near the end. Eyes are brown and legs and feet are yellow.

Juveniles are similar to the adults, with some spotting on the breast and flanks. Thighs are whitish with black spotting. Tail is whitish at the base and brownish-gray with several indistinct dark bars on the remaining portion. Eyes, legs, and feet are yellow. The dark, or mela-

nistic, color phase is characterized by dark brown plumage underneath as well as above. The tail and wings are the same as in the light phase, which is usually more common (Brown and Amadon 1968).

Ferruginous hawks are sexually dimorphic; females average 1.3 times heavier than males. Howard (1975) presented data, utilizing weight and measurements of the flexed hallux of nestlings older than 30 days, which appear to permit accurate sexing of nestlings. Ferruginous hawks, especially in the melanistic phase, may be confused with Swainson's, red-tailed, and rough-legged hawks under less than optimum field conditions. Brown and Amadon (1968) elaborated on field identification of these species.

See Friedmann (1950), Brown and Amadon (1968), and birding guides for characteristics for identification of parts or products.

Distribution: Breeds in the semi-arid western plains, from southern Alberta, Saskatchewan, Manitoba, and eastern North Dakota south to southern Arizona, New Mexico, and Kansas (Weston 1969; AOU 1957). Winters over much of its breeding range south to Baja California, northern Mexico, and Texas, rarely occurring east of the Mississippi River.

Habitat: Found primarily in semi-arid western plains region (Brown and Amadon 1968; Olendorff 1973). During post-breeding and migration these birds occur in high mountain shortgrass valleys (L. R. Powers, personal communication).

Preferred habitat appears to differ somewhat from region to region but generally is characterized by relatively unbroken terrain with scattered trees, rock outcrops, or tall trees along creek bottoms available for nesting sites (Bent 1937; Weston 1969; Howard and Powers 1973; Oldendorff 1973). In general, ferruginous hawks remain in the southern plains region during the winter (Weston 1969).

Feeding Habits: Ferruginous hawks have a relatively restricted diet when compared with other western buteos, consisting primarily of lagomorphs and rodents. In several different studies lagomorphs, primarily black-tailed and white-tailed jackrabbits, accounted for up to 80–95% of prey biomass consumed (Smith and Murphy 1973; Howard 1975); this apparently coincided with relatively high points of the jackrabbit cycle. In central North Dakota, jackrabbits are infrequently taken; Richardson's ground squirrels, northern pocket gophers, and thirteen-lined ground squirrels form the bulk of the diet (D. S. Gilmer, personal communication). Other sources, including lizards and snakes, are utilized during jackrabbit "lows" or on habitat types lacking jackrabbits (Howard and Powers 1973; L. R. Powers, personal communication). Much of the avian prey consisted of recently fledged birds in northeastern Colorado (Olendorff 1973).

Several methods of hunting are utilized: from a perch, while soaring, or more frequently, systematic searching and hovering at 12–18 m, and low, rapid flight over open country. Nesting birds will hunt cooperatively, especially for larger prey like jackrabbits (Howard and Powers 1973; Snow 1974). Hunting occurs most frequently near sunrise and sunset (Weston 1969).

Reproduction and Development: Ferruginous hawks utilize a wide variety of nesting situations including ground nests on low hillsides, cutbanks, buttes or small cliffs, in short trees in open country, powerline structures, haystacks, and in tall trees along creek bottoms (Olendorff 1973). In some areas, many of the tree nests are in man-created sites such as shelterbelts and trees around wells or dammed creek beds. Nesting activities normally begin in March and April and perhaps later in the northern parts of its range.

Little is known about courtship behavior. Three or four eggs are typically laid; as many as six have been recorded. Eggs are usually laid in April and are incubated primarily by the female (about 35 days); the male takes over while she eats. The male provides all the food until the young are about 2 weeks old, when the female can leave them for increasing periods of time (Weston 1969; Howard and Powers 1973).

Fledging occurs at 38–50 days; males leave first and females as long as 10 days later. Males weigh about 1,250 g and females 1,800 g at fledging (Schmutz 1977). They are dependent on their parents for several weeks after fledging (Smith and Murphy 1973).

Little is known about age of sexual maturity; 2 years would be consistent with other species. Two of the oldest known records of age are 20 years and 17 years, 3 months (Snow 1974).

Diseases and Parasites: Mortality caused by disease and parasites appears to be unimportant. Howard (1975) noted myiasis in a low percent of nestlings, but observed no mortality.

Predators and Other Mortality Factors: Great horned owls prey on nestlings and recently fledged young (Howard 1975). Several instances of coyotes being successfully driven away from the nest have been observed (Angell 1969).

Illegal shooting constitutes a substantial source of mortality (Salt 1939; Smith and Murphy 1973; Snow 1974; Howard 1975). Roadway accidents also frequently cause mortality; birds feeding on road kills are in turn hit by vehicles. Other causes of mortality include heat prostration of nestlings, starvation, and a variety of accidents. High winds may cause considerable nest losses (D. S. Gilmer, personal communication).

Population Level: Overall population estimates for the ferruginous hawk are lacking. Studies in Idaho and Utah

(Platt 1971; Howard and Powers 1973; Smith and Murphy 1973; Howard 1975; Powers et al. 1975) indicate that present populations are probably holding their own. The Blue List for 1976 (Arbib 1975) considers the ferruginous hawk as "threatened" in southern Idaho, holding its own in east-central Wyoming, declining in Utah, and disputed as to status in the Southwest. The reasons for these differing reports for Idaho and Utah are unclear; on one hand there are intense field studies on relatively restricted areas, on the other, casual observations over widespread areas. One very plausible explanation is the widespread crash of jackrabbits in the Utah-Idaho region (82% reduction in numbers) that occurred in late 1972 and 1973 resulted in a normal depression of nesting (Howard and Wolfe 1976). Woffinden (1975) reported very few nesting attempts in 1973 in an area supporting over 20 pairs when jackrabbit populations were higher (Weston 1969). Powers and Craig (1976) reported decreased nesting attempts in southeastern Idaho in 1975 during the jackrabbit low even though populations of Richardson's ground squirrels remained high. The significance of human disturbance in these areas is unknown.

Thacker (1971) estimated 24 ferruginous hawks held for research purposes and 2 in zoos. An additional number, probably less than 50, are held for falconry purposes. Although ferruginous hawks have bred in captivity (Snow 1974), little emphasis has been placed on breeding this species.

Reasons for Current Status: Habitat alteration appears to be the major cause of declines. Overgrazing often results in sagebrush taking over grassland areas. Federal agencies are attempting to reclaim these grassland areas by various methods, including chaining, plowing, and herbicide applications, often reducing nesting and prey habitat considerably (Snow 1974; Powers et al. 1975; Howard and Wolfe 1976). Of these reclamation techniques, chaining appears least destructive to the natural community (Howard and Wolfe 1976). Proposed geothermal exploration and increased emphasis on marginally productive agricultural lands pose a serious threat (Howard 1975). Snow (1974) and Howard (1975) made recommendations regarding land-use practices that will enhance ferruginous hawk habitat.

Human disturbance during the incubation period appears to be a critical factor in nest desertion (Snow 1974; Howard 1975; Powers et al. 1975). Field researchers quickly recognized the problem and have restricted nest visits during this period (Fyfe and Olendorff 1976). The number of desertions resulting from spring agricultural practices, recreation, and other activities is a matter of conjecture but may contribute to declines in some areas.

See Snow (1974) and Howard (1975) for reclamation techniques conducive to maintaining ferruginous hawk habitat. Natural fluctuations in jackrabbit cycles may account for the current pessimistic attitude maintained in some quarters since 1972 (Arbib 1975). Electrocution may occur when powerlines are used for perching.

Management Activities: Modification of powerlines is being undertaken by various western power companies to reduce deaths by electrocution (Marshall 1940; Miller et al. 1975).

Ferruginous hawks are protected by the United States–Mexico Migratory Bird Treaty of 10 March 1972. Migration counts are maintained at various hawkwatches around the country.

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Marsh Hawk
(*Circus cyaneus hudsonius* Linnaeus)

Status: Stable or declining slowly; local habitat loss poses the greatest threat to marsh hawks.

Original Discovery and Description: *Falco hudsonius* Linnaeus, Syst. Nat., ed. 12, vol. 1, 1766, p. 128. Based on the Ring-tailed Hawk *Pygargus canadensis*, Edwards, Nat. Hist. Birds, 107 (ad fretum Hudsonis = Hudson Bay). American Ornithologists' Union 1957.

Background: The marsh hawk is the only North American representative of the harrier family, a family that is common in the eastern hemisphere. It usually hunts on the wing, systematieally quartering fields and marshes, covering up to 160 km a day.

Status Determination: On the Blue List, an "early warning" list of species exhibiting potentially serious declines, sinee 1971 (see December issues of American Birds, 1971 to present).

Description: A slender-bodied hawk characterized by long wings and tail, long slender legs, and a white rump.

Marsh hawks are sexually dimorphic; females average 1.4 times heavier than males. Adult males are grayish on the head, back, and tail and have a white rump. The tail is crossed with six to eight light grayish-brown bands. They are white underneath, with cinnamon brown spots on the legs and sides. The ends of the outer primaries are black. Eyes and legs are yellow. Adult females are brownish on the head, back, and tail and have a white rump patch. The tail is crossed with six to eight darker bands. They are buffy underneath, with brownish to cinnamon streaks and spots. The ends of the outer primaries are black. Adult plumage is attained at 1 year (Hamerstrom 1968). Eyes are brown the first year, becoming mostly yellow by the third year (see Hamerstrom 1968). Legs are yellow. Juveniles are similar to adult females but are darker brown above and are more cinnamon on the breast in the fall. Eyes of juvenile males are grayish; eyes of females are brown. Legs are yellow. For a more complete discussion, see Hamerstrom (1968) or Brown and Amadon (1968).

Clark (1972*b*) compares various aspects of marsh hawk pellets and droppings with those of the short-eared owl, a species with similar food habits. Marsh hawk pellets tend to have less bone material, 17% by weight, when compared with short-eared owl pellets, which have 44% bone. Droppings of marsh hawks tend to be chalky white with a pellet-like greenish to black center. Short-eared owls' droppings are buffy with stringy black centers.

See Friedmann (1950), Brown and Amadon (1968), Hamerstrom (1968), or birding guides for characteristics for identification of parts or products.

Distribution: Breeding range extends from northern Alaska and Canada south to northern Baja California, Mexico, and the southern United States. Absent from the southeastern United States. Winters from southern Canada to northern South America. Occasionally observed in the Caribbean chain (AOU 1957).

Habitat: Inhabits non-forested areas such as marshes, grasslands, and prairies for nesting and hunting. Nest sites are usually in tall grass in open fields or in marsh areas. Winter roosts are in undisturbed fields or marshes.

Habitat requirements are less specific during the nonbreeding season; areas far removed from nesting habitat are utilized. Communal roost concentrations of up to 80–90 marsh hawks have been observed in areas of high prey density in the winter (Littlefield 1970; Mumford and Danner 1974; Weller et al. 1955; Craighead and Craighead 1956).

Critical Habitat: Marshes, wetlands, and potholes are being drained and grasslands are being plowed for agriculture.

Feeding Habits: Marsh hawks prey on a wide variety of prey including mammals, birds, reptiles, amphibians, arthropods, carrion, and even fish (Errington 1933; Breckenridge 1935; Randall 1940; Selleck and Glading 1943; Bond 1947; Long 1961; Proctor 1973).

Marsh hawks hunt primarily on the wing, systematically searching meadows and marshes. Sometimes they hunt from low perches. Most hunting is early in the morning, with a definite lull during midday; hunting is resumed in the late afternoon (Hamerstrom and Wilde 1973).

Food habits vary greatly with season and geographic area. During the breeding season, small to medium-sized mammals and birds typically form the bulk of the diet with actual proportions dependent upon local abundance and availability of prey. Inexperienced juveniles may prey more heavily on easily taken amphibians and arthropods. Small mammal populations may become more important for northern wintering marsh hawks with the departure of migrant birds (Munoff 1963).

Reproduction and Development: Nesting generally starts in middle to late spring. The nest is built by the female; the male assists in bringing the nesting material, which is largely composed of grasses, weeds, and water plants. Nests are usually on the ground; deeper, more bulky nests are built in shallow water (Clark 1972*a*). The general nesting area is usually in grasslands or marshy areas (Breckenridge 1935; Sealy 1967; Hamerstrom 1969; Clark 1972*a*). Sometimes, nesting is semi-colonial with several pairs nesting close together in a large area of continuous habitat (Errington 1930*a*; Hall 1947; Hecht 1951; Hamerstrom 1969). High vole populations are associated

with an increase in the number of nesting marsh hawks (Hamerstrom 1979).

Sky dancing, a ritualized courtship usually performed by adult males, appears to be instrumental in male selection and advertisement of territory. But males not connected with a territory also sky dance (Hamerstrom 1969). Females rarely sky dance. Copulation is rarely observed and little is known about frequency or location (Hamerstrom 1969). Clark (1972*a*) saw one pair copulating on a fence post. From three to six eggs are usually laid; the incubation period is 23–26 days. Females incubate the eggs; males have rarely been observed on the nest (Christensen and Trelease 1941; Hamerstrom 1969). The male provides essentially all food during incubation and the early nestling period, usually dropping food to the female in an aerial food transfer. If the female is absent, he drops the food at the nest and leaves (Hecht 1951).

At hatching the young are covered with white down; the juvenile plumage appears at about 2 weeks of age. Munoff (1963) found that greatest weight increases occurred during the second week and the greatest rate of primary growth during the third and fourth weeks. The young wander from the nest before they are able to fly, usually forming a well-developed trail system in the surrounding vegetation. Young males fledge at 31–34 days and females at 35–38 days (Scharf and Balfour 1971).

Hamerstrom (*in* Schmutz and Schmutz 1975) observed 16 subadult females and 3 subadult males (1 year old) of 163 breeding adults. She found successful breeding to at least 7 years. Kennard (1975) reported the longest known life-span as 16 years, 5 months. Hickey (1952) estimated the immature mortality rate to be 59% and the average annual adult mortality rate to be 30%.

Diseases and Parasites: Little is known about diseases and parasites. Scharf (1966) reported louse flies (Hippoboscidae) on marsh hawks. Nest screwworm flies (Calliphoridae) are commonly associated with those raptors having bulky nests with damp interiors (Sargent 1938).

Predators and Other Mortality Factors: The ground-nesting habits of marsh hawks render them more vulnerable than most other raptors to a much wider range of predators and other problems, except wind. Hamerstrom (1969) included deer, cattle, skunk, and carrion beetles as known causes of nestling mortality. Many other mammalian, reptilian, and avian predators may prey upon eggs and young. Weller et al. (1955) found remains of five dead marsh hawks on a winter roost in central Missouri. Although some were apparently killed by mammals, one was killed and eaten by a great horned owl.

Nests are destroyed by haying and other agricultural operations. Prolonged rains may drown out nests in marshes. As with many raptors, shooting continues to be a considerable source of mortality. Hamerstrom (1969, 1970) attributed deterioration of reproductive behavior to pesticide contamination. The number of nests on her study area is back to normal since the ban on DDT (Hamerstrom 1979).

Population Level: The population status of the marsh hawk is unclear. It appears that declines occurred to a greater extent in the eastern United States than in the West (Arbib 1973). Hackman and Henny (1971) indicated a 7% annual decline in observations of fall migrant marsh hawks from 1951 to 1961. Hamerstrom (1979) found a close association between numbers of nesting marsh hawks and vole abundance. During locally heavy DDT application (1965–68) nesting marsh hawks failed to respond to a vole high. Nesting in pre- and post-DDT years was comparable. Numbers of migrants showed a 70% decline from 1960 to 1969. Brown (1973) showed a general decline of winter populations through 1965 and an increase from 1966 to 1969. At this time (1980) the marsh hawk population does not appear to be in serious trouble; however, adequate knowledge of population parameters is lacking.

Thacker (1971) estimated a total of seven marsh hawks in captivity, primarily in zoos. Marsh hawks are rarely used for falconry. Captive breeding of this species has not received much attention.

Reasons for Current Status: Extensive draining of wetlands and monotypic farming have probably had the severest impact on the marsh hawk (Lokemoen and Duebbert 1976).

Illegal shooting may be considerable in some areas but appears to be declining.

Pesticide contamination does not appear to be a significant factor at this time. Local populations may have been affected by agricultural pesticides (Hamerstrom 1969, 1970, 1979).

Management Activities: None specifically for marsh hawks at this time; however, wetland preservation aimed primarily at waterfowl and habitat management programs for other species (e.g., prairie chickens, see Hamerstrom 1969) are also beneficial to marsh hawks.

Marsh hawks are protected under the United States–Mexico Migratory Bird Treaty of 10 March 1972.

Migration counts have been established at various hawk watches around the country (see Newsletter of the Hawk Migration Association of North America).

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Merlin (*Falco columbarius* Linnaeus)

Status: Severe declines in Richardson's merlins (*Falco columbarius richardsonii*) due to habitat loss and reproductive difficulties appear to have leveled out. Taiga and black merlin populations appear stable after slight declines. Primary threats include habitat loss to Richardson's merlin and continued use of organochlorine biocides in Central and South America which results in contamination of prey species.

Original Discovery and Description: Eastern or taiga merlin (*F. c. columbarius* Linnaeus): *Falco columbarius* Linnaeus, Syst. Nat., ed. 10, vol. 1, 1758, p. 90. Based on The Pigeon Hawk *Accipiter palumbarius* (Catesby, Caroline, Vol. 1, p. 3, plate 3; in America = South Carolina). American Ornithologists' Union 1957; Temple 1972*b*.

Richardson's merlin (*F. c. richardsonii* Ridgway): *Falco Hypotriorchis richardsonii* Ridgway, Proc. Acad. Nat. Sci. Philadelphia, 22, no. 3, Aug.–Dec. 1870 (Mar. 14, 1871), p. 145 (mouth of the Vermillion River, South Dakota). AOU 1957.

Black merlin (*F. c. suckleyi* Ridgway): *Falco columbarius* var. *Suckleyi* Ridgway, bull. Essex Inst., 5, No. 12. Dec. 1873 (Feb. 1874), p. 201 (Shoalwater Bay, W.T., Ft. Steilacoom = Shoalwater Bay, Washington). AOU 1957.

Western or taiga merlin (*F. c. bendirei* Swann): *Falco columbarius bendirei* Swann, Bull. Brit. Orn. Club, 42, no. 264, Feb. 2, 1922, p. 66 (Fort Walla Walla, Washington State). AOU, 1957; Temple 1972*b*.

Background: Temple (1972*b*) discussed the systematics of North American merlins. On the basis of phenotypic and phylogenetic characteristics he considers *F. c. columbarius*, *F. c. richardsonii*, and *F. c. suckleyi* taxonomically distinct. There appears to be no basis for separating *F. c. bendirei* and he suggests considering it a synonym of *F. c. columbarius* (cf. AOU 1957).

The merlin is a small falcon of panboreal distribution. Four subspecies are currently recognized as occurring in North America (AOU 1957, but see Temple 1972*b*). Preys chiefly on small to medium-sized birds. Declines in recent years are primarily pesticide related.

Status Determination: The merlin has been on the Blue List, an "early warning" list of species exhibiting potentially serious declines, since 1971 (see December issues of American Birds, 1971 to present). *F. c. columbarius* and *F. c. richardsonii* are considered as Status Undetermined by the U.S. Fish and Wildlife Service (1973).

Richardson's merlin is listed as Endangered in Canada (Godfrey 1970).

Description: A small to medium-sized falcon, characterized by long pointed wings and long-appearing tail. Adult males are slaty blue-gray above, varying from light gray to nearly black. Underneath buffy with prominent cinnamon to black streaking. Tail is dark with three to five gray or buff bands. Adult females and juveniles are similar to adult male, but are dark brownish above instead of bluish. Adult plumage is attained when 1 year old (Temple 1972*c*).

Merlins are sexually dimorphic; females average 1.3 times heavier than males. Adult and immature females are very similar; however, the rump and upper tail coverts of adult females are slate brown in contrast to the brown dorsal plumage. Immatures lack this contrast. Immature males have grayish bands in the tail, whereas immature females have buffy bands. There are considerable differences in coloration of subspecies. *F. c. richardsonii* is characteristically lighter colored and *F. c. suckleyi* is considerably darker. For a more comprehensive discussion, see Temple (1972*b*, 1972*c*). See Friedmann (1950), Brown and Amadon (1968), Temple (1972*b*, 1972*c*), and birding guides for characteristics for identification of parts or products.

Distribution:

Taiga merlin.—Breeds in the boreal forest regions of Canada, Alaska, and northern United States. Winters in the western United States and Canada, along the Gulf and Eastern coasts, and south to northern South America (Temple 1972*b*; AOU 1957).

Richardson's merlin.—Breeds in the prairie–parkland regions of central Canada and the northern Great Plains.

Winters from the northern Great Plains south to northern Mexico (AOU 1957; Temple 1972*b*).

Black merlin.—Breeds in the humid Pacific Coastal regions and on offshore islands. Primarily resident; some birds range throughout the western United States during winter (AOU 1957; Temple 1972*b*).

The southern limit of breeding range of the taiga merlin is now somewhat farther north due to human encroachment. Agricultural land-use patterns have affected much of the habitat of Richardson's merlin (Fyfe 1972).

Habitat: Taiga merlins breed in the boreal forest biome. Nests are usually found in coniferous trees near open areas such as forest edges, bogs, and lakes. Nesting near water appears to be common. Although few nests of the black merlin have been described, it appears that their habitat requirements are similar to those of the taiga merlin. Richardson's merlins breed in the prairie–parkland biome in the northern Great Plains. Nests are usually found near water, in isolated groves of trees on the prairies, and wooded areas along rivers. Nests in deciduous trees are common (Fox 1964).

Merlins, as is common with falcons, do not build their own nests but utilize nests built by other species. Old nests of crows, ravens, magpies, and various species of hawks are usually used. Near the arctic treeline the eggs are often laid in a scrape in the soil under bushes or small trees. Ground nesting has never been recorded for Richardson's merlin, although nesting has been observed in tree cavities and in old magpie nests on cliffs. They have been breeding successfully in Saskatoon, Manitoba (Oliphant 1974), and several other cities (Trimble 1975; McCowan 1978).

Wintering taiga and black merlins utilize a wide variety of habitat types, almost any type encountered in their winter range. Richardson's merlins tend to remain in prairie habitat even in winter (Fox 1964).

Critical Habitat: Richardson's merlins nest in small groves of trees on areas of prairies, especially near water.

Feeding Habits: Merlins prey almost entirely on small to medium-sized birds. Mammals, other than bats, are very rarely taken. Dragonflies and other insects may form part of the diet during summer and fall, especially for young merlins just learning to hunt (Williams and Matteson 1947; Lawrence 1949; Bond 1951; Street 1960; Eyre and Paul 1973).

Merlins often hunt in a manner similar to accipiters, utilizing inconspicuous perches and searching flights to surprise potential prey. If the first strike fails, pursuit is continued with a series of short stoops (Brown and Amadon 1968). Merlins will also take prey by stooping from great heights in the manner of the larger falcons (Laing 1938; Craighead and Craighead 1940).

Reproduction and Development: Nesting begins in early to late spring depending on latitude and, to some extent, weather. Males arrive on the breeding areas as much as a month before the females. Nests are seldom reused; however, ground nest scrapes have been used for as long as 23 years (S. A. Temple, personal communication).

Males usually select the nest site and attract females with vocalizations and display. Average clutch size for all populations is 4.8 eggs per clutch (Temple 1970:42). Eggs are incubated 28–32 days, mostly by the female. However, males may contribute substantially; they were on the nest about 1/3 of the time birds were flushed from the nest in Newfoundland (Temple 1972*c*).

The young are covered with white down and begin feathering out at 2–3 weeks of age. The male provides most of the food for the first two weeks, bringing the prey unplucked. The female plucks the prey and feeds it to the young. When the young no longer need constant brooding, the female also hunts. The young fledge at 25–35 days, remaining dependent upon the parents for up to 5 weeks after fledging (Lawrence 1949; Fox 1964; Brown and Amadon 1968; Eyre and Paul 1973; Oliphant 1974).

It appears that merlins may breed successfully when 1 year old; however, most birds probably do not breed until they are 2 years old (Temple 1972*c*). The life-span of merlins is unknown; a tentative maximum of 8–10 years is probably consistent with that of other species.

Diseases and Parasites: Diseases and parasites do not appear to pose a significant threat to merlin populations. Parasites most frequently encountered include nest screwworm flies (Calliphoridae), louse flies (Hippoboscidae; Mueller et al. 1969), chewing bird lice (Mallophaga), and Simulium flies (Trimble 1975). Diseases include trichomoniasis, coccidiosis, and aspergillosis (Beebe and Webster 1964).

Predators and Other Mortality Factors: Predation is limited primarily to the nesting season; adults may be taken at other times by other raptors or large mammals under unusual circumstances. Crows, jays, and other typical nest predators will eat eggs if the adults are forced away from the nest. However, merlins will renest if the eggs are destroyed early in incubation. Great horned owls and other owls may prey on nestlings and recently fledged young.

Severe storms may result in the loss of eggs and the death of nestlings (Oliphant 1974). Although illegal shooting probably had a detrimental impact in earlier years, it does not now appear to be a major mortality factor (Fyfe 1977). Persistent organochlorine pesticides, PCB's, and heavy metals cause eggshell thinning, aberrant reproductive behavior of adults, and embryonic mortality (Temple 1972*a*). The most serious declines have occurred in the typically agricultural regions inhabited by Richardson's merlin (Fyfe 1972; Trimble 1975).

Population Level: Richardson's merlin has suffered considerable declines due to habitat loss and DDE-induced

eggshell thinning. Taiga and black merlins may have suffered slight declines, especially during the era of heavy DDT use (Fox 1971; Trimble 1975). Oliphant and Thompson (1978) reported production in Saskatchewan Richardson's merlins from 1970 to 1977 as comparable to pre-1950 levels. Restrictions on the use of DDT and other persistent pesticides offer encouragement for the future. Although meaningful increases have not been noted, declines do not appear to be continuing (Fyfe 1972).

Thacker (1971) estimated 22 merlins (not broken down to subspecies) held for research purposes and 2 in zoos. An additional number, probably less than 50, are held for falconry purposes. Several people have been successful in breeding merlins, including John Campbell, Black Diamond, Alberta, and Richard W. Fyfe, Canadian Wildlife Service (Trimble 1975).

Reasons for Current Status: Agricultural practices on the Great Plains, such as cutting and burning around prairie potholes, have severely reduced Richardson's merlin habitat, including nesting sites and adequate prey habitat (Fyfe 1975). Richardson's merlin appears to be shifting its range somewhat to compensate for habitat changes. Fox (in Trimble 1975) predicted increased nesting in Montana, Wyoming, and the Dakotas, although recent variability of weather patterns may result in declines of agricultural expansion on the Canadian prairies. Taiga and black merlins have not suffered substantial habitat losses; however, recent interest in peat fuels as an energy source may be construed as a potential threat to habitat of taiga merlins.

Organochlorine pesticides are primarily responsible for declines in productivity, especially in the more contaminated prairie regions inhabited by Richardson's merlin. However, recent changes in chemical seed treatments eliminating dieldrin, heptachlor, and mercury, and restrictions of DDT use give cause for guarded optimism regarding reproductive difficulties (Fyfe 1972).

Management Activities: Restrictions on DDT use in the United States and Canada. Merlins were added to United States–Mexico Migratory Bird Treaty on 10 March 1972.

Richard Fyfe is monitoring reproductive success in Alberta. Migration counts are maintained at various hawkwatches around the country (see Newsletter of Hawk Migration Association of North America).

John Campbell, Black Diamond, Alberta, reared four young in 1974, the first successful captive propagation. Richard Fyfe obtained fertile eggs in 1974, but none hatched; however, three young fledged in 1975.

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48(6):97.
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Northern Aplomado Falcon (*Falco femoralis septentrionalis* Todd)

Status: Peripheral – Rare.

Original Discovery and Description: *Falco femoralis septentrionalis* Todd: *Falco fuscocoerulescens septentrionalis* Todd, Proc. – Biol. Soc. Washington, 29, June 6, 1916, p. 98 (Fort Huachuca, Arizona). American Ornithologists' Union 1957. The original discovery of the aplomado falcon was made in 1853 by Dr. A. L. Heerman in southern New Mexico (Baird 1858).

Background: The range of the northern aplomado falcon extends south to northern Guatemala where it evidently intergrades with *F. f. femoralis*, whose range extends south to Patogonia (Howell 1972).

The aplomado falcon is a medium-sized falcon inhabiting the extreme southwestern United States. It is currently ranked ninth on the American Birding Association's list of most desired bird sightings in the United States (West 1979).

Status Determination: Listed as Status Undetermined by the U.S. Fish and Wildlife Service (1973). The aplomado falcon is listed in Appendix II of the Convention on International Trade in Endangered Species of Wild Flora and Fauna (USFWS 1978). It also receives special protection in Texas, Arizona, and New Mexico, where it formerly nested (Hector and Knopf 1979).

Description: Medium-sized falcon; adults are bluish gray above, slightly darker on the crown; tail blackish with white bars and a white tip. A buffy line extends back from each eye, often joining to form a collar on the neck. A broad black stripe extends below and behind the eye and joins a narrow black malar stripe. Throat and cheeks are white or buffy and breast is buffy. Sides and a band across the belly are black with white feather edgings. Cere and legs yellowish, eye dark brown. Immatures are blackish brown above with less distinct tail bars. Eyestripe, breast, and abdomen deep cinnamon to orangish, fading to whitish as the season progresses. Breast immaculate or with black streaking. Eye brown (Brown and Amadon 1968).

Sexes colored alike, females are larger. Males, wing 248–267 mm, tail 172–193 mm; females, wing 272–302 mm, tail 192–307 mm (Brown and Amadon 1968). See Brown and Amadon (1968:187, plate 156), Oberholser (1974), and birding guides for characteristics for identification of parts and products.

Distribution: Breeds from northern Guatemala north to Arizona, New Mexico, and Texas (AOU 1957). The extent of winter movements are unclear; northern birds may move into central Mexico (Bent 1938). However, collected specimens and observations in the United States are most abundant from September to December, which suggests the possibility of year-round residency by this species (Dean Hector, personal communication).

Arizona. – Locally common summer (or permanent?) resident in southeast Arizona before 1890; since then virtually extirpated – three records, one before 1910, one on 11 November 1939, and one on 7 October 1940 (Ligon 1961).

New Mexico. – Locally common in open valley and prairie land in southwestern New Mexico west of the Guadalupe Mountains. Now very rare; generally confined to open yucca desert land west of the Rio Grande although a pair was observed east of the Rio Grande on 11 May 1962, in Lea County. One nesting record in 1952 (Ligon 1961; Porter and White 1977).

Texas. – Locally common in southwest Texas, common in southern Texas between Brownsville and Point Isabel (Smith 1910; Streeker 1930; Griscom and Crosby 1925). Populations declined severely between 1890 and 1910; there has been one breeding record since 1910, a nest with three eggs found on 13 March 1941, in southern Brooks County (Oberholser 1974; Porter and White 1977).

Habitat: The aplomado falcon inhabits grassy plains and valleys with scattered mesquite, yucca, and cactus (Oberholser 1974).

Aplomado falcons require nesting platforms such as stick nests of corvids and raptors in desert terrain. Other sites, such as bromeliads, are used in the tropics (Dean Hector, personal communication).

Critical Habitat: Uncertain; preferred habitat requirements are little known.

Feeding Habits: Aplomado falcons are primarily bird hawks and take species ranging from the size of rock doves (Brown and Amadon 1968) and brown jays (about 250 g) to seedeaters and warblers (about 30–40 g). They also feed on insects, primarily cicadas, locusts, and beetles (Dean Hector, personal communication).

Typically hunts from perches, interspersed with searching flights. Pairs are often observed hunting together after sundown (Ligon 1961). They also have been observed catching insects stirred up by advancing grass fires (Brown and Amadon 1968; Oberholser 1974).

Reproduction and Development: Nesting begins in late March and April. The aplomado falcon uses old nests of other species, often those of the white-necked raven, usually in yucca, mesquite, or cacti (Ligon 1961; Brown and Amadon 1968; Oberholser 1974).

Little is known about courtship behavior. From two to four eggs, usually three, are laid (Ligon 1961; Oberholser 1974). Both parents are known to incubate (Brown and Amadon 1968). Incubation period is unknown but is

probably around 28–32 days.

Predators and Other Mortality Factors: Organochlorine contamination and concomitant eggshell thinning has been reported in the aplomado falcon. The extent of DDE-indueed eggshell thinning in Mexican populations appears similar to other populations of bird-eating raptors experiencing severe reproduction diffieulties due to DDE eontamination. Eggshells colleeted between 1957 and 1966 and in 1977 averaged 25.4 and 24% thinner, respectively, than pre-DDT eggshells (Kiff et al. 1980).

Population Level: The last nesting record for the United States was in 1952; however, the aplomado falcon was locally common in the southwestern United States before 1900 (Porter and White 1977).

Breeding potential is probably fair, considering recent advances in the breeding of large falcons. Three aplomado falcons in the Oklahoma City Zoo exhibited courtship behavior but did not reproduee (Snelling and Lueck 1976) and have since been separated (Dean Hector, personal communication). Several birds have been kept for falconry purposes in Arizona and California (Dean Hector, personal communication).

Management Activities: Leaving scattered trees standing in the implementation of range management practices designed to reduce brush-encroached areas would provide potential nest sites for aplomado falcons.

Dean P. Hector, Oklahoma State University, is conducting a study of the aplomado falcon whieh will attempt to answer the following questions: (1) What is the present status of this species in the United States? (2) What constitutes preferred habitat for the species? (3) Do areas presently exist in the United States that could support populations of the aplomado falcon? (4) How is continuing DDT use in Mexico affecting the productivity of the species? (5) What is the general and hunting behavior ecology of this species in Mexico? (6) What is the cause of decline in the United States?

Aplomado falcons are proteeted under the United States–Mexico Migratory Bird Treaty of 10 March 1972.

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Osprey (*Pandion haliaetus carolinensis* Gmelin)

Status: Severe declines, especially on the East Coast. Productivity has been recovering and, in many instances, populations stabilizing following the DDT ban in the United States. Populations in northwest United States have been increasing with artificial water impoundments. Primary threat is continued use of organochlorine biocides in Central and South America.

Original Discovery and Description: *Falco carolinensis* Gmelin, Syst. Nat., vol. 1, pt. 1, 1788, p. 263. Based mainly on the fishing hawk, *Accipiter piscatorius* Catesby Carolina, vol. 1, p. 2, plate 2 (in America-South Carolina). American Ornithologists' Union 1957.

Background: There is some indication (Ogden 1977*a*: 149–151) that Florida ospreys are intermediate in form between *P. h. carolinensis* and *P. h. ridgwayi*, which inhabits the Bahamas, Yucatan, British Honduras, and possibly Cuba (Brown and Amadon 1968).

The osprey, a large raptor of worldwide distribution, feeds on live fish, often diving beneath the water's surface to capture its prey. Recent major declines have been attributed primarily to eggshell thinning caused by environmental contaminants (Henny 1977*a*).

Status Determination: On the Blue List, an "early warning" list of species exhibiting potentially serious declines, since 1971 (see December issues of American Birds, 1971 to present). Classified as Status Undetermined by the U.S. Fish and Wildlife Service (1973). Godfrey (1970) classified the osprey as endangered in Canada.

Description: The osprey is a large raptor, appearing intermediate in size between large buteonine hawks and eagles. Ospreys are white underneath with brownish-black wristmarks, buff to brown speckles in the breast, and brown to brownish-black above. Head is white with a thick, brownish-black eyestripe. Cere and feet are blue-gray. In flight it can often be distinguished by the black wristmarks and the definite crook in the wings (see Peterson 1947).

Juvenile ospreys have orangish-red to dark brownish-yellow irides and buffy feather edging on the back. Adults have yellow irides and lack the buffy feather edges on the back. Males typically are less extensively marked on the breast (Peterson 1947; Friedmann 1950; Brown and Amadon 1968).

The large nests placed at the top of trees (usually dead) are unique and are used in locating osprey territories during air and ground searches (Mathisen 1968*b*).

See Brown and Amadon (1968) and birding guides for characteristics for identification of parts or products.

Distribution: Breeds north to northwestern Alaska and central Canada; south to southern United States, the Sonoran coast, and Baja California. Winters from the southern United States south as far as Chile and Argentina. Non-breeding subadult birds (1-year-olds) remain on the wintering grounds through the northern summer (AOU 1957; Henny and Van Velzen 1972). (See range map in Henny (1977*a*:200) for areas of breeding concentrations.)

Habitat: The osprey, a fish-eating bird, is typically associated with water. Significant nesting populations are found in coastal areas and in regions with an abundance of lakes (Henny 1977*a*).

Fishing sucess appears to be greatest in areas of relatively shallow water. Shallow areas in lakes and rivers, floodings, and intertidal areas are favored (D. S. MacCarter 1972; Ueoka and Koplin 1973). Nesting habitat is fairly specific: dead or open-topped live trees are favored in natural situations. Nests are invariably placed at the very top of the tree. Ospreys are very adaptable to artificial nesting structures, nesting commonly on old duck blinds, channel markers, telephone poles, and a variety of other man-made structures (Mathisen 1968*b*; Reese 1970; French 1972; D. L. MacCarter 1972; Ogden 1977*a*). Nesting platforms erected specifically for ospreys have been very successful (Postupalsky and Stackpole 1974; Rhodes 1977). Ospreys usually nest close to water; however, lack of suitable nest sites in some areas apparently results in nesting as far as several kilometers from the nearest body of water (Postupalsky 1977*b*).

Banding recoveries indicate that 1-year-old birds remain on the wintering grounds during their first summer. Two-year-old birds return to the United States and an estimated 25–54% return to their natal areas (Henny and Van Velzen 1972).

Critical Habitat: Decreasing availability of suitable nesting trees due to forestry practices, drainage, weather damage, and human disturbance. Reduced feeding habitat due to recreational use of lakes and reduced fisheries due to acid rain. Lakes with high sensitivity to acid rain are generally found in northern California, Oregon, Washington, northern Idaho, Montana, northeastern Minnesota, northern Wisconsin and Michigan, and east of the Appalachians (U.S. Environmental Protection Agency 1979).

Feeding Habits: Ospreys prey almost exclusively on live

fish; dead fish are occasionally taken (Dunstan 1974). There are several scattered reports of non-fish prey, including carrion (Miller 1923; Petrovic 1972; Wiley and Lohrer 1973; Hosford 1974; Kern 1976; Proctor 1977; Thorpe and Boddam-Whetham 1977).

Dunstan (1974) described several types of fishing behavior in Minnesota. Ospreys soared 10–60 m over the water, hovering briefly, or perched in trees along the shoreline while searching for fish. They also dragged their feet in the water for short distances, especially over weedbeds, ostensibly to startle fish into movement. Grubb (1977*a*) found that capture rate and number of dives were significantly less under cloudy skies or when wind rippled the water surface, apparently due to reduced visibility. Under cloudy, windy conditions the energy expended per prey capture may be six times greater than under calm, sunny conditions. Visibility also appears to be affected by the prey's movement relative to the water surface; osprey dives from a hover have been found to be 50% more successful than dives from a glide, or "interhover" (Grubb 1977*b*). Osprey dive into the water and seize the fish, often completely submerging beneath the water's surface. Captured fish are aligned head-first to the direction of travel, presumably decreasing air resistance (D. S. MacCarter 1972).

Little is known about feeding habits on the wintering grounds. Ueoka and Koplin (1973) described changes in success rates as the breeding season progressed and also changes in success rates during different stages of the tidal cycle.

Reproduction and Development: Courtship activities and egg-laying typically begin in late spring, shortly after the ice is out on inland lakes, in the northern United States and Canada. Southern populations are less synchronous. Egg-laying in Florida ranges from late November to March; the peak is in December and January (Ogden 1977*a*). In northwestern Baja California egg-laying begins in January and continues through March (Jehl 1977). Nests are constructed of dead sticks, grasses, mosses and lichens, and miscellaneous materials (Bent 1937; Mathisen 1968*b*; D. L. MacCarter 1972; Garber 1972*b*; Beebe 1974; Stinson 1976*c*). Nesting materials are brought to the nest primarily by the male (Brown and Amadon 1968; Garber 1972*b*). Nest-building and defense of the nesting territory are carried out by the female (Garber 1972*b*).

Ospreys perform noisy courtship displays, one consisting of steep dives by the male, often in pursuit of the female, and the other a slow, hovering flight (Beebe 1974). Copulation takes place on or near the nest (Bent 1937). Clutches of three eggs are normally laid; incubation lasts about 38 days (Garber and Koplin 1972). Incubation is shared by both sexes; the male incubates about 30% of daylight hours (Garber 1972*b*; Garber and Koplin 1972). Food is provided by the male during incubation and early nesting stages. When the young no longer require constant brooding (5–6 weeks), the female also hunts (Garber 1972*b*; D. S. MacCarter 1972).

Garber (1972*b*) found that young were sheltered from excessive sun, rain, and wind until they were about 7 weeks old; the female then perched nearby, although young were still brooded at night. Young ospreys fledge at 44–59 days of age (Stotts and Henny 1975; Stinson 1977*a*). In Virginia, Stinson (1977*a*) found the young to be dependent on their parents for at least 6 weeks after fledging, although this may be considerably shorter at higher altitudes and more northern latitudes (Beebe 1974; Henny 1977*b*).

Ogden (1977*a*) reported that Florida ospreys do not migrate, dispersing only short distances northward during the non-breeding season. Ospreys from the northern United States and Canada spend the winter in Panama, the West Indies, and South America (Henny and Van Velzen 1972). Young of the year spend at least 16 continuous months in the tropics and do not return north until they are 2 years old. Of these, 28–54% return to their natal area (Henny 1977*a*) and 5–10% may go through the motions of nesting, or "keeping house." Breeding has not been documented for 2-year-olds and such attempts cannot be counted in assessing reproductivity of the population (Henny and Van Velzen 1972). Most ospreys begin breeding at 3 years of age although some may not attempt breeding until age 4 (Ogden 1977*a*), and sometimes not until age 6 (S. Postupalsky, personal communication). Little is known about the length of sexual activity and life-span of the osprey although life tables derived from band recoveries (Henny and Wight 1969) indicate a life-span of 15–20 years. They estimated a first-year mortality at 51.5–57.3%, and 16.2–19.6% each year thereafter.

Various State and Federal agencies conduct annual reproduction surveys—see Henny (1977*a*) and Ogden (1977*b*).

Diseases and Parasites: Little published information is available concerning diseases and parasites of the osprey.

Predators and Other Mortality Factors: Predation occurs primarily during the egg and early nestling stages of the osprey. Gulls are normally repelled from the nest, even in the presence of human observers, but in extreme situations may cause some losses of eggs or small young (Ames and Mersereau 1964; Garber 1972*b*). Although interspecific aggression occurs frequently between ospreys and bald eagles, actual predation appears to be infrequent (Ogden 1975). Raccoon predation may become locally severe in some instances but normally appears not to be a serious factor (Reese 1977*b*). Most investigators consider predation to be minimal on their study areas (Ames and Mersereau 1964; Garber 1972*b*; D. L. MacCarter 1972).

Organochlorine pesticides, notably DDT and its derivatives, are primarily responsible for recent declines of the osprey (Ames and Mersereau 1964; Ames 1966; Keith 1966; Anderson and Hickey 1972; Henny 1972; Johnson

et al. 1975; Wiemeyer et al. 1975; Grier et al. 1977; Henny 1977*a*; Spitzer et al. 1977). Eggshell thinning and resulting poor productivity have been associated with high concentrations of DDE (Spitzer et al. 1977). It appears that eggshell thinning greater than 15–20% is associated with reproductive difficulties (Henny 1977*a*). In addition, high concentrations of PCB's and heavy metals (mercury and lead) have been associated with increased embryonic mortality in other species (Wiemeyer et al. 1972). Locally severe weather, hurricanes (Wiemeyer et al. 1975), and illegal shooting contribute to mortality but have not had a major impact on osprey populations. Illegal shooting pressure appears to be declining in the United States as a result of increasing public awareness of raptorial species and increased law enforcement. Major causes of mortality in a group of 33 ospreys recovered from 1964 to 1973 were impact injuries, emaciation, shooting, and respiratory infections (Wiemeyer et al. 1980).

Population Level: Henny (1977*a*) discussed United States osprey populations on a regional basis.

North Atlantic Coast.—Osprey declines were first noted in this region; the population is probably less than 10% of its former size. The osprey populations of Connecticut, Rhode Island, and Gardiner's Island declined at a rate of 6.5% for 1945–60, 14.4% for 1961–65, 14.3% for 1966–70, and 4.0% for 1971–75. Productivity should continue to improve as long as persistent pollutants are not used.

South Atlantic Coast.—This region probably has the highest breeding concentrations in the world. More than two-thirds of the birds nest on man-made structures (channel markers, duck blinds, and artificial nest platforms). Most populations are at normal or slightly below normal rates of productivity.

Great Lakes Region.—Ospreys showed declines similar to the North Atlantic Region in the 1950's and 1960's. Recent production appears to be normal or nearly so and populations more or less stabilized.

Western North America.—Little historical data are available on declines and extent of osprey populations. Production has been normal in most areas except in Yellowstone Park, where human disturbance may be a factor. Osprey populations have increased in the last two decades in northern Idaho and northeastern Washington. Present populations, nesting on relatively new man-made reservoirs, may be greater than in historic times.

Southern Region.—Florida and Mexican populations are non-migratory and may have mortality and recruitment rates differing from northern populations; however, present production appears adequate in terms of recruitment rates of northern populations.

Spitzer et al. (1978) reported that productivity in the Connecticut–Long Island area had increased to 1.2 young fledged per pair in 1976–77, which approaches pre-DDT levels of productivity. This increase coincides with a decrease in DDE and dieldrin residues in unhatched osprey eggs. Such increases in productivity, following the DDT ban, appear to be typical of North American osprey populations (Henny and Anderson 1979).

Thacker (1971) estimated three ospreys held in captivity (zoos). Captive breeding potential is unknown.

Reasons for Current Status: Although traditional habitat of tree-nesting ospreys is disappearing in many areas, ospreys are adaptable to nesting on man-made structures such as duck blinds, channel markers, and man-made platforms and do not appear seriously affected by this loss. In Chesapeake Bay, only one-third of nesting ospreys were using trees (Henny et al. 1974) and the trend toward man-made nest sites continues along the entire mid-Atlantic coast (Henny et al. 1977).

Persistent pollutants, notably DDE, have been primarily responsible for declines of osprey populations (Henny 1977*a*). Productivity in most populations has been increasing since the decrease and eventual banning of DDT use in the United States (Henny 1977*a*).

Management Activities: Osprey management areas are being implemented, especially in the western United States where osprey concentrations are on State or Federal land. Management plans consider human and management activities in nesting areas, preservation and construction of nest sites, reproductive surveys, and management of non-game fish (Henny 1977*a*).

The ability of ospreys to adapt to artificial nesting sites has encouraged the erection of nesting platforms by the U.S. Forest Service, State agencies, and private citizens (Reese 1970; Rhodes 1972, 1977; Henny 1977*a*; Postupalsky 1977*b*). Aerial surveys along the Atlantic coast have shown nesting platforms in use from New York to South Carolina (Henny 1977*a*). In some areas nesting success may be higher for birds on nesting platforms than in trees (Henny et al. 1974).

Readers are referred to Ogden (1977*b*) and Henny (1977*a*) for recent research activities and overall status of the osprey.

Ospreys are protected under the United States–Mexico Migratory Bird Treaty of 10 March 1972.

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Peregrine Falcon (*Falco peregrinus* Tunstall)

Status:

American peregrine falcon.—Endangered; restocking of vacated range with other forms appears feasible with the ban on United States use of DDT.

Arctic peregrine falcon.—Endangered; continued and increasing use of organochlorine biocides in Central and South America spells an uncertain future for this subspecies.

Peale's falcon.—Stable.

Original Discovery and Description: American peregrine falcon (*F. p. anatum* Bonaparte): *Falco anatum* Bonaparte, Geogr. and Comp. List, 1838, p. 4. New name for *Falco peregrinus* Wilson, Am. Ornithol. vol. 9, 1814, p. 120, plate 76 (Egg Harbor, New Jersey). American Ornithologists' Union 1957.

Arctic peregrine falcon (*F. p. tundrius* White, new subspecies): Type—adult male, No. 46581 National Museum of Canada, near northwestern Sherman Basin, Adelaide Peninsula, Northwest Territories, Canada, 15 August 1957 (White 1968*b*).

Peale's falcon (*F. p. pealei* Ridgway): *Falco communis* var. *Pealei* Ridgway, Bull. Essex Inst., 5, no. 12, Dec. 1873 (Feb. 1874), p. 201 (Oregon to Sitka-Oregon). AOU 1957.

Background: In a recent biosystematic study of the peregrine falcon, White (1968*b*) separated *F. p. tundrius* as a new subspecies from *F. p. anatum*. *Tundrius* is not yet officially recognized by the American Ornithologists' Union (1973, 1976). *Tundrius* is currently recognized as breeding in the tundra biome and *anatum* as south of the tundra biome.

The peregrine falcon is of great ecological significance, because it is the focal point of inquiries into the effects of DDT and other contaminants on the environment. *F. p. anatum* has been extirpated from the eastern portions of its range and is doing very poorly in the western United States and Canada. *F. p. tundrius* is also doing poorly as a result of increasing pesticide use in Central and South America where the falcons winter. *F. p. pealei* appears to be maintaining its population. The peregrine represents one of man's more concentrated efforts in the restoration of breeding populations in its range. Intensive field studies and captive propagation are now being carried out toward these ends.

Status Determination: *F. p. tundrius* and *F. p. anatum* are on the U.S. Department of the Interior Endangered List (U.S. Fish and Wildlife Service 1970*a*, 1970*b*, 1973). *F. p. anatum* is considered as Endangered by the International Union for Conservation of Nature and Natural Resources (1969) and in Canada (Godfrey 1970). These listings were made shortly after White's (1968*b*) separation of *F. p. tundrius* and could include *tundrius*.

Description: Peregrines are large falcons with long, pointed wings and a moderately long tail. Females average 1.6 times heavier than males. In general, adults are slate gray to bluish gray with black head and a blackish malar stripe. Underneath they are pinkish to dark rufous with blackish spotting and barring. Immature peregrines are more brownish above with whitish or buff feather edges. Underneath they are buffy and have dark streaks. The malar stripes are less well defined and light-colored immature arctic peregrine falcons have a broken malar stripe, with a light break extending from the corner of the mouth (Beebe and Webster 1964; Brown and Amadon 1968; White 1968*b*).

Anatum peregrines vary in size and color from east to west and from north to south. The population formerly breeding in the eastern United States tended to be darker, to plumbeous black above, whereas birds in the western United States tend to have a brownish, more rufous, cast. Northern birds tend to be lighter above and less extensively barred underneath. They appear to be short-to medium-range migrants, in contrast to the more southern populations, which are primarily resident year-round. *Tundrius* peregrines, which occupy the tundra biome of North America, are highly migratory and exhibit "leapfrog" migration, passing over the more resident *anatum* populations and extending during winter into Central and South America. They are smaller, paler above, and lack the rufous underparts of *anatum* birds. Peale's falcon, which occupies the Pacific Coastal islands and the Aleutians, is larger and darker than American and arctic peregrines (White 1968*b*).

Locations of eyries and perching places are often revealed by the streaks of white droppings below perches.

See Beebe and Webster (1964:114), Brown and Amadon (1968); White (1968*b*), and birding guides for characteristics for identification of parts or products.

Distribution: Breeding range of the American peregrine falcon extends northward across Canada and Alaska about to tree line where it intergrades with the Arctic peregrine. It extends south to 23° N latitude in Baja California, east to Tamaulipas, Mexico (Cade 1975; Fyfe et al. 1976), southwestern Texas, Kansas, Arkansas, Missouri, Tennessee, southern Illinois, Indiana, Pennsylvania, New Jersey, and in the Appalachian Mountains through Virginia to eastern Tennessee and to South Carolina and Georgia (Bent 1938; Friedmann 1950; AOU 1957; White 1968*b*). Southern populations of the American peregrine are primarily resident during winter range, whereas northern populations are short- to medium-range migrants, wintering in the southern United States and into Central America. The now extirpated eastern population tended to move to the eastern coastal regions during the winter.

The Arctic peregrine falcon breeds north of the tree line in Alaska, Canada, and Greenland to about 77° N latitude. It winters from the United States Gulf Coast and Baja California south to 40° S latitude in Chile and probably 35° S latitude in Argentina (White 1968*b*).

Peale's falcon is primarily a permanent resident of the Queen Charlotte and other Pacific Coast Islands; its range extends northward through the Aleutian Islands (White et al. 1971). Some wintering individuals are observed inland on the Pacific Coast (AOU 1957).

The American peregrine falcon was extirpated in the eastern and middle United States and southern Canada. Scattered areas of breeding remain in the western United States and Mexico, notably in Idaho, Colorado, Arizona, and Chihuahua. A few scattered pairs remain in northern Alberta, northern Canada, and the forested regions of Alaska (Fyfe et al. 1976).

Present range of arctic and Peale's falcon is essentially the same as its former range, although substantial declines of arctic populations have occurred in the last 5–10 years (Fyfe et al. 1976).

Habitat: Breeding American and Peale's falcons are typically associated with tall cliffs, which provide sanctuary from disturbances, and ledges, potholes, or small caves suitable for constructing the nest scrape. Arctic peregrines utilize a variety of nest sites from slopes, cutbanks, and cliffs on northern rivers to shoreline cliffs and seastacks (Cade 1960; Hickey and Anderson 1969; White and Cade 1971). Old stick nests of ravens and rough-legged hawks constructed on river slopes and cutbanks often provide a more stable nest site and are frequently utilized (Cade 1960). Winter habitat requirements are less specific than breeding habitat. Areas that provide abundance of prey and are relatively free of pollutants are the most important.

Nest sites are typically located near lakes, rivers, or marshes where prey species are more abundant and vulnerable. Accordingly, areas providing suitable prey and cliffs or other nesting habitat are the most important. Peregrines occasionally nest on various man-made structures, even within large cities (Groskin 1947, 1952; Hall 1970), and a remnant population nested in holes and broken-off stubs of giant trees before the 1940's in the Mississippi Valley (Hickey 1942). In more northern regions, cutbanks and gravel slopes associated with rivers replace cliffs as nesting areas. Due to the ephemeral nature of this type of nesting situation, historical occupancy is not characteristic of most northern sites as it is with the southern cliffs.

The more migratory northern populations encounter a wide variety of habitat types while on migration. Migrating peregrines tend to follow closely Great Lakes, coastal, and barrier beach shorelines. In general, areas with adequate prey populations are selected for wintering.

Critical Habitat: Entire breeding range of American and arctic peregrines where suitable nest sites are available. Assessment of historical sites to determine suitability for

reintroduction of stock produced in captivity is currently under way. Habitat of Peale's falcon appears relatively undisturbed at the present time.

Feeding Habits: Although a wide variety of prey species have been recorded, peregrines feed almost entirely on birds. Medium-sized passerines, icterids, shorebirds, pigeons, and small to medium-sized waterfowl form the bulk of their diet. Rarely, mammals and even fish have been recorded (Bent 1938; Cade 1960; White and Cade 1971).

The peregrine falcon shows an impressive display of speed and power when pursuing prey, whether in direct pursuit or in swift dives from above (Hickey and Anderson 1969). It has been estimated that peregrines attain speeds of 242–312 km/h when stooping on prey; more recent evidence indicates that up to 443 km/h may be attained (Brown and Amadon 1968). It might be noted that man, in free fall, reaches a terminal speed of about 193 km/h.

Prey pursuit may be initiated from a perch or while soaring at great heights. Small to medium-sized birds are usually captured directly; birds too large to be carried are knocked to the ground by one or more stoops and then killed by severing the neck vertebrae with the sharply notched beak. Cochran (1975) gave a good account of hunting behavior during migration.

Seasonal food habits reflect seasonal and geographical distribution and availability of prey species, and seasonal distribution of peregrines. For example, breeding waterfowl and shorebirds would be more available to northern populations whereas passerines, starlings, and pigeons might be more available to wintering and southern breeding populations.

Reproduction and Development: Peregrines lay their eggs in shallow depressions scraped in the gravel and debris on the nesting ledge. Eggs are typically laid in late March and April in the United States and southern Canada and into June in the far north (Hickey 1942; Cade 1960).

The male is typically the first to arrive at the nesting cliff in the spring. Mates are attracted to the cliff and to aerial displays of the resident birds. Although the male and female investigate various ledges together, the female makes the final selection for the nest scrape. Eggs are incubated (about 33 days) primarily by the female. Average clutch size varies from 2.9 to 3.7, being highest in the mid-latitudes and lowest in the far north (Hickey and Anderson 1969).

The male provides all the food and relieves the incubating female for short periods of time while she eats. After the eggs hatch, the female remains closely attached to the eyrie until the young are 2–3 weeks old, at which time she begins to supply additional food for the rapidly growing young. If the first clutch is destroyed, a second clutch is frequently laid about 2 weeks later; it is usually smaller than the first clutch. However, the very short breeding season in the far north precludes any renesting in the event of destroyed first clutches; even late-nesting birds may not have enough time to fledge their young in some years.

Peregrines are covered with short whitish down after hatching and feathers appear at about 2 weeks of age. The young fledge at 5–6 weeks of age. They gradually become independent of their parents as their power of flight improves and they are able to kill on their own. In the far north, peregrines may fledge as late as early September, and with migration beginning as early as mid-September, the fledged young must quickly learn to kill for themselves.

Peregrines usually begin breeding when they are 2 to 3 years old although breeding 1-year-olds have been observed (Fyfe 1976*a*). The maximum life-span is generally believed to be about 20 years in the wild (Enderson 1969*c*; Young 1969). Enderson (1969*c*) estimated immature mortality to be 70% and the average annual adult mortality to be 25%. The effects of senescence upon reproductive efficiency is unknown, although a female known to be at least 19 years old raised two young (Hall 1970).

Diseases and Parasites: Peregrines may contract a considerable number of diseases, none of which are considered to have a great effect on peregrine populations. However, on a local scale, botulism, myiasis, and trichomonas are known to have caused considerable mortality (White 1963; Trainer 1969; Stabler 1969; Porter et al. 1973). Inclusion body disease, a herpesvirus infection, has caused death in captive peregrines (Graham et al. 1975).

Predators and Other Mortality Factors: Mammalian predators, including raccoons, bobcats, fox, striped skunks, ringtails, and opossums are known to rob nests of eggs and small young. Great horned owls may prey on nestlings and recently fledged young (White and Lloyd 1962; Porter et al. 1973:45). Cade (1960) listed timber wolf, red fox, arctic ground squirrel, and golden eagle as the most important predators in northern Alaska.

Organochlorine pesticides, notably DDT and its metabolites, are primarily responsible for the catastrophic decline of the peregrine. Heavy metals, mostly mercury and lead, have been implicated in increased embryonic mortality. Other chemicals known to be detrimental to reproductive success include aldrin, dieldrin, and PCB's (Jefferies and Prestt 1966; Cade et al. 1968, 1971; Enderson et al. 1968; Enderson and Berger 1968; Hickey and Anderson 1968; Hickey 1969; Lincer et al. 1970; Ratcliffe 1970; Risebrough et al. 1970; Bogan and Mitchell 1973; Walker et al. 1973; White et al. 1973; Clement 1974; Peakall et al. 1975). Illegal shooting by irresponsible hunters is still a considerable source of mortality. Inexperienced juvenile birds are more susceptible than adults. Of a selected sample of peregrine band returns, 50% of the immatures and 33% of the adults had

been shot (Enderson 1969*c*).

Severe weather conditions may also cause considerable mortality at various stages of the life cycle, especially in the far north. Ruos (1970) found a significant correlation between number of migrating peregrines (primarily arctic) on the east coast and daily minimum temperatures in the Arctic. Various accidents such as young falling from the nest ledge, rocks falling on the nest ledge, and young hitting wires or automobiles contribute to mortality (Cade 1960; Cade and Fyfe 1970:242; White and Cade 1971; Burnham et al. 1974; Mattox 1975).

Population Level:

American peregrine falcon.—Extirpated in the middle and eastern United States and Canada. Fyfe et al. (1976) reported only 62 occupied sites in the western United States and adjacent Mexico. In Alberta only 4 of the 48 known sites showed any activity. In the western Canadian boreal forest, declines of 50% or more have occurred. It is estimated that less than 200 pairs of peregrines attempted to nest in the forested regions of Alaska (Fyfe et al. 1976).

Arctic peregrine falcon.—Although historical data for the Arctic are lacking, it appears that declines of 50% or more have occurred. As yet, complete extirpation of any region has not been documented (Fyfe et al. 1976).

Peale's falcon.—Present populations are essentially the same as in historic times (Fyfe et al. 1976).

Thacker (1971) estimated 116 peregrines held in captivity by zoos and for research. The number of peregrines held for falconry purposes is unknown; 100–200 is probably a reasonable estimate. An additional number are held by captive breeding establishments, primarily The Peregrine Fund, with facilities at Cornell University, Ithaca, New York, and Fort Collins, Colorado, and the Canadian Wildlife Service facilities at Edmonton, Alberta (Fyfe 1976*a*; Cade and Dague 1976). Captive breeding potential appears very good.

Reasons for Current Status: The effects of human encroachment and consequent destruction of habitat reduces prey populations and renders nesting sites unsuitable. Agriculture and extensive wetland drainage have also reduced prey populations. Mining, general urban development, road construction, and recreation (e.g., picnicking, rock climbing) are a few of the facets of human disturbance that have resulted in eyrie abandonment (Herbert and Herbert 1969:139; Porter et al. 1973). As yet there has been relatively little disturbance of breeding habitat in the North. However, exploitation of petroleum reserves and the ensuing disturbance of arctic wilderness poses a threat to peregrine breeding habitat (Cade and Fyfe 1970; Clement 1974).

Collecting of birds, and particularly eggs, for museum and private collections reached considerable proportions in the late 1800's and early 1900's. In the 1930's much of this activity subsided only to be replaced by removal of young for falconry (Herbert and Herbert 1969:135). These activities apparently had little effect because major declines were not observed during this period. Capture of migrating arctic peregrines for falconry is similarly thought to have had little effect on populations (Hickey 1969).

Eggshell thinning caused by DDT is the primary factor believed responsible for peregrine declines. American peregrine populations have been completely exterminated in the eastern and middle United States and lower Canada and are on the verge of extirpation in the western United States and Mexico. Declines of 50% or more have occurred in the boreal forest regions of Canada and Alaska. More recently, in conjunction with increasing pesticide use in Central and South America, declines of arctic populations have accelerated and in most instances less than 50% of the former populations remain. The primarily resident Pacific Coast populations (Peale's falcon) appear to be maintaining themselves at the present time (Fyfe et al. 1976).

Recovery Team: Information concerning recovery teams and recovery plans in progress may be obtained from the Office of Endangered Species, 1000 Glebe Road, Arlington, Virginia 22203.

Management Activities: Protection of nesting sites will be attempted by publishing only general locations of eyrie sites to prevent disturbance and by securing cooperative agreements of eyrie site landowners. Upon reoccupation of the breeding area by peregrines, actual acquisition will be made of the surrounding land.

In areas where lack of nesting sites is a limiting factor, potholes dug into the cliffs have been readily accepted by prairie falcons and peregrine falcons (Porter et al. 1973:60; Cade 1974*a*:91).

Protection plans as outlined in Endangered Species Peregrine Falcon Recovery Plans involve protection from killing, taking, or disturbance by humans or natural predators; encouraging public support; and striving for wise use of potential environmental pollutants.

Migration counts are maintained at various hawk-watches around the country (see Newsletter of Hawk Migration Assoc. of North America). Ward (1976) has organized an international color-banding program to aid in migration studies. Reproductive success of North American peregrines is summarized by Fyfe et al. (1976).

In addition to several relatively small private breeding projects (Snow 1972; Clement 1974), a major effort is being put forth by several institutions. The most notable is that directed by Thomas J. Cade at Cornell University. Starting in 1973 with 20 young, they have raised 434 peregrines through 1979 and reintroduced a total of 211 young in the East and 131 in the West. About 70% of these fledged successfully and reached independence (Cade and Dague 1977, 1978, 1979). In 1979 several pairs

of released birds laid eggs, fertile in at least one nest, but hatched no young. There were also eight other sightings of individual birds in the East. The reestablishment of breeding peregrines in the East appears a certainty (Cade and Dague 1979). The Canadian Wildlife Service, under the direction of Richard Fyfe, Edmonton, Alberta, is also producing a large number of young for reintroduction purposes (Cade and Dague 1976).

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Prairie Falcon (*Falco mexicanus* Schlegel)

Status: Prairie falcon populations appear stable; some local declines due to habitat loss have been offset by increases in other areas. Available habitat appears to be at maximum carrying capacity in some areas.

Original Discovery and Description: *Falco mexicanus* Schlegel, Abh. Zool. Vergl. Anat., Heft 3, 1851, p. 15 (Mexico). American Ornithologists' Union 1957

Background: The prairie falcon is a large falcon inhabiting the western United States, southern Canada, and northern Mexico. No close relatives occur in North America. Although some local declines have been noted, it has held its own in most areas and appears to have taken over some areas vacated by declining peregrine falcon populations. Harvesting of prairie falcons for falconry has increased with the unavailability of peregrines for this purpose.

Status Determination: Listed as Threatened by the U.S. Fish and Wildlife Service (1973). Has been on the Blue List, an "early warning" list of species exhibiting potentially serious declines, since 1971 (see December issues of American Birds, 1971 to present).

On Canada's list of endangered birds (Godfrey 1970). Fyfe (1977) reported that prairie falcon populations were stable in Canada.

Description: The prairie falcon is a large falcon, slightly lighter in build than the peregrine. Females average 1.5 times heavier than males. Brown to sandy brown above, with buffy feather edgings. Creamy white underneath with brown streaking; adults have barring on the thighs. Axillars and upper flanks form a dark triangle visible at the base of the underwings in flight (Brown and Amadon 1968).

Young prairie falcons tend to be darker above and buffy underneath, with lance-shaped streaking on the flanks. The buffiness usually bleaches out several months after fledging. Cere and legs are bluish to bluish-gray. Adults are lighter with triangular barring on the flanks. Cere and feet are yellow; the age at which this occurs appears to vary. One-year-old birds (still in juvenile plumage) in breeding or potential breeding situations have yellow feet and cere (Brown and Amadon 1968; USFWS Office of Migratory Bird Management, unpublished data).

Locations of eyries and perching places are often revealed by streaks of white droppings below perches.

See Friedmann (1950), Brown and Amadon (1968), or birding guides for characteristics for identification of parts or products.

Distribution: Breeds from central British Columbia, southern Alberta and Saskatchewan, and North Dakota south to Baja California, formerly to northwestern Missouri (see range map in Snow 1974). Winters from the northern parts of its breeding range south to central Mexico and east to the Mississippi River (AOU 1957).

Habitat: Prairie falcons inhabit relatively arid western regions. During the breeding seasons they are found in the foothills and mountains, which provide cliffs and escarpments suitable for nest sites. Escarpments associated with river systems are also used. Nesting sites are typically associated with open, treeless terrain which accommodates their low-level style of hunting. During the non-breeding season they leave the higher elevations and migrate to the intermontane valleys and Great Plains.

Breeding areas are generally at those elevations supporting suitable hunting habitat; the highest recorded nest site is 3,688 m in Colorado (Marti and Braun 1975). Nest sites with southern or eastern exposure are preferred (Enderson 1964; Leedy 1972); however, in southwestern Idaho no preference was noted, ostensibly due to milder conditions there (Ogden 1973:28).

There are marked seasonal habitat preferences; wintering birds are found away from the breeding areas in the intermontane valleys and on the Great Plains (Enderson 1964). Enderson (1964) recognized three distinct population units in terms of seasonal habitat use in Colorado: the breeding population, a post-breeding population found from June to October, and a wintering population. Age ratios of wintering populations appear to vary widely; only adults were found wintering on the northern fringe of their range (Calgary, Alberta) and only 3 of 22 birds caught near Albuquerque, New Mexico, were immature. In Colorado, 38% of wintering birds were immature (Enderson 1964). In Utah, immature Prairie falcons made up 64 to 73% of the wintering population during 1961–68 (White and Roseneau 1970).

Critical Habitat: Prey habitat must be preserved and breeding areas protected from unauthorized human disturbance.

Feeding Habits: Prairie falcons utilize a wide variety of foods, including mammals, birds, reptiles, and insects. In many areas, mammals, primarily ground squirrels, are used extensively during the breeding season (Ogden 1973; U.S. Bureau of Land Management 1975). Denton (1975) reported both mammal and bird remains at nests. In areas lacking ground squirrels, small to medium-sized birds and even reptiles (primarily lizards) predominate (Bond 1936*b*; Ogden 1973; Denton 1975; Kochert and Bammann 1975:29–31; Oliphant et al. 1976:367). Garrett and Mitchell (1973) reported that small mammal control programs in San Joaquin Valley, California, have reduced mammalian prey species and appear to have reduced nesting densities of prairie falcons; the remaining population preys primarily on small passerines.

Prairie falcons typically hunt from perches and in flight, flying at considerable speed. Prey is usually captured on or near the ground (Brown and Amadon 1968). During the breeding season extra food is cached near the nest for subsequent use (Peterson 1976:230). The extent of this behavior during the non-breeding season is unknown.

Recently fledged birds may concentrate on prey less difficult to capture, such as reptiles and insects (White 1962). In Idaho, the main prey species, the Townsend's ground squirrel, goes into estivation soon after young prairie falcons fledge. The Idaho population leaves the breeding areas during this period and presumably prey

species change considerably at this time (Ogden 1973:36; Kochert and Bammann 1975:41). Food habits of post-breeding populations are little known; wintering birds appear to depend heavily on horned larks in the western United States (Enderson 1964; White and Roseneau 1970; Garrett and Mitchell 1973:12).

Reproduction and Development: Reproductive activities begin in late winter to early spring (Denton 1975:32). Nest sites are typically found in several different situations: potholes or larger caves, horizontal ledges, and vertical or columnar cracks with lodged material forming a suitable nest site. Old nests of ravens, hawks, or eagles are sometimes used. Sites with an overhanging ledge affording protection from the elements are preferred (Enderson 1964; Leedy 1972:17; Ogden 1973; Denton 1975:18). Eggs are laid in shallow depressions scraped in the soil and debris. The height of the nest site on the cliff varies; generally any nest site over 4.5 m and inaccessible to mammalian predators is suitable (Leedy 1972; Ogden 1973:27).

Courtship and mate selection occur on the breeding grounds and last about a month before egg-laying (Enderson 1964; Brown and Amadon 1968). Pairs spend long periods of time sitting near the nest site and copulate at least several times per day (Enderson 1964:340). Most of the incubation, which lasts about 33 days (J. H. Enderson, personal communication), is done by the female.

Clutches of four or five eggs are typical (Brown and Amadon 1968), and if destroyed, a second clutch will be laid in 2–3 weeks (Enderson 1964). The male provides all the food during incubation, relieving the female while she eats, and during the early nestling period. As the young grow older and need less attention the female also hunts. Nest defense is carried out by both adults; human observers have occasionally been struck and their presence often provokes attacks on other nesting raptors in the area such as barn owls, great horned owls, and red-tailed hawks (Dawson 1913; Webster 1944; Enderson 1964:340; Ogden 1973:25).

At hatching, the young are covered with white down, which is replaced with juvenal plumage at about 2 weeks. Fledging occurs at about 30 days. The post-fledging period spent in the natal area is relatively short in those areas where ground squirrels are a major food source. Dispersal of juveniles (and also adults) is correlated with estivation of ground squirrels, which occurs from the end of May for adults to mid-July for juveniles (Johnson and Melquist 1975:158). In Washington, prairie falcons disperse to the alpine areas of the Cascade Mountains during late summer (Parker 1972).

Some prairie falcons breed when 1 year old (Webster 1944), but most probably do not begin breeding until their second year (Enderson 1964). Little is known about the length of sexual activity. Prairie falcons may live as long as 20 years (Enderson 1969*b*:506); however, the longest known banding recovery is 13 years. Enderson estimated immature mortality to be 74% and average annual adult mortality to be 25%. Shor (1975) estimated the life expectancy of the average falcon as 2.4 years.

Diseases and Parasites: Several diseases and parasites have been reported to cause mortality of prairie falcons, primarily nestlings. Platt (1975) attributed the abandonment of one clutch and the death of seven young in two other nests to the presence of the Mexican chicken bug (*Haemotosephon inodorus*). Trichomoniasis or "frounce" (*Trichomonas gallinae*) has affected up to 2% of nestlings in some populations (Ogden 1973) and can cause mortality of adults. Myiasis, a larval infestation by the nest screwworm fly (Calliphoridae), occurs frequently but rarely causes mortality (Ogden 1973); however, White (1963) attributed the death of 26 dead young in nine nests to myiasis.

Generally, the drier conditions found in prairie falcon eyries preclude severe infestations of the nest screwworm fly. Oliphant et al. (1976) noted an infestation of ticks (*Ornithodoros concanesis*) in one nest which had severely debilitated four of five young and resulted in the death of two of the four taken for rehabilitation. The presence of lice, mites, ticks, and fleas is apparently a common occurrence in prairie falcon nestlings, but severe debilitation or death is rare (Ogden 1973; Oliphant et al. 1976). Ward et al. (1970, 1971) noted aspergillosis and inclusion body hepatitis in captive prairie falcons, but did not believe that either was a significant threat to wild populations. Air sac nematodes have been recovered from prairie falcons (Ward et al. 1970) and have been implicated in several deaths (Bigland et al. 1964; Ward and Fairchild 1972).

Predators and Other Mortality Factors: Adult prairie falcons are little affected by predators, although incubating birds could conceivably be taken by great horned owls at night. Predation by coyotes, dogs, badgers, bobcats, golden eagles, and great horned owls is probably the greatest overall factor in nestling mortality by predators (Edwards 1973; Ogden 1973; USBLM 1975).

Shooting remains the most common cause of mortality for prairie falcons (Ogden 1973; Shor 1975). Human disturbance during the breeding seasons results in abandonment of nest sites in some areas (Leedy 1972; Edwards 1973). Various accidents also contribute to mortality. Craig and Powers (1976) reported an adult prairie falcon that drowned in a stock tank. Falling rock and debris may crack or dent eggs, usually resulting in hatching failure (Ogden 1973). Human disturbance and improper research techniques may result in desertion and damage to eggs or young (Leedy 1972; Edwards 1973; Fyfe and Olendorff 1976). Environmental contaminants are well-known causes of mortality and decreased reproduction: chlorinated hydrocarbons, notably DDE, result in eggshell thinning and consequent breakage (Fyfe et al. 1969; Enderson and Berger 1970; Blus et al. 1972; Enderson

and Wrege 1973; Ivens and Halliwell 1974). Mercury contributes to embryonic mortality (Fimreite et al. 1970) although its relationship and the cumulative effects with other biocides is not fully understood.

Population Level: Although most populations are probably reduced from historic times, prairie falcons do not appear threatened at this time and remain abundant. Garret and Mitchell (1973) reported that populations are declining in portions of California, whereas in other areas prairie falcons exhibit successful reproduction and remain at levels comparable to historic times. In Colorado, although production levels appeared relatively low in the early 1960's, the population was not deemed to be declining (Enderson 1964, 1969*a*). Olendorff and Stoddart (1974) believed that current populations in Colorado are relatively unchanged from historic times. More recently, studies in Washington, Idaho, Colorado, and Montana showed higher levels of production and stable or increasing populations (Leedy 1972; Parker 1973; Ogden 1975; Olendorff 1975). The Oregon population appears to be stable or increasing; many of the old peregrine sites have been taken over by prairie falcons (C. J. Henny, personal communication). In Canada, Fyfe (1977) reported declines during the DDT era and increasing populations since then. The inclusion of the prairie falcon on the Blue List (see December issue of *American Birds*, 1971 to present) does not appear warranted in light of the above studies.

Thacker (1971) estimated 22 prairie falcons held by zoos for research purposes. A considerable number of prairie falcons are utilized for falconry (Braun et al. 1977). A limited example is provided by the U.S. Fish and Wildlife Service (1976:Table 16): in California, Colorado, and Washington, 43 prairie falcons were harvested in 1973 and made up 5.8% of the total number of raptors taken for falconry (red-tailed hawks and American kestrels formed the majority). Prairie falcons are being bred successfully in captivity. Captive-raised birds are being placed in wild eyries to elucidate techniques for reintroduction of peregrine falcons and a considerable number are also being distributed to falconers (Freienmuth 1976*a*, 1976*b*). About 35 prairie falcons were distributed to falconers in 1975 and 1976. Future expansion of this program promises to considerably relieve the taking of wild birds.

Reasons for Current Status: It is difficult to determine the effects of land-use changes on prairie falcon populations. Significant alteration of prey habitat following water impoundment and various agricultural practices undoubtedly have had adverse effects. In California, pest control eliminated 1 million passerines from 1966 to 1972; roughly 30% of these were horned larks, a major winter prey species (Garret and Mitchell 1973). Habitat loss, however, is probably the most important factor threatening prairie falcon populations.

An accurate assessment of the number of prairie falcons taken for falconry is available for most States. In Washington, falconry harvest has been determined to be well within allowable rates. It is estimated that as many as 175 young could be harvested yearly from the estimated 200 pairs at current levels of reproduction. Current harvest, estimated at 20–30 per year, is substantially below that (Parker 1972). The impact of falconry on prairie falcon populations is not considered significant at this time nor is it expected to be (USFWS 1976). Captive breeding programs will undoubtedly become more important in reducing the take of birds from wild populations.

Organochlorine contaminants and mercury appear to have been primarily responsible for earlier declines (Fyfe et al. 1969, 1976; Enderson and Berger 1970; Enderson and Wrege 1973). Restrictions on mercury and DDT use have alleviated considerably the declines caused by biocide pollution (Fyfe 1975, 1977). Local populations in areas of agricultural pesticide use continue to show lowered reproduction (Leedy 1972; Parker 1972). In areas where prairie falcons feed primarily on birds, productivity and nest success are much lower than where the diet is primarily mammalian (Fyfe 1972*b*).

Management Activities: The most significant step toward prairie falcon habitat management was the establishment of the Snake River Birds of Prey Natural Area, 12,545 ha of prime nesting habitat set aside by the U.S. Department of the Interior (USBLM 1975, 1976, 1977; Olendorff and Kochert 1977). A moratorium on further agricultural development is in effect while habitat requirements of the prey utilized by breeding raptors are being studied.

In many areas, prairie falcons are limited by lack of nest sites even though suitable cliffs are present. Nesting ledges and holes dug in relatively permanent substrates have been widely accepted by prairie falcons in Canada (Fyfe and Armbruster 1977). The placement of nesting barrels on cliffs subject to erosion could provide much additional habitat in the western United States (Olendorff and Stoddart 1974).

The Snake River Birds of Prey Natural Area represents a large step forward in the study of raptorial species, including the prairie falcon. Project objectives encompass a broad program designed to determine requirements in terms of habitat, successional stage, food, and space for raptor population dynamics, and the effects on raptor populations (Kochert and Bammann 1975:vii).

There are restrictions on mercury and organochlorine (primarily DDT) use in United States and Canada. Prairie falcons are protected under the United States–Mexico Migratory Bird Treaty of 10 March 1972.

Various reproductive studies have been carried out on the Snake River Birds of Prey Natural Area and by Richard Fyfe of the Canadian Wildlife Service.

The Peregrine Fund (facilities at Cornell University, Ithaca, New York, and at Fort Collins, Colorado) raised prairie falcons on a relatively large scale up to 1978 to

elucidate techniques for their peregrine reintroduction program. The North American Peregrine Foundation and a considerable number of private individuals are raising prairie falcons for falconry purposes, alleviating pressure on wild populations.

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Sharp-shinned Hawk
(*Accipiter striatus velox* Wilson)

Status: Appears to be recovering from earlier declines. Primary threat probably is the continued use of organochlorine biocides in Central and South America, which results in contamination of prey species.

Original Discovery and Description: *Falco velox* Wilson, Am. Ornithol., Vol. 5, 1812, p. 116, plate 45, Fig. 1 (Banks of the Schuylkill, near Mr. Bartrams'-Philadelphia, Pennsylvania. American Ornithologists' Union 1957.

Background: The Pacific sharp-shinned hawk, *A. s. perobscurus* Snyder, breeds in the Queen Charlotte Islands and possibly adjacent areas of western Canada and winters south to Oregon; similar to *A. s. velox* in size but darker, especially in juvenal plumage. The Mexican sharp-shinned hawk, *A. s. suttoni* van Rossem, breeds in the mountains of Mexico south to Michoacan and Veracruz and intergrades with *A. s. velox* in northern Mexico; slightly larger than *A. s. velox*, underparts paler, less brownish, and more reddish with considerably reduced markings (Friedmann 1950: AOU 1957; Wattel 1973). Easily confused with Cooper's hawk which, although larger, is very similar in appearance.

A small woodland hawk preying almost entirely on small to medium-sized birds. Considerable numbers observed at various hawk-watching lookouts in central and eastern United States. Declines in recent years are attributed to organochlorine pesticides.

Status Determination: Has been on the Blue List, an "early warning" list of species exhibiting potentially serious declines, since 1971 (see December issues of American Birds, 1971 to present).

Description: A small accipiter, characterized by long legs, long tail, and short rounded wings. Adults dark bluish-gray above, underparts white, broadly barred with rufous or cinnamon, usually more rufous on the flanks. Females slightly browner above. Iris yellow-orange to deep red. Juveniles brownish above, underparts cream with broad cinnamon or brown streaks on the breast, diamonds or arrowheads on the abdomen, and barring on the flanks. Tail is relatively long and crossed with four dark bands. Iris pale yellow, claws and beak blackish. Adult plumage attained during second summer (Friedmann 1950; Wattel 1973).

Sharp-shinned hawks exhibit considerable sexual dimorphism in size; females average 1.7 times heavier than males. Iris color becomes progressively redder with age; it is pale yellow in the first year, yellowish-orange to reddish-orange in the second, and deep red by the third or fourth year. Males appear to change faster and also attain darker red color than do females. Variation in intensity and rate of eye color change preclude establishing precise relationships between age and eye color (Roberts 1967; Snyder and Snyder 1974).

Breeding sharp-shinned hawks characteristically use "plucking posts" ("butcher block"), where they deplume and partially dismember prey before taking it to the nest. These areas, with feathers and other body parts strewn about, are a good indication of nearby nesting activity (Brown and Amadon 1968).

See Friedmann (1950), Brown and Amadon (1968), Wattel (1973), and birding guides for characteristics for identification of parts or products.

Distribution: Breeds from Alaska and central Canada south to the southern United States, but scarce in the Southeast. Winters from British Columbia and northern United States south to Panama, the Gulf Coast, and the Bahamas (Friedmann 1950; AOU 1957; Wattel 1973).

Habitat: Breeds primarily in the coniferous and mixed conifer–birch–aspen forests of the Canadian and Transition life zones northward to the Arctic tree line. Less commonly found in other woodland types in the United States except in mountainous areas.

Nests are usually placed in trees with dense foliage below a well-developed canopy (Platt 1976; Hennessy 1978); conifers apparently meet this condition most frequently. In Oregon and Utah, proximity to water appeared important, as did the more mesic conditions associated with north-to-east slopes (Hennessy 1978; Reynolds 1978).

Large concentrations of migrating sharp-shinned hawks occur in the fall and spring along mountain ridges, lakeshores, and coasts, which provide updrafts and serve as barriers to migration. On migration and in winter sharp-shinned hawks occur in almost any type of habitat containing trees or shrubs.

Critical Habitat: Mixed coniferous–deciduous forest appears important as breeding habitat (Platt 1976).

Feeding Habits: Small to medium-sized birds (warblers and sparrow-sized species) predominate, and occasionally small mammals, insects, reptiles, and amphibians are taken. Mean weight of prey captured was calculated as 17.6 g by male and 28.4 g by female sharp-shinned hawks (Bent 1937; Storer 1966; Wattel 1973). Storer (1966) noted proportions of 97% birds to 3% mammals.

Sharp-shinned hawks use two basic methods of hunting: still hunting from inconspicuous perches and fast, stealthy flights along paths and around bushes and trees. Thus surprised birds are taken by sudden, fast attack. Captured prey is almost entirely plucked before being eaten; favorite "plucking posts" are frequently used.

Reproduction and Development: Nesting begins in early to late spring depending on latitude and, to some extent, weather. Adults may arrive at nest sites as much as a month before eggs are laid. Nests are usually constructed in densely foliated conifers and consist of small sticks and twigs. Nests are rarely reused; new nests are generally constructed in the immediate area of the previous year's nest (Brown and Amadon 1968; Platt 1976).

Little is known about mate selection in the sharp-shinned hawk; however, a recent study on a closely related species, the European sparrow hawk (*Accipiter nisus*) sheds some light on the process in accipiters (Newton and Marquiss 1978). Six male sparrow hawks in marginal habitat were followed by telemetry. Two spent all their time hunting over their entire territory and attracted no mates. Two others tended to concentrate somewhat in one area and attracted mates for 4 and 7 days, then resumed hunting over their entire territory and within 2 days the females had left. The final two birds spent much time concentrated at the nest area, attracted mates, and eventually bred successfully. Apparently the ability of the male to secure enough food to remain in the nesting area and devote his time to courtship and nest-building is crucial to pair formation and eventual breeding success.

Eggs, usually four or five, are laid in the late spring and take 30–32 days to hatch (Brown and Amadon 1968; Platt 1976). Eggs are incubated primarily by the female; the male provides all the food and may attend the nest for short periods while the female is eating.

The young are covered with white down when hatched and begin feathering out at 10–14 days (Brown and Amadon 1968). The male provides most of the prey for the first 2 weeks, after which the female spends increasing periods of time hunting as the young require less attention. Young males fledge at about 21–24 days and females at 24–27 days (Platt 1976; R. T. Reynolds, personal communication); they remain dependent on the parents for food for several weeks.

Sharp-shinned hawks usually begin breeding when 2 years old; the maximum known life-span is 12 years (Kennard 1975).

Mortality Factors: Significant sources of predation have not been described; eggs and small young may be taken by typical nest predators such as raccoons, snakes, and crows.

Sharp-shinned hawks have shown clear declines since the pre-1947 (pre-DDT) years. Analyses of sharp-shinned hawk eggs have shown exceedingly high levels of DDE (Snyder et al. 1973). Known relationships between DDE levels and eggshell thinning indicate that significant shell thinning is occurring. Although sufficient data on reproduction are lacking due to difficulties involved in finding nests, indices of migrating sharp-shinned hawks show declines between 1947 and 1971, the years of heaviest DDT use (Robbins 1974). Although shooting was a significant source of mortality when large-scale shooting occurred at various migration concentration points, it is now a relatively minor source of mortality for sharp-shinned hawks. Various accidents, storms, and factors affecting prey populations also contribute to mortality (Bent 1937; Snyder et al. 1973).

Population Level: It is very difficult to assess the population level of sharp-shinned hawks. Data on reproduction and nesting density are lacking. Indices collected at various migration concentration points (e.g. Hawk Mountain, Pennsylvania; Cape May, New Jersey; Hawk Cliff, Ontario; Cedar Grove, Wisconsin; Duluth, Minnesota) are subject to observer bias, lack of consistency of counts from year to year, and lack of standard observation and reporting procedures. Weather variables, which affect migration greatly, are difficult to assess in terms of magnitude of observed migration. However, looking at long-term trends (Robbins 1974), which tend to average out weather variables, and correcting for number of hours of coverage, it appears that sharp-shinned populations declined, especially in the eastern United States, until about 1971. Data from subsequent years indicates an upward trend (Robbins 1974; J. L. Ruos, C. J. Henny, R. T. Reynolds, personal communications).

Sharp-shinned hawks are relatively difficult to keep in captivity. A 1971 survey (Thacker 1971) reported two birds. An additional number, probably less than 20, are utilized for falconry. Captive breeding is technically possible; little emphasis has been placed on breeding sharp-shinned hawks.

Reasons for Current Status: Intensive forest management, particularly in western coniferous forests, results in large blocks of monotypic habitat, thus reducing potential and active nest sites as well as prey species (R. T. Reynolds, personal communication).

The actual magnitude of the large-scale shooting at migration concentration points is unknown but was most prevalent from 1895–1930 (Robbins 1974) and may have contributed to early declines. Protection from environmental contamination is limited to the DDT ban in the

United States. Large-scale use of DDT and other organochlorines continues in Central and South America.

Organochlorines, primarily DDE, may be responsible for observed declines (Snyder et al. 1973). The DDT ban in the United States appears to have helped sharp-shinned hawk populations considerably (Robbins 1974); DDT residues in migratory songbirds (primary sharpshin prey) have been declining since 1964 (Johnston 1974). However, large-scale use continues in Central and South America contaminating prey species that return to the breeding range of the sharp-shinned hawk as well as those in its wintering areas (Fyfe 1977). The proportion of sharp-shinned hawks wintering south of the United States may be considerable. Whereas 9 of 21 sharp-shinned hawks banded at Duluth, Minnesota, were recovered in Mexico and Central America during November through February, 6 of 9 recoveries were south of the United States in January and February. By March all recoveries were north of Mexico (D. L. Evans, unpublished data).

Management Activities: Hawk shooting at migration concentration points has been eliminated due to combined efforts of private individuals, Audubon Society, and law enforcement officials to increase public awareness. Sharp-shinned hawks are protected under the United States–Mexico Bird Treaty of 10 March 1972.

The Hawk Migration Association of North America (HMANA) is establishing standard procedures of observation and reporting at the various hawkwatches in the United States (J. HMANA (1):1–2).

See Snyder (1973) for current research on accipiters.

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APPENDIX

Emergency Care for Ill and Injured Raptors

1. Stop bleeding. If bleeding is severe, use direct pressure on wound.
2. Contact a raptor rehabilitation center near you (see Raptor rehabilitation) or call your local veterinarian. Seek further instructions if possible. If this is not possible, the following initial treatment is usually recommended:

   • The most critical problem is usually dehydration and starvation, not the wounds or broken bones that initially incapacitated the bird. Therefore, you should administer fluids orally, at a dose of 6 tablespoons per pound, every 3 h the first day. (Eagles weigh 8–12 lb (3.6–5.5 kg), great horned owls 2-1/2–4 lb (1.1–1.8 kg), and red-tailed hawks 1-1/2–2-1/2 lb (0.6–1.2 kg). The best fluid is Gatorade, because it provides glucose, phosphate, and salts. It is boiled to remove carbonation. If Gatorade is not available, use water (*not sugared*). Administer the fluid with a syringe, poultry baster, small rubber tube, etc., but be careful to avoid getting fluids down the trachea (windpipe).

   • Immobilize broken wings by binding them to the bird's body snugly with gauze, cloth strips, or masking tape.

   • Place the bird in a dark box or dark room. Keep it warm. Put newspapers in the bottom of the box and cut slits near the bottom of the box for ventilation.

   • If you have to hold the bird for 1 or more days, try to feed it; perhaps force-feed it if necessary. Use raw meat (poultry or beef) or a fresh roadkill.

   • Advise a veterinarian to dose the bird with a broad-spectrum antibiotic (tetracycline or chloramphenical are good; give at the rate of 20 mg/lb in three divided doses daily).
3. If the bird dies, freeze it as soon as possible to preserve it for valuable postmortem examination.
4. Raptor rehabilitation:

   Dr. Pat Redig and Dr. Gary Duke
   Dep. of Veterinary Medicine
   University of Minnesota
   St. Paul, Minnesota 55108

   Jim Wisecarver and Gary Bogue
   Alexander Lindsay Museum
   Walnut Creek, California 97596

   New Jersey Raptor Association
   21 Spring Lane
   West Caldwell, New Jersey 07006

   Dr. John Lee
   Meridian Veterinary Clinic
   Meridian, Idaho 83542

   Tom Buchanon
   2450 Glendale Avenue
   Abilene, Texas 79604

   Stillami Ure
   2322 Walker Lane
   Salt Lake City, Utah 84117

   Hope Carpenter
   R.D. 1, Box 150A
   Mt. Bethel, Pennsylvania 18343

   Dr. Tom Thomas
   USAF Academy
   Colorado Springs, Colorado 80840

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