ENHANCING RAPTOR POPULATIONS

A Techniques Manual

by

Carl D. Marti
The Peregrine Fund
5668 West Flying Hawk Lane
Boise, Idaho 83709
United States of America
January 2002

Telephone (208) 362-3716
www.peregrinefund.org
tpf@peregrinefund.org
Fax (208) 362-2376

Art Credits

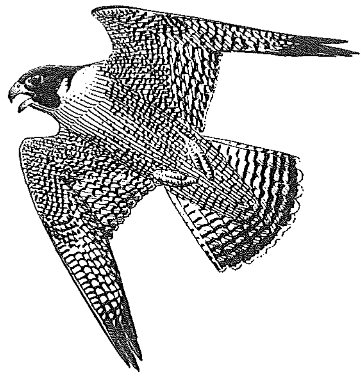
John Schmitt
Cover and pages 1, 3, 4, 27, 28, 29, 30, 31, 32
33, 34, 36, 37, 41, 42, 43, 44, 50, 51, 53, 54

Hans Peeters
Page i

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES



INTRODUCTION

Raptors—falcons, hawks, eagles, vultures, and owls—are birds that fascinate humans because their powerful flight, keen eyesight, acute hearing, and sharp talons make them incredibly efficient predators (Burnham, 1990). Interestingly, raptors represent three separate evolutionary lines that have converged in appearance and habits. The taxonomic order Ciconiiformes contains the New World vultures; Falconiformes includes the kites, eagles, hawks, falcons, and Old World vultures; and the Strigiformes consists of the owls.

Raptors are relatively scarce animals even under the best conditions because they exist at the top of food chains where the amount of energy available will support only small populations. Their rarity, though, is another characteristic that humans value—the occasional chance of seeing a raptor is appreciated more than seeing common, everyday species. Rarity has its drawbacks, too, because existing at small population size engenders a substantial risk of extinction for any animal. Thus, anything that reduces the already small populations of raptors is especially critical to their survival.

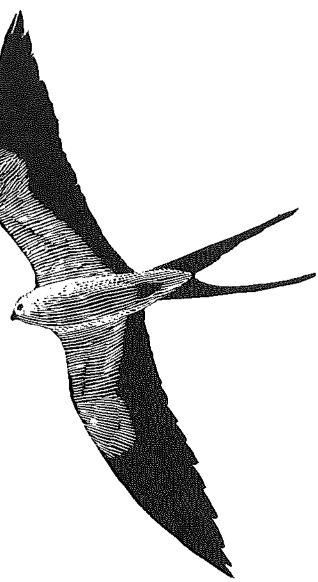
Because raptors are predators, their survival relies not only upon their own adaptations but also on the success of countless other species lower in the energy pyramid. Feeding high on food chains also makes them more susceptible to poisoning by pesticides and other pollutants than short-lived or plant-eating species. Certain toxicants accumulate in organisms over time, and become concentrated as they move up through organisms in food chains (Keith, 1966; Henny, 1977a). Consequently, some toxic substances have had catastrophic impacts on the populations of raptors (Newton, 1979). The Peregrine Falcon (*Falco peregrinus*), for instance, was eliminated from much of North America largely as the result of the extensive use of DDT and related pesticides which began shortly after World War II. By 1964 Peregrines had been extirpated east of the Mississippi River (Cade et al., 1988).

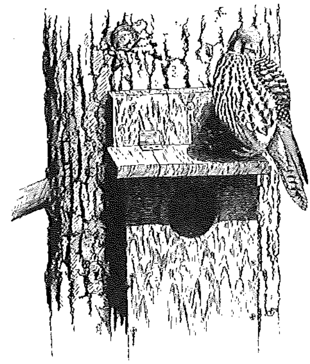
Even though many raptors have adapted with varying success to human-dominated landscapes (Bird et al., 1996), numerous populations have suffered declines resulting from negligent and irresponsible enterprises by humans (Bijleveld, 1974; Newton, 1979). These actions, including direct killing and environmental degradation, have reduced many raptors to threatened or endangered status. Some of these species, such as the Peregrine Falcon and the California Condor (*Gymnogyps californianus*) needed large-scale, professional intervention to restore their populations to viable levels. Numerous other species, however, can benefit from small-scale projects, even those conducted by individual people, possibly keeping them from reaching the critically low populations that require much more expensive and extensive recovery efforts.

This manual presents varied techniques that have been used to enhance raptor populations, including the establishment of artificial perches and nest structures, protecting nesting raptors from disturbance, reducing the risks of collisions and electrocution, captive breeding, rehabilitation of injured raptors, and artificial feeding. Such procedures are often not widely known or available to the people who would be willing to put them into practice. Some of them, e.g., building nest boxes, are easily and inexpensively implemented and those are emphasized herein. Others, e.g., captive breeding, are expensive and require specialized knowledge and are covered briefly with emphasis on how individuals can contribute.

Before attempting any of the projects in this manual, interested persons should carefully consider and understand that risks, both to the birds and to humans who attempt to work with them, are inherent in working with raptors. Raptors may abandon nests, roosts, or feeding areas if they are approached by humans, and the degree of this sensitivity varies considerably among species, individuals, geographic area, and season of the year. Many raptors are capable of inflicting serious damage with their feet and beaks, some will attack people who approach their nests, and most defend themselves vigorously if handled. People who lack the background to evaluate these risks, but still desire to carry out projects to enhance raptor populations, should consult with experts before beginning.

Can one person's contribution make a difference in enhancing raptor populations? Is it too late to begin? Who is qualified? Hamerstrom (1979) suggested that the answers to those questions were yes, no, and everyone. She emphasized that anyone interested in raptors can make a contribution of some kind by directing his/her skills in the right direction. The objective of this manual is to help direct individuals and organizations in assisting in the conservation of raptor species. Anyone can help make a difference!





ARTIFICIAL NESTS

Carrying capacity for raptors is determined mainly by the number of nest sites or food density, and whichever of these is in shorter supply may limit the number of breeding pairs (Newton, 1979). Nest-site shortages can be remedied for some species by the addition of artificial nests including nest boxes for cavity nesters, platforms for tree or ground nesters, and ledges for cliff nesters.

The Value of Nest Boxes

The loss of trees, and especially dead trees with natural cavities, limits populations of many cavity-nesting birds (Gary and Morris, 1980; Twedt and Henny-Kerr, 2001), but nest boxes can be used as supplementary nest sites. Not only can boxes increase the number of nesting sites, often they are more secure from weather and predators than natural cavities and may increase the production of young (Møller, 1994). Many studies have demonstrated that the provisioning of nest boxes can increase breeding numbers. Two species, the American Kestrel (*Falco sparverius*) and the Barn Owl (*Tyto alba*), in particular, have benefitted from nest boxes. Neither of these species is endangered, but because they are common and widespread they have been studied intensively. What we learn from them may be applicable in the conservation of species that are at higher risk.

The addition of nest boxes increased populations of American Kestrels in many locations of North America (Hamerstrom et al., 1973; Stahlecker and Griese, 1979; Toland and Elder, 1987, Highhouse, 1989). Other species of kestrels also nest in boxes, but less is known about the effect of artificial nest sites on their populations; in the Czech Republic the Eurasian Kestrel (*Falco tinnunculus*) increased its population density by

14 times over what it was prior to the addition of nest boxes (Plensník, 1990). Lesser Kestrels (*Falco naumanni*) in Spain used nest boxes placed upon buildings to compensate for declining availability of natural nest sites (Pomarol, 1996), and nest boxes were a part of the recovery effort for a critically endangered raptor, the Mauritius Kestrel (*Falco punctatus*; Jones et al., 1991).

The Barn Owl readily uses nest boxes and its populations have sometimes increased dramatically when added nest sites were made available. These results have been seen in such diverse locations as Utah (Marti et al., 1979), Switzerland (Juillard and Beuret, 1983), California (Schulz and Yasuda, 1985), Malaysia (Duckett, 1991), United Kingdom (Taylor et al., 1992; Petty et al., 1994), and Israel (Kahila et al., 1994). Bellocq and Kravetz (1993) found that productivity of Barn Owls in Argentina was greater in nest boxes than in natural cavities, and average Barn Owl brood size increased in Germany when nest boxes were available (Ziesemer, 1980).

The breeding population size of two other owl species increased after nest boxes were provided–the Ural Owl (*Strix uralensis*) in Finland (Pietiäinen, 1989) and the Little Owl (*Athene noctua*) in Germany (Exo, 1992). Petty (1987) thought that Tawny Owls (*Strix aluco*) gained the advantage of protection from weather and predators when they switched from natural nest sites to nest boxes even though the number of breeders probably did not increase.

Additional raptor species known to use nest boxes include the Peregrine Falcon (Orr and Anderson, 1993), Barred Owl (*Strix varia*; Johnson, 1987), Eastern Screech-Owl (*Otus asio*; Gehlbach, 1994), Western Screech-Owl (*Otus kennicottii*; Doremus, 1991), Flammulated Owl (*Otus flammeolus*; Marti, 1997) Ferruginous Pygmy-Owl (*Glaucidium brasilianum*; Proudfoot and Beason, 1997), Eurasian Pygmy-Owl (*Glaucidium passerinum*; König, 1995), Boreal/Tengmalm's Owl (*Aegolius funereus*; Hayward et al., 1992; Korpimäki, 1987), and Northern Saw-whet Owl (*Aegolius acadicus*; Cannings, 1987), but any cavity-nesting raptor is a potential user of nest boxes.

It must be recognized that putting up nest boxes does not guarantee that they will be used by raptors, nor that they will enhance breeding populations. If some other resource is limited or lacking in the vicinity, the boxes will have little, if any, impact. This was the case in several midwestern states where boxes were put up to increase populations of Barn Owls; several hundred boxes were placed in Illinois, Indiana, Iowa, Michigan, Missouri, Nebraska, Ohio, and Wisconsin, but very few were used, apparently because food was too scarce (Marti, 1988). Boxes placed in spruce forest in the United Kingdom were never used by Eurasian Kestrels, seemingly because old crow nests were numerous and used instead (Petty, 1985).

Nest Box Construction

General Considerations—Several general guides to constructing nest boxes for birds are available (Gary and Morris, 1980; Henderson, 1984; Dewar and Shawyer, 1996), and they all recommend wood as the best material for nest boxes. Exterior plywood can be used, but it deteriorates more rapidly than solid lumber. Redwood and cedar are long-lasting woods, but expensive and rather soft. No. 2 grade 1-in-thick fir or pine dimension lumber (actually 3/4 in thick) is the best choice, considering both price and durability. A table or radial-arm saw should be used to cut the box parts precisely and a drill press or hand-held electric drill with a circle-cutter bit used to make the entrance hole. The parts can be assembled with a hammer and galvanized nails, but the longest-lasting joints are made with exterior, construction adhesive and grabber screws. Grabber screws can be driven quickly and easily with an electric drill and screwdriver bit. The floorboard must be enclosed with the sides of the box to prevent water from seeping in. Four to five 1/4 in holes drilled in the bottom will drain any rain that enters the entrance hole. The outsides of boxes can be left untreated, but boxes will last longer if given one to two coats of a wood preservative or paint; subdued colors that blend with the tree or other substrate on which the box will be mounted are preferred. Insides of boxes should not be painted or otherwise treated. A 2.5–5 cm (1–2 in) thick layer of wood chips must be placed in the bottom of the box because hole-nesting raptors do not make a nest. Sawdust should not be used because it tends to hold moisture and becomes matted.

Boxes have also been made of plastic. Petty et al. (1994) used 80 l (21 gal) plastic buckets mounted either upright or on their sides for use by Barn Owls. A wooden cover was made for the open end of the bucket and a square hole cut in the bucket as an entrance. Similar but smaller 25–30 l (6.5–8 gal) buckets were used as Eurasian Kestrel boxes in the

Czech Republic (Plensník, 1990). Polyvinyl chloride (PVC) pipe was used to make nest boxes for American Kestrels (Pasa, 1988); a 46 cm (18 in) piece of 25 cm (10 in) diameter PVC was equipped with a wooden top and bottom. Tops were attached with a hinge and bottoms were held in place with a removable pin for cleaning. Fifty percent of such boxes were used in the first year by kestrels in Iowa.

A more aesthetic alternative to the use of nest boxes is to construct artificial cavities in live trees. One way to accomplish this is with a chain saw, hammer, and chisel (Gano and Mosher, 1983). Two cuts parallel with the ground are made in a vertical tree trunk or limb with the chain saw. The hammer and chisel are then employed to remove the slab and hollow out a cavity. An entrance hole is drilled in the slab, and the slab is secured to the tree with 7.6 cm (3 in) strips of rubber inner tube wrapped around the tree and nailed. Size of the cavity and entrance hole depends on the target species. Cavities took 1.5 hours to complete and 84% were used within 12 months by birds and mammals.

Techniques to produce nest cavities in trees through the use of fungi are also being explored. These mechanisms are slow, but the cavities produced are natural and may be more aesthetic to human eyes and attractive to wildlife. Carey and Sanderson (1981) removed a triangular piece from live trees and inoculated the hole with fungal cultures specific to the tree species. After 4–5 years, the cavities formed were mostly still too small for even the smallest cavity nesting raptors, but were used by small mammals. A similar approach is being developed by Huss et al. (In press) who suspected that decay in tree trunks caused by fungi facilitated the excavation of cavities by woodpeckers. After collecting and isolating appropriate fungal strains, Huss et al. (In press) inoculated trees by inserting hollow dowel plugs containing the fungi into holes drilled into live trees. A piece of PVC tubing was inserted after the dowel to prevent the tree from healing over the wound. If this technique works, eventually woodpeckers will excavate cavities where the fungal decay has produced softer areas. In later years, these cavities will provide nesting places for other species, including some raptors.

Kestrel/Small Owl Box—American Kestrels, screech-owls, Northern Saw-whet Owls, Boreal Owls, and Flammulated Owls will all use a box with internal dimensions of approximately 18 x 23 x 41 cm (7 x 9 x 16 in) and a 7.5 cm (3 in) entrance hole. See Fig. 1 for construction details and exact dimensions.

For kestrels, such boxes may be attached to either live or dead trees, poles, and buildings about 3–5 m (9–15 ft) high with a clear flight path to the box. Kestrels are versatile and have occupied nest boxes in urban areas (Sutton and Tyler, 1979; Marti, pers. obs.), deciduous forests (Jacobs, 1995), boreal forests (Bortolotti, 1994), and deserts (Steenhof, 1991). In areas where tree squirrels are present, Wilmers (1982) recommended placing boxes at least 50 m (165 ft) from forest borders to discourage use by the squirrels; he also suggested placing boxes at least 150 m (495 ft) apart, but 400 m (1320 ft) may be the optimum distance.

Direction of the entrance hole did not seem to matter in California (Bloom and Hawks, 1983), although 67% of occupied boxes in Missouri faced south or east (Toland and Elder, 1987). Eurasian Kestrels preferred boxes sheltered from the prevailing wind (Shutt and Bird, 1985) and larger boxes located in sheltered places (Valkama and Korpimäki, 1999) in Finland. Crawford and Postovit (1978) discovered that American Kestrels using natural sites selected higher nests with smaller openings from among those available.

European Starlings (*Sturnus vulgaris*) can be important competitors for this size of nest box (Curley et al., 1987; Bechard and Bechard, 1996), but starlings dislike boxes with light interiors (Lumsden, 1976; Wilmers, 1982). Hence, to reduce the use by starlings, boxes should be placed where sunlight infiltrates the entrance hole. The light color of raw wood helps illuminate the interior and is a further reason not to paint the inside of the boxes.

Peregrine Falcon Box—Details on the construction and placement of nest boxes for Peregrine Falcons are given in detail in Cade et al., (1996).

Barred Owl box—The Barred Owl needs a larger box with a bottom measuring 29 x 29 cm (11.5 x 11.5 in) and about 60 cm (24 in) deep with a 17.8 cm (7 in) diameter entrance (see Fig. 2). Boxes should be attached to trees 5–6 m (15–20 ft) above the ground in wooded areas. Records of Barred Owls using nest boxes are scarce (Johnson, 1987, Postupalsky et al., 1997), but two closely related Old World species, Tawny and Ural owls, commonly use nest boxes (Southern, 1970; Lundberg and Westman, 1984; Petty, 1987; Pietiäinen, 1988). Petty (1987) used a box much like the one depicted in Fig. 2 for Tawny Owls, but Southern (1970) used a box that resembled a broken-off and rotted-out limb.

NOTES:
Build with 1" x 10" pine
Coat with clear wood finish
Drill five 1/4" drain holes in bottom and two 1/2" vents in sides
Assemble with waterproof construction adhesive and 1 5/8" grabber screws
Top is removable for cleaning--do not attach it with glue or screws

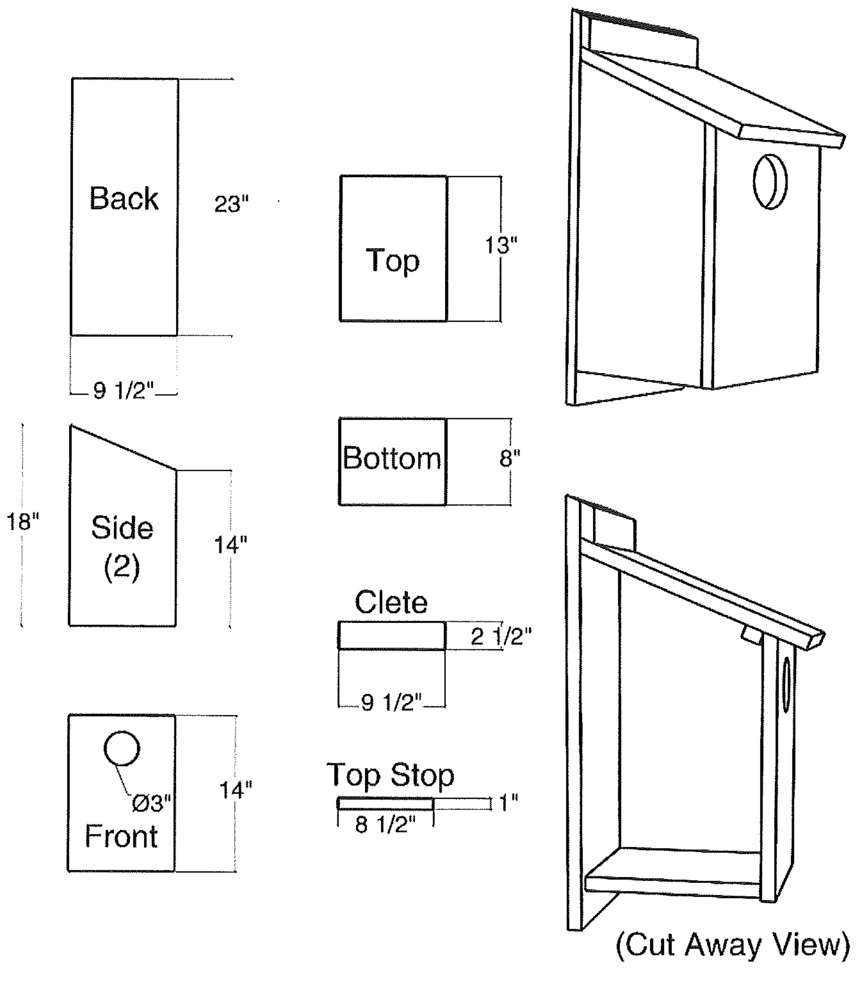


Figure. 1. Nest box for kestrels and small owl species built from 3/4 in dimension lumber.

NOTES:
Build with 1/2" exterior plywood
Coat with clear wood finish
Drill five 1/4" drain holes in bottom

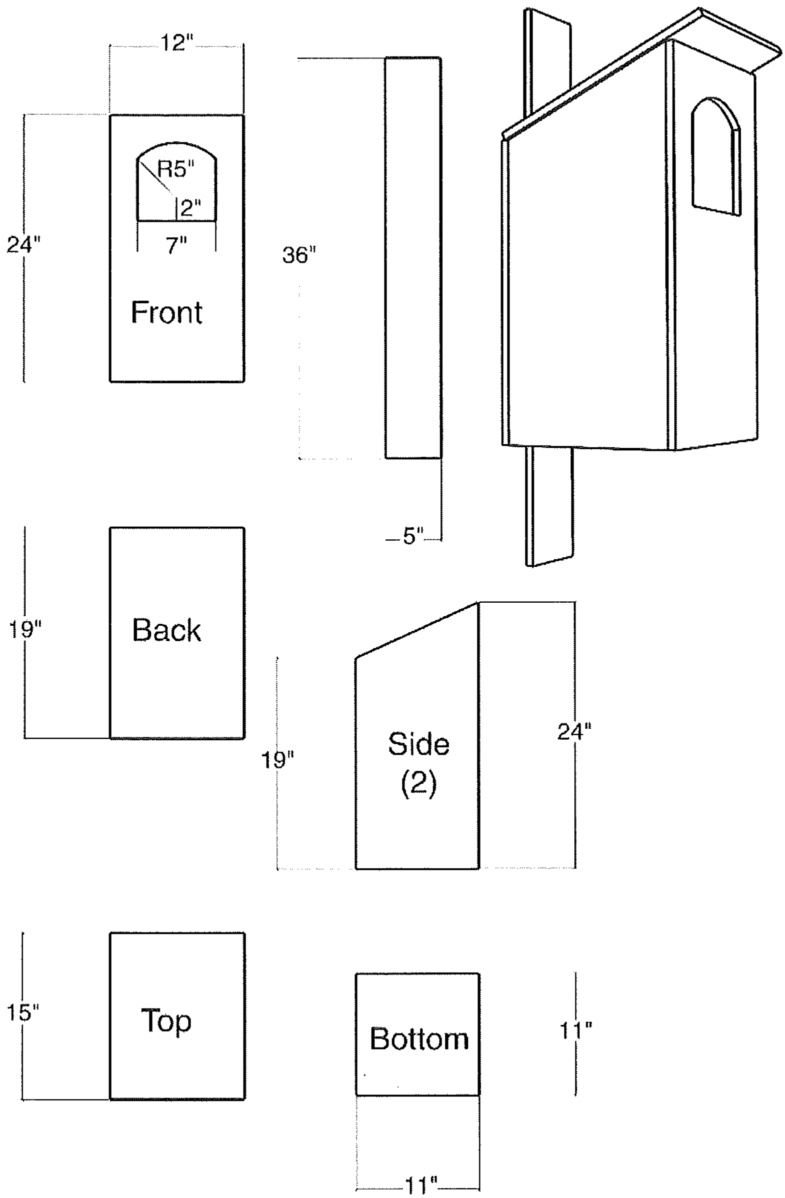


Figure. 2. Nest box for Barred Owls made from 1/2 in exterior plywood.

Barn Owl Box—Barn Owls nest in a wide variety of natural cavities and likewise are very adaptable in the types of nest boxes they will use. Schulz and Yasuda (1985) placed boxes in trees in California, Marti et al. (1979) put them in silos in Utah, Colvin (1983) and Taylor (1994) mounted boxes in barns in Ohio and Scotland, respectively. Boxes were placed on free-standing poles in plantations in Malaysia (Duckett, 1991).

Barn Owls are medium-sized birds and have large broods so they need rather roomy nest boxes. The bottom should be about 0.36 m^2 (4 ft^2) and the box should be about 40.5 cm (16 in) in height. The entrance should be square, measuring 15–20 cm (6–8 in) on a side. Boxes used by Barn Owls have been made with diverse designs. See Figs. 3–4 for construction details.

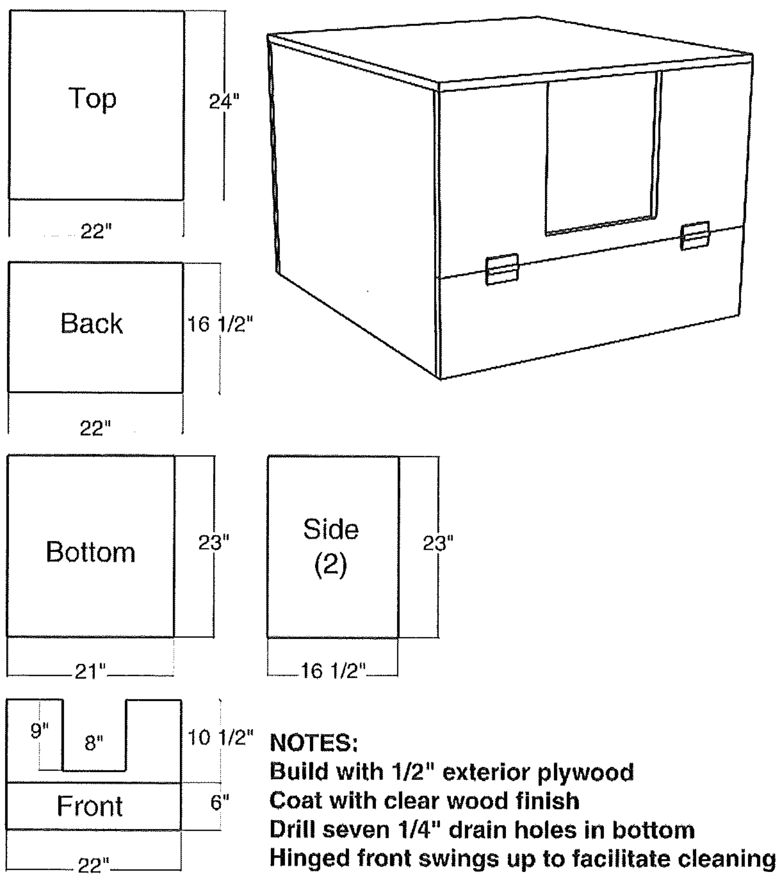


Figure. 3. Nest box for Barn Owls for mounting inside silos, barns, or other open buildings.

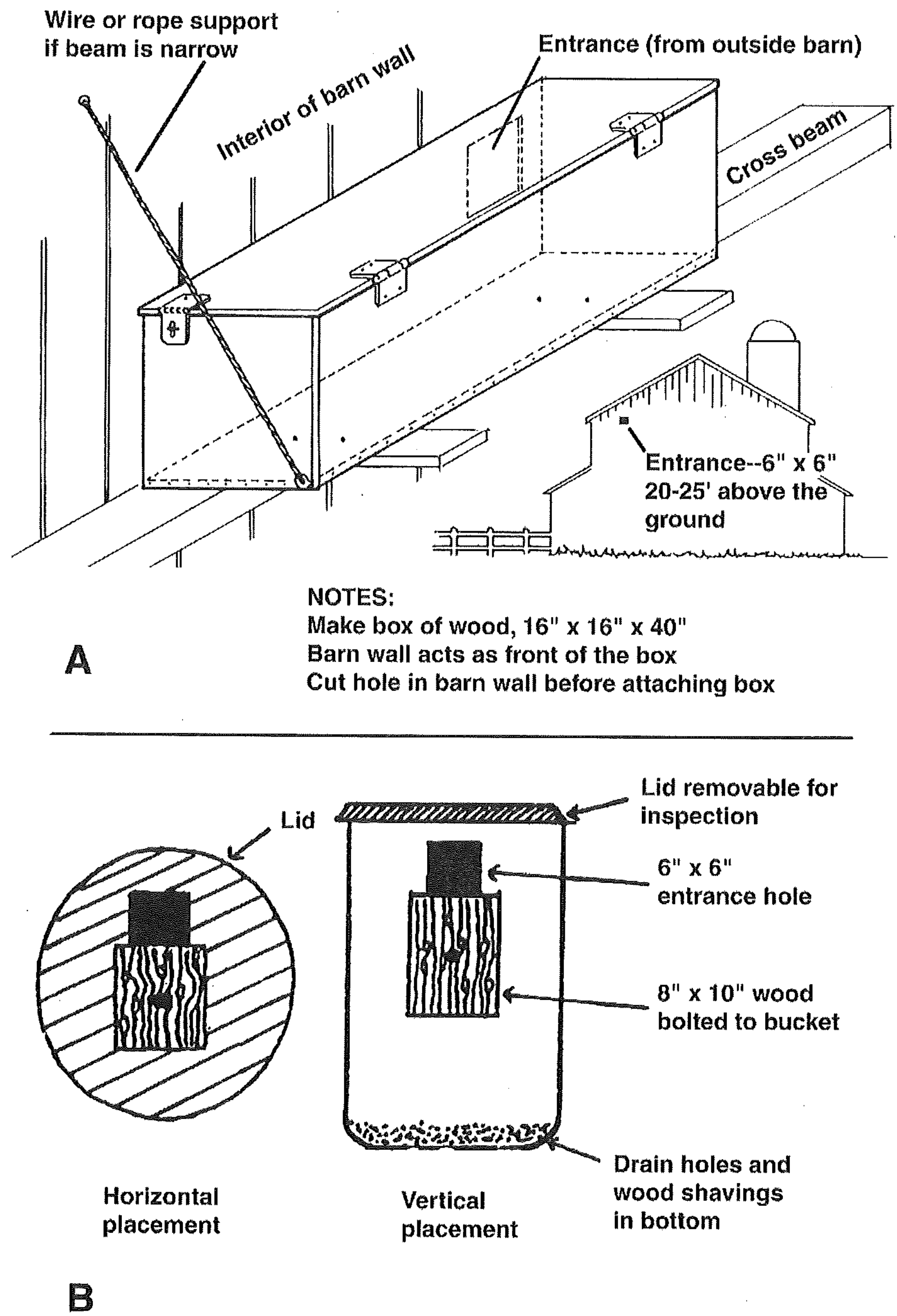


Figure. 4 . A. Barn Owl nest box designed for placement inside barns with direct access to the outside (Modified from Colvin, 1983). B. Barn Owl nest box made from 80-l plastic bucket for mounting in trees (modified from Petty et al., 1994).

Nest Platforms

Raptors that use open nests can also be induced to use artificial nests for the purpose of augmenting their populations. A number of these species have suffered declining populations at least partly due to loss of nesting places. Ospreys (*Pandion haliaetus*) received the most attention in terms of artificial nests, and building artificial nests for them was among the earliest management strategies designed to help them recover from population declines (Henny, 1977b). Techniques to provide artificial nests include killing live trees to create snags attractive to Ospreys (Glinski et al., 1983) and topping live trees; Airola and Shubert (1981) cut the tops off trees with trunks more than 35 cm (14 in) in diameter and built platforms on the top (Fig. 6C). See some examples of other Osprey nest platforms in Figs. 5–8. Construction details for a variety of Osprey nest platforms to be used in trees, on existing poles or towers, and self-standing nest platforms are given in Ewins (1994). The use of such platforms has benefitted Ospreys by increasing the breeding population, decreasing nestling mortality, and increasing fledging rates (Rhodes, 1972; Postupalsky, 1978; Houston and Scott, 1992).

Ewins (1994) made the following recommendations regarding placement of Osprey nest platforms:

1. Place them within 50 m (165 ft) of water preferably 1–2 m (3-6 ft) deep.
2. Use small rock islets, if possible, for predator protection.
3. Put structures in the highest trees available or on poles more than10 m (30 m) from the nearest trees because Ospreys need room to maneuver in flight.
4. Place structures at least 100 m

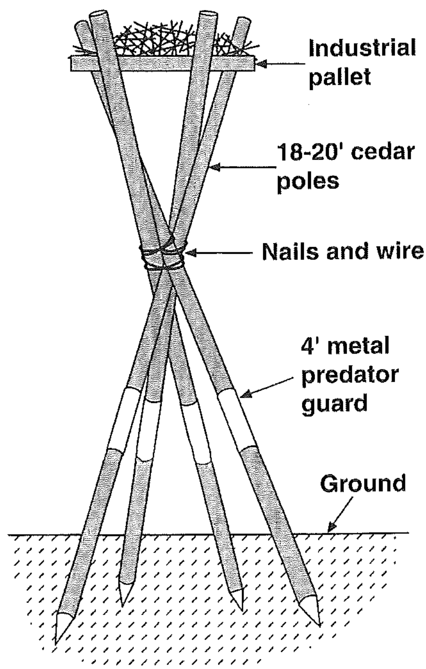


Figure. 5. Quadrapod Osprey nest platform. Designed for stability in water that freezes(modified from Ewins, 1994).

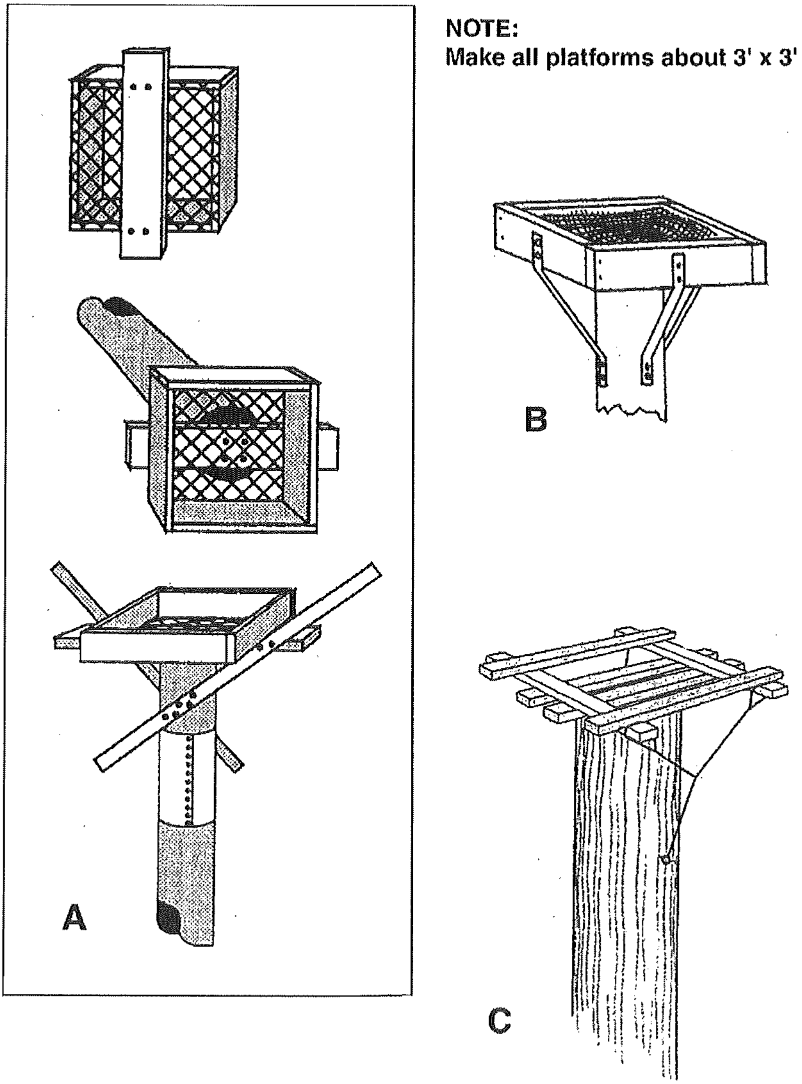


Figure. 6. Three Osprey nest platforms. A. International Osprey Foundation design. B. Minnesota design. C. Platform for top of sawn-off tree (modified from Ewins, 1994). See Fig. 7 for measurements.

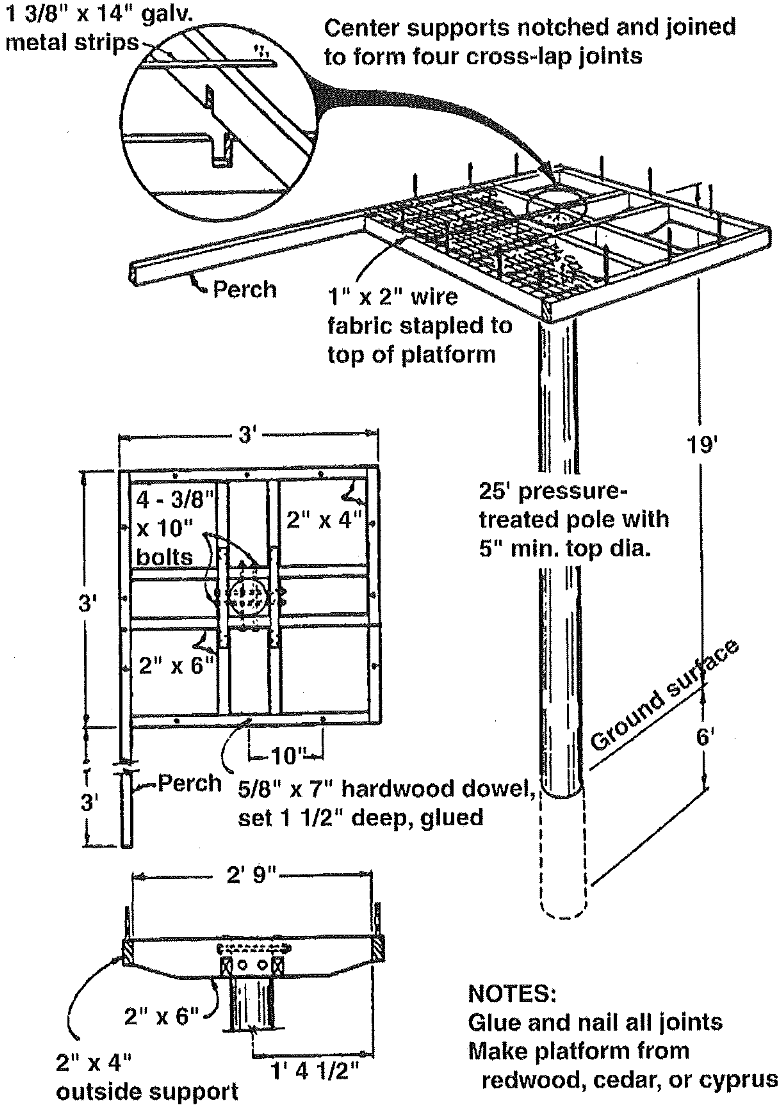


Figure. 7. U.S. Bureau of Reclamation design Osprey nest platform (modified from Ewins, 1994).

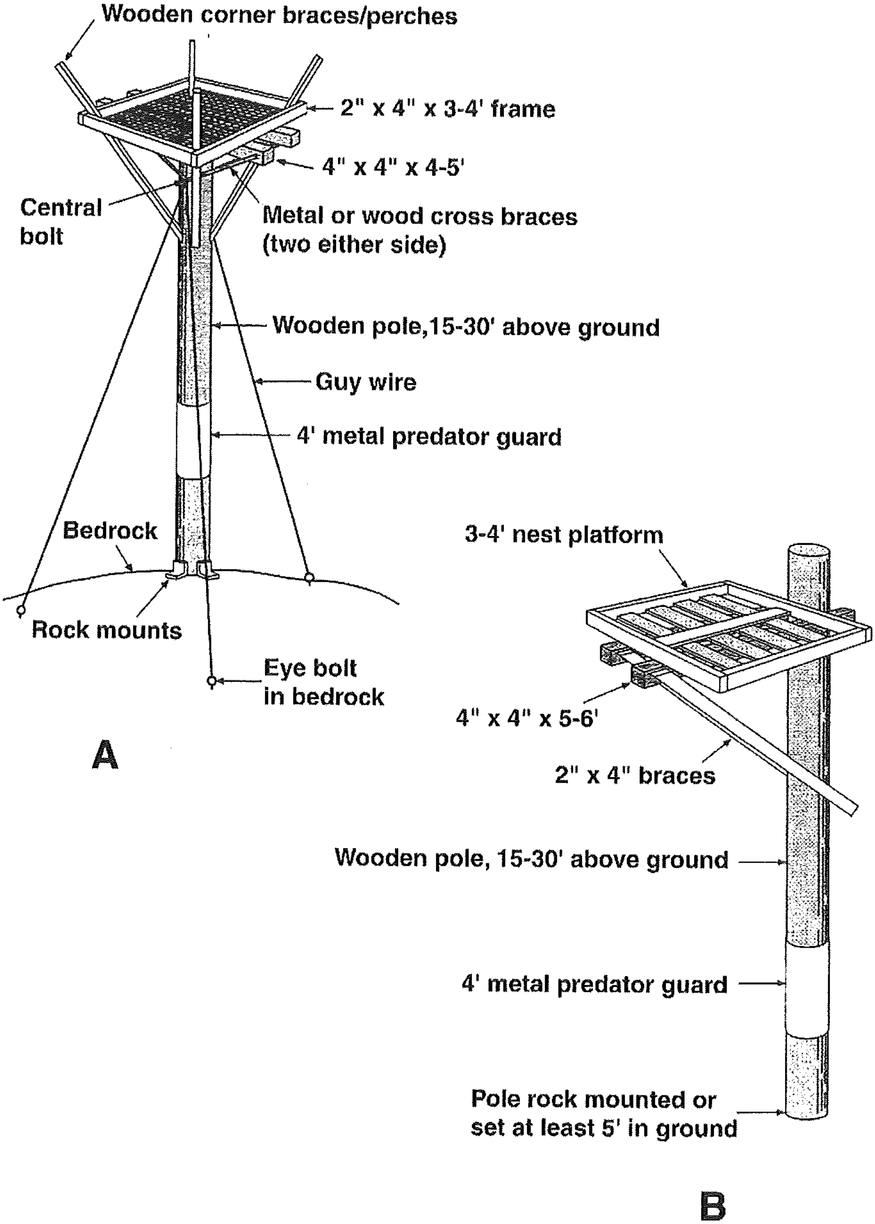


Figure. 8. Two Osprey nest platforms. A. Georgian Bay design for mounting on bedrock. B. Ontario Ministry of Natural Resources and Environment Canada design made from hardwood industrial pallet (modified from Ewins, 1994).

(330 ft) from houses or heavily traveled roads.

5. If platforms are on poles on dry ground, use an anti-predator guard on the pole.
6. Space platforms at least 200 m (660 ft) apart.
7. Avoid areas with lots of Bald Eagles (*Haliaeetus leucoephalus*).
8. Contact the local wildlife agency before erecting platforms to make sure that Ospreys will not interfere with sensitive wildlife.

Construction notes fromEwings (1994) include:

1. Cedar is the best wood to use. Avoid pressure treated wood because it can leach preservatives into water courses.
2. Use galvanized nails, bolts, and wire. Pre-drill holes to avoid splitting wood.
3. If no tree perches are located near the platform, nail a length of wood to the platform sticking out 1 m (3 ft) for a perch.
4. If raccoons (*Procyon lotor*) are in the vicinity, it is essential to firmly wrap and nail a 1.5–2 m (5–6 ft) length of sheet metal (aluminum, steel, or tin) around the pole to prevent raccoons from climbing to the platform.

Next to Ospreys, the Ferruginous Hawk (*Buteo regalis*) has benefitted most from artificial nesting platforms. This large buteo has declined in many parts of its range in western North America (Olendorff, 1993), and, although nest-site loss has not been directly implicated in the declines, nest platforms have been an integral part of most management efforts for them (Howard, 1980; Schmutz et al., 1984; Base and Siever, 1987). Artificial nests increased the breeding density of Ferruginous Hawks (Houston, 1982), and the added protection from predation resulted in higher production of fledglings on nest platforms compared to natural nests (Call and Tigner, 1991).

A widely used Ferruginous Hawk nest structure was described by Schmutz et al. (1984). A single pole set in a 1.2 m (4 ft) deep hole holds the nest platform about 5.5 m (18 ft) above ground. The platform, made from 2 x 4 in lumber, is triangular, measuring 90 cm (36 in) on a side and is nailed to the pole at one acute angle and braced by two boards between the pole and the platform. The braces extend about 1 m (3 ft) above the platform to provide an anchor for nest materials. No. 9 wire is strung around the pole and the two braces, and some sticks are added on top of the platform. Schmutz et al. (1984) placed their structures at least 500 m

(1,650 ft) from frequently traveled roads and, where possible, used natural geographic features to reduce their visibility and the chance of human disturbance. Structures were spaced at least 1 km (1.6 mi.) apart.

Another construction technique is a square platform made by bolting 2 x 6 in lumber on top of a wooden pole (Fig. 9; Call and Tigner, 1991). Howard (1980) used an all steel platform made from 15 cm (6 in) diameter pipe and a 1 x 1 m (3 x 3 ft) square basket made from welded wire and supported on top of the pole with two pieces of 4.5 cm (1.75 in) angle iron (Fig. 10).

Swainson's Hawks (*Buteo swainsoni*) occasionally use the structures described above for Ferruginous Hawks (Schmutz et al., 1984; Skeen et al., 1987), and several other species are known to use artificial platforms/nests. Red-tailed Hawks (*Buteo jamaicensis*) and Great Horned Owls (*Bubo virginianus*) have used a wide variety of artificial nests placed in trees, including stick nests made to look like real hawk nests (Ellis and Kellett, 1970), wire baskets lined with sticks (Bohm, 1977; Zimmer, 1994), wooden boxes (Scott, 1970), and platforms on utility poles (Roppe and Nelson, 1982). Both of these species are widespread and common and artificial nests are not needed to enhance their populations, but they can be attracted to areas by adding artificial nests if that is desired.

Although Bald Eagles infrequently use artificial nests, one pair used a 1.2 x 1.2 m (4 x 4 ft) plywood platform that had been attached to the side of a tree for an observation blind (Bortolotti et al.,1988), and others have used Osprey nesting platforms (Postupalsky, 1979). A nest platform designed to attach to live trees is shown in Fig. 11. In Arizona, two kinds of artificial nests were constructed for Bald Eagles. One was a platform supported by a tripod of 10 cm (4 in) diameter aluminum pipe. This structure was used by nesting eagles, but was expensive ($900 for materials) and required 6–12 people and a helicopter to erect (Grubb, 1980). A more esthetic and much less expensive nest was built in a tree from sticks to closely simulate a real eagle nest (Grubb, 1995).

In Latvia, artificial nests were provided for the White-tailed Eagle (*Haliaeetus albicilla*). These nests were built from spruce poles about 20 m (66 ft) above ground and 4–5 m (13–16 ft) from the top of the tree. Four of 19 nests were used by eagles in the third year after construction (Lipsbergs, 1993). Many artificial nests built in Belarus were used by Osprey, Short-tailed Eagles (*Circaetus gallicus*), Golden Eagles (*Aquila chrysaetos*), and White-tailed Eagles (Ivanovski, 2000).

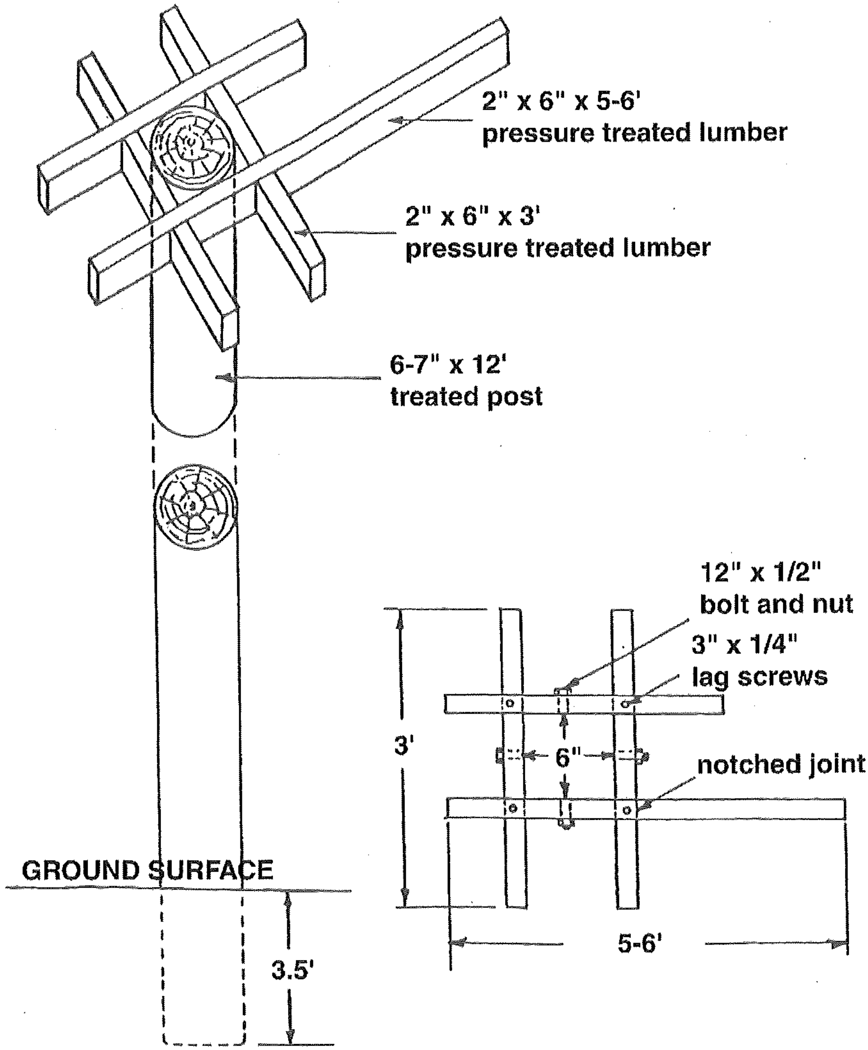


Figure. 9. Nest platform for Ferruginous Hawk. Welded wire fencing (4 x 4 in) stapled to the top to hold nest material (adapted from Call and Tigner, 1991).

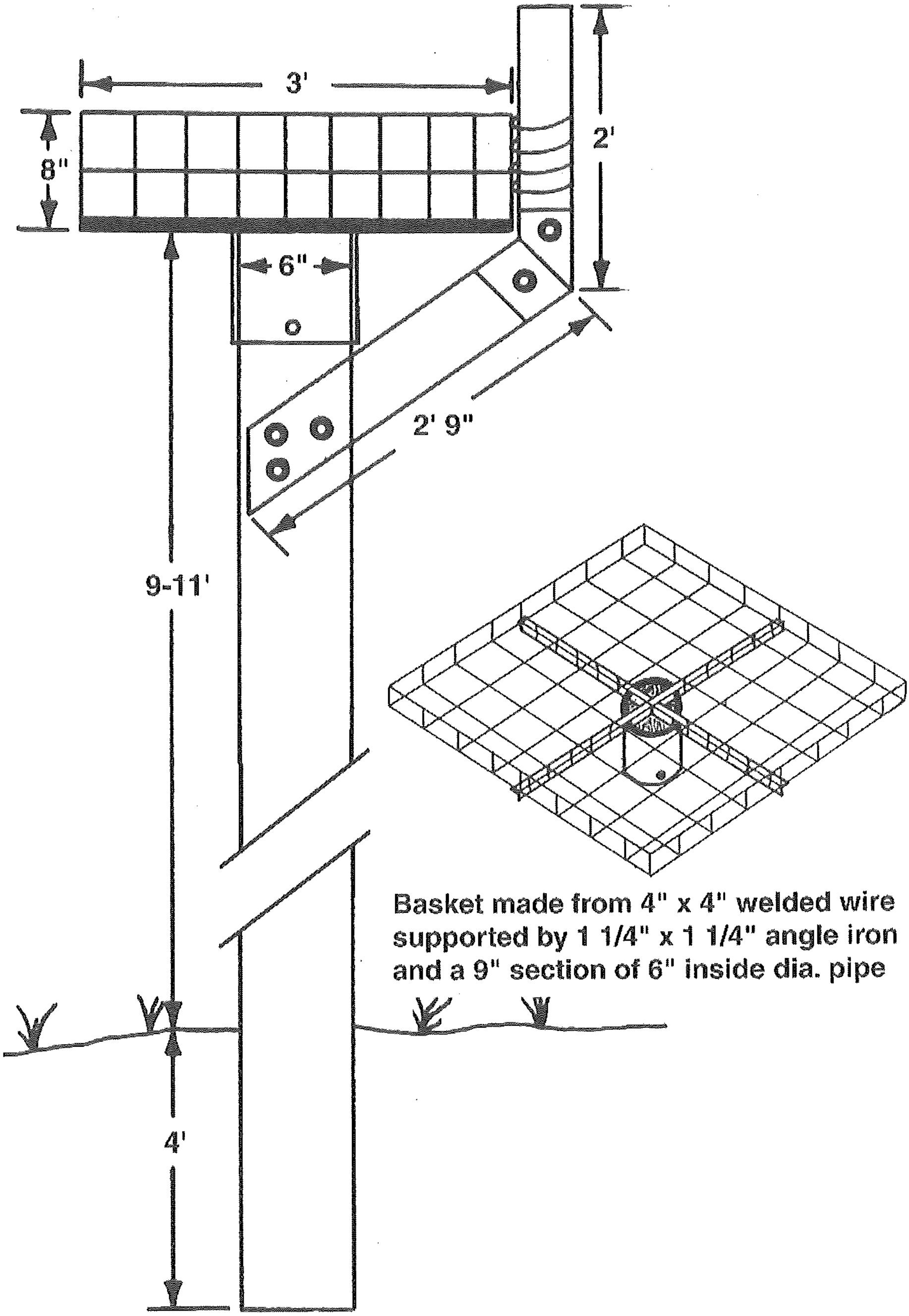
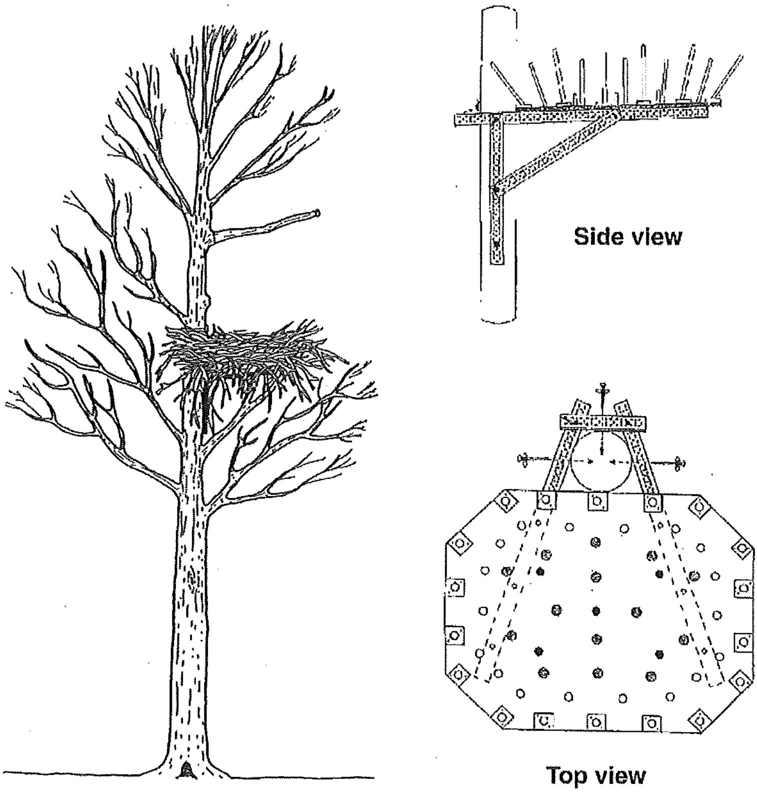


Figure. 10. Nest platform for Ferruginous Hawk. Basket attached to top of wooden utility post with 4 in x 3/8 in lag screws. Make perch and brace from pressure treated 2 x 4 in lumber (adapted from Howard, 1980).



NOTES:
Make 4' x 5' platform from 3/4" exterior plywood
Add 3/4" x 4" x 4" blocks around perimeter to support outer dowels
Insert 3/4" x 5/16" dowels into holes in top of platform to hold nest
Make brace from slotted steel angle bracket--cut to fit on site
Attach brace to tree with 3/8" lag screws
Weave sticks into dowels to resemble eagle nest
Add sphagnum moss and grass to form nest cup
Remove limbs above nest to permit access
Prune and leave one large limb over nest for perch

Figure 11. Nest platform for Bald Eagles designed to place in live trees (modified from Roseneau et al., 1987).

Snail Kites (*Rostrhamus sociabilis*), an endangered species in the United States, build nests in marsh vegetation that are subject to collapse in heavy winds. In order to augment their productivity, artificial nests made from metal and supported by a 1.5 m (5 ft) tube were installed near kite nests that appeared to be fragile. Moving the kite eggs to the artificial nest was successful in all four times the technique was tried (Sykes and Chandler, 1974).

Artificial nest platforms have been tried for two owl species whose population densities were of concern. In North America, three varieties of artificial structures were tried for the Great Gray Owl (*Strix nebulosa*): wooden platforms attached to tree trunks, wire baskets filled with sticks in tree limbs, and cavities made in sawed-off tree trunks. In Oregon, Bull et al. (1987) used shallow, open-top platforms (Fig. 12) attached on the northeast side of live trees with limbs trimmed away to permit access by the owls. An 8-cm (3 in) deep layer of chips was placed in each platform covered by 1-cm (0.4 in) diameter twigs. In 3 years, 12 pairs of Great Gray Owls nested on these platforms, preferring those mounted 15 m (50 ft) high over those at 9 m (30 ft). Bull et al. (1987) noted that eight such platforms could be erected in a 10-hour day and the cost was $40 each to build and mount them.

Nero (1982) and Bohm (1977) made baskets with a base of stucco wire or poultry netting filled with sticks (Fig. 13) to resemble hawk nests

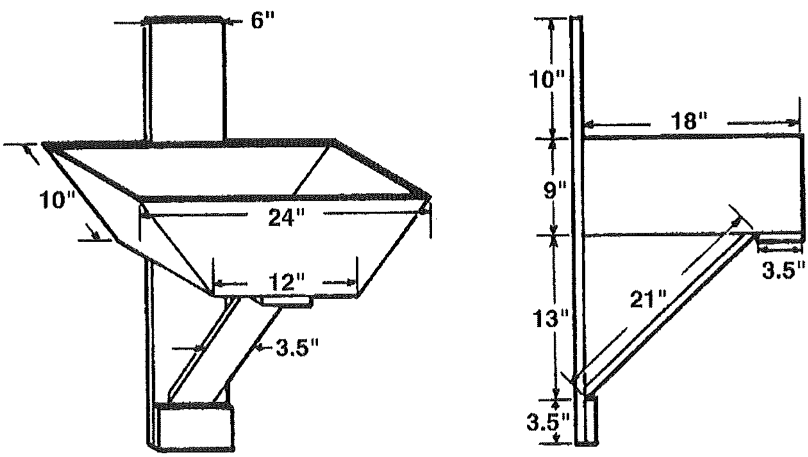


Figure. 12. Nest platform for Great Gray Owl made from 3/4 in lumber, stained, and coated with linseed oil (modified from Bull et al., 1987).

which were used by Great Gray Owls in Alberta and Minnesota. The most natural but also most costly technique for making artificial Great Gray Owl nests involved topping live trees and hollowing out the tops with a chain saw; two of 12 such nests were used within 2 years of construction in California (Beck and Smith, 1987). Mikkola (1983) revealed that Great Gray Owls also used artificial nest platforms in Europe.

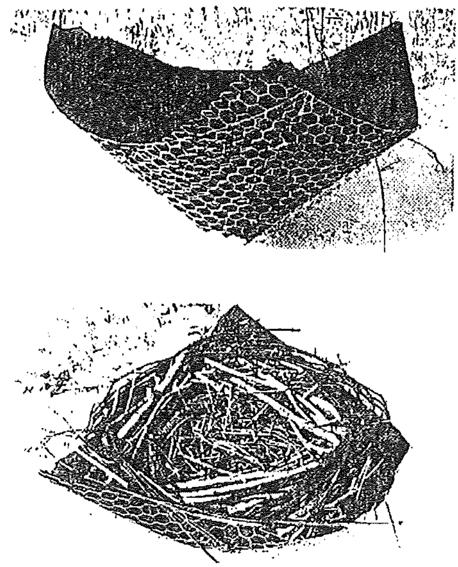


Figure. 13. Nest basket for use by open-nest-using raptors. Cone made from poultry netting lined with perforated tar paper and filled with sticks (Bohm, 1977).

Artificial nest baskets have been tested for Long-eared Owls (*Asio otus*) primarily in the United Kingdom (Williams, 1993; Leslie, 1994; Garner and Milne, 1997). Garner and Milne (1997) used woven-willow, fruit-picker baskets measuring 300 mm (12 in) in diameter and 150 mm (6 in) deep. After two coats of marine varnish were applied, they were placed 3.5–5 m (12–16 ft) high in scrubby trees, secured with wire, and filled with small sticks. The number of available baskets was increased for several years until eight of 12 were used by Long-eared Owls. A further increase to 20 nest baskets resulted in a maximum of nine being used but no further increase in the Long-eared Owl population. Williams (1993) had similar results with three to nine nest baskets used by Long-eared Owls per year out of 20 available baskets

Artificial Ledges

Humans have attempted to improve natural sites or construct new ones to increase the availability of aeries for cliff-nesting raptors, mostly Peregrine Falcons and Prairie Falcons (*Falco mexicanus*). Some were fairly simple improvements of natural sites already used for nesting by raptors (Boyce et al., 1982; Kirven et al., 1983). Others were hand-dug cavities in cliffs (P. Wagner; J. McKinley, pers. commun.). A much more expensive and time-consuming technique involved the fabrication of ledges made from metal and custom fitted to each cliff site (BioSystems Analysis, 1979; Boyce et al., 1980). Where the cliff substrate was soft clay or sandstone and prone to collapsing, cavities were dug by hand and reinforced with prefabricated frames made of sheet metal, plywood, or corrugated fiberglass (Fig. 14). The space between the frame and the cavity walls was filled with mortar and the inside painted to match the substrate (Mayer and Allen, 1987). Interior dimensions were about 50 cm (20 in) tall, wide, and high. Explosives have even been used to excavate nest cavities in cliffs (Becker 1981; Smith, 1985; Pagel, 1989).

All of these techniques require technical climbing skills and are not recommended for use by untrained individuals. The use of explosives is especially dangerous and must be attempted only by people certified in their use.

Fyfe and Armbruster (1977) suggested these criteria for artificial ledges:

1. Build them close to suitable prey populations.
2. Place them away from excessive human activity.
3. Place on a cliff face of at least 7 m (23 ft) in height.
4. Build on solid substrate with freedom from excessive erosion.
5. Have minimum dimensions of 30 cm (12 in) deep x 60 cm (24 in) long x 30 cm (12 in) high.

Even though many artificial ledges have been built for raptor nesting, few data are available on the success of such projects. Some artificial or

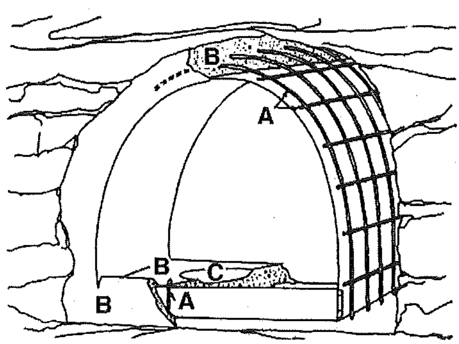


Figure. 14. Reinforced artificial nesting ledge for falcons (adapted from Mayer and Allen, 1987). A = wire mesh support. B= mortar. C = nest depression.

enhanced ledges have been used (Fyfe and Armbruster, 1977; Boyce et al., 1980; Boyce et al., 1982; Pagel, 1989), but their impact on raptor populations is not known.

Artificial Burrows

Only one raptor, the Burrowing Owl (*Athene cunicularia*), nests underground, and it is a species suffering serious population reductions requiring extensive mitigating management (James and Espie, 1997; Clayton and Schmutz, 1999). One reason for its decline in many areas was the loss of nesting burrows, most of which are constructed by prairie dogs (*Cynomys* spp.) and ground squirrels (*Spermophilus* and *Citellus* spp.) whose own populations have been reduced by poisoning and shooting (James and Espie, 1997).

Collins and Landry (1977) were the first to try artificial burrows for Burrowing Owls. They buried plywood boxes measuring 30 x 30 x 20 cm (12 x 12 x 8 in) with a 1.8 m (6 ft) long entrance tunnel 10 x 10 cm(4 x 4 in) with one right-angle bend to reduce light inside. Twenty of 30 boxes were used in the second year of availability. Olenick (1990) used a similar wooden nesting chamber buried 30–50 cm (12–20 in) below the surface, but used 15 cm (6 in) diameter corrugated, perforated plastic pipe for entrance tubes (Fig. 15). He found that placing a perch near the entrance made the site more attractive. In two years (80 boxes/years) 35 nestings occurred. Another construction variation was devised by Botelho (1996). He used 19 l (5 gal) plastic buckets with an entrance tunnel made from two 2.5 m (8 ft) x 10 cm (4 in) diameter PVC pipes connected at a right angle. Eight such burrows replacing natural burrows were used by Burrowing Owls, but 16 others were not used even though they were within 100 m (330 ft) of natural burrows. Poulin (1999) provided instructions for building an artificial burrow with an ingenious lid to allow easy inspection of the nest contents.

Smith and Belthoff (2001) recommended using artificial burrows having nest chambers with a floor area more than 900 cm^2 and entrance tunnels with a diameter of 10 cm. These values were determined from experiments using three sizes of nest chambers: 30 cm dia plastic buckets, 30 x 30 cm plastic containers, and 35 x 50 cm plastic containers. The owls showed a clear preference for the largest chambers. A related experiment tested 10 cm dia. entrance plastic tunnels versus 15 cm dia. tunnels, both

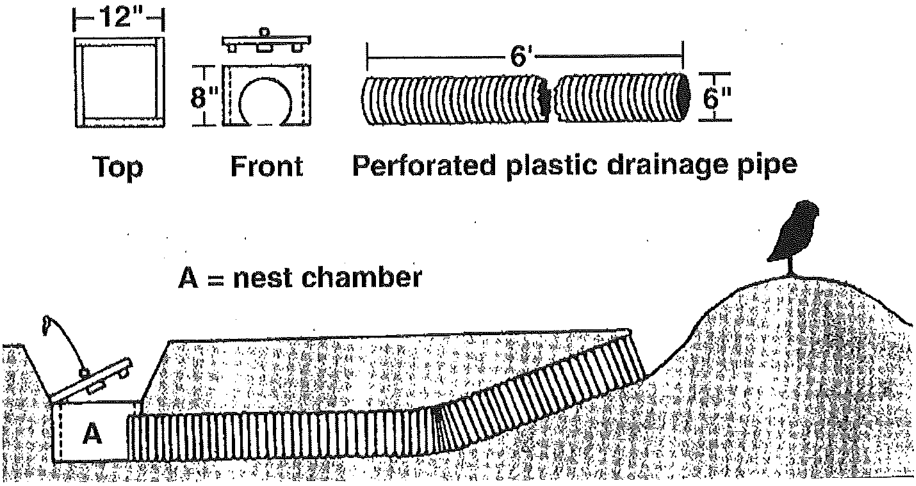
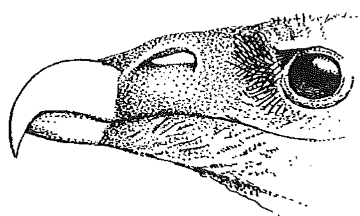
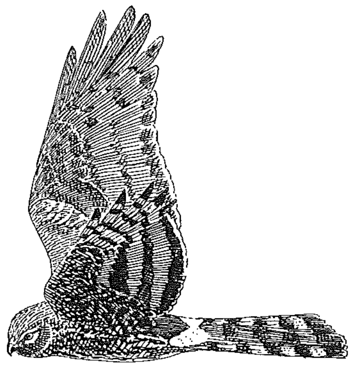


Figure. 15. Artificial nest burrow for Burrowing Owls (adapted from Olenick, 1990).

with the same size of nest chamber. The smaller entrance tunnels were preferred by the owls.

Artificial burrows not only enhance Burrowing Owl populations by providing more potential nests, but also make sites safer from predators (Faminow, 1997) and allow easier study of their reproduction (Henny and Blus, 1981). Artificial burrows have also been employed in projects to relocate Burrowing Owls (Harris and Feeney, 1989).





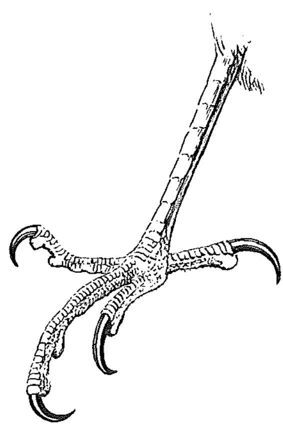
ARTIFICIAL PERCHES

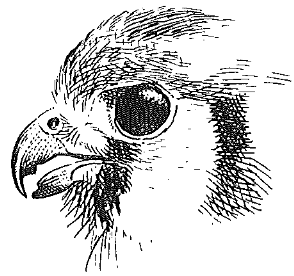
Because many raptors search for prey while perched, artificial perches for their use have been constructed mostly with a goal of increasing predation pressure on mammal pests (Christensen, 1972; Forren, 1981; Hall et al., 1981; Askham, 1990; Kay et al., 1994; Widén, 1994). Placing artificial perches in areas without natural perches does attract raptors, and thus could be a reasonable technique to enhance raptor populations by making prey more vulnerable to capture. Widén's (1994) project was the most carefully controlled study to date, and he found in a two-year experiment that areas where perches were provided were used by raptors significantly more than control areas without perches.

Most artificial perches were t-shaped devices. Askham (1990) constructed them from 7.6 m (25 ft) long x 12.7 cm (5 in) diameter poles set 1–1.5 m (3–5 ft) in the ground. Extensions made from 3.8 cm (1.5 in) dowels extended the height of the perch above ground to 9 m (30 ft). The perch itself was made from 2.5 cm (1 in) diameter dowels. Forren (1981) used t-shaped perches of two heights–3 and 6 m (10 and 20 ft). All perches received some use by American Kestrels, Red-tailed Hawks, and Great Horned Owls but the 6 m (20 ft) ones were used significantly more than those at 3 m (10 ft). Widén's (1994) perches were also 6 m (20 ft) high and t-shaped. They were used mostly by Eurasian Kestrels and Common Buzzards (*Buteo buteo*).

In Australia, perches were made from 3 m (10 ft) x 9 cm (3.5 in) diameter plastic pipe with a 100 x 25 x 25 mm (4 x 1 x 1 in) hardwood perch (Kay et al., 1994). The plastic pipe was slipped over 1.5 m (5 ft) iron posts driven 0.5 m (1.5 ft) into the ground. Adding these perches to soybean fields significantly increased the numbers of raptors using the fields over fields without perches. Spacing the perches at 100 m (330 ft) intervals was better than at 200 m (660 ft). Black-shouldered Kites (*Elanus notatus*) and Australian Kestrels (*Falco cenchroides*) were the most numerous raptors using the perches.

An alternate perch design was used in California alfalfa fields (Hall et al., 1981). Pine blocks 5 x 5 x 45 cm (2 x 2 x 18 in) were bolted onto pipe floor flanges and screwed onto either a 2.5 m (8.25 ft) or 5 m (16 ft) piece of 1.9 cm ($^3/_4$ in) galvanized pipe. The pipes were wired to metal fence posts driven about 70 cm (28 in) into the ground. Perches were spaced at 100-m (330 ft) intervals in rows that were 45 m (150 ft) apart. All of the perches received some use by American Kestrels, Red-tailed Hawks, Barn Owls, and Great Horned Owls. Kestrels and Great Horned Owls preferred the higher perches but Barn Owls had no preference. In a mountain meadow in Utah, 3.6–6 m (12–20 ft) high perches made from telephone poles with aspen limb cross arms 1.5–1.8 m (5–6 ft). long attracted American Kestrels, Red-tailed Hawks, Swainson's Hawks, Long-eared Owls, and Great Horned Owls (Christensen, 1972).





CAPTIVE BREEDING

When conservationists became concerned about declining raptor populations, one strategy to relieve those losses was the breeding of raptors in captivity and releasing their progeny to the wild. Although these birds are difficult to breed in captivity (Weaver and Cade, 1988), more than 80 species of diurnal raptors (Cade, 1986, 2000) as well as several species of owls (Klös, 1983; Warburton, 1983; Wiemeyer, 1987) have been bred in captivity since the late 1960s. Many of the species bred in captivity are not endangered and most have been bred in only small numbers. However, captive breeding has played a major role in the recovery of several endangered raptor populations, most dramatically the Peregrine Falcon. About 6,100 Peregrines were released in North America between 1974–1994, most of which were produced by The Peregrine Fund, the Santa Cruz Predatory Bird Research Group, and the Canadian Wildlife Service (Enderson et al., 1995). Although other factors were involved, this population augmentation helped in removing the Peregrine from endangered status in the United States in 1999 (U.S. Fish and Wildlife Service, 1999).

Captive breeding has also played an important role in the recovery of two of the most highly endangered raptor species. The Mauritius Kestrel was once the most endangered raptor in the world, reduced to two breeding pairs in the wild (Cade and Jones, 1993). Captive breeding and release played a major role in bringing back a viable population (Jones et al., 1994).

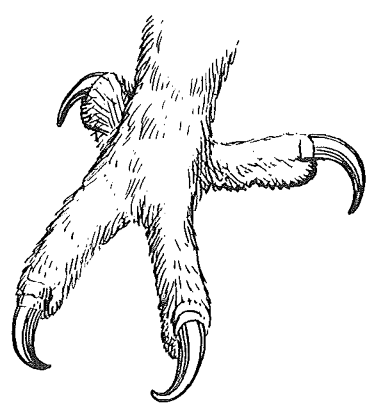
Propagation and release also have played an important role in the recovery of the California Condor (U.S. Fish and Wildlife Service, 1996). By 1987 the six remaining wild California Condors were captured and, along with 21 condors already in captivity, were entered into a breeding program (Snyder and Snyder, 1989; Kiff, 2000). This captive flock of 27 birds represented all the remaining California Condors in the world; the first successful captive breeding occurred in 1988. Captive-bred condors were initially released into the wild in 1992 (Cohn, 1993); 104 were released at five sites in Arizona and California by the end of 1999. As of March 2001, the total population of California Condors was 160 of which 45 were in the wild. California Condors are being bred at the San Diego Wild Animal Park, the Los Angeles Zoo, and The Peregrine Fund's World Center for Birds of Prey.

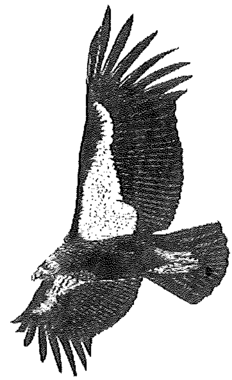
Initial condor releases suffered from problems of lead poisoning caused by bullet fragments ingested from carcasses (Meretsky et al., 2000). Another problem with captive-raised condors was their tameness and orientation toward humans, causing Meretsky et al. (2000) to favor limiting releases to parent-raised birds rather than those raised by humans wearing condor hand puppets.

Andean Condors (*Vulture gryphus*) were reintroduced in Colombia, South America, using captive-raised birds formerly employed as surrogates in the California Condor reintroduction program; most of them were still alive two years later (Lieberman et al., 1993).

Griffin Vulture (*Gyps fulvus*) reintroductions in France successfully restored a breeding population (Sarrazin et al., 1994). This program had better fortune with releasing adults than juveniles or immatures (Sarrazin et al., 1994).

Captive breeding as a technique to rebuild diminished raptor populations is beyond the reach of individuals and even most organizations. The process demands a large budget because extensive facilities, highly trained staff, food, and other supplies are needed to raise the quantities of offspring required to increase wild raptor populations. Persons interested in this technique can best contribute by making financial donations and volunteering at the organizations that have captive breeding programs.





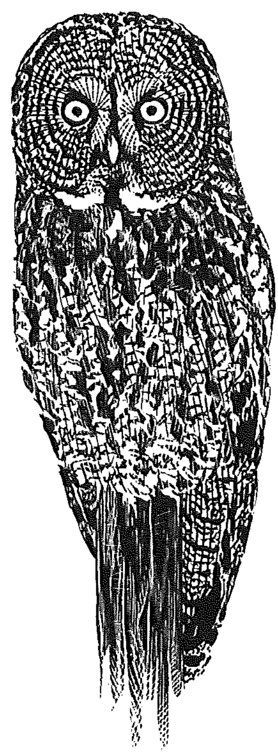
PROVIDING FOOD

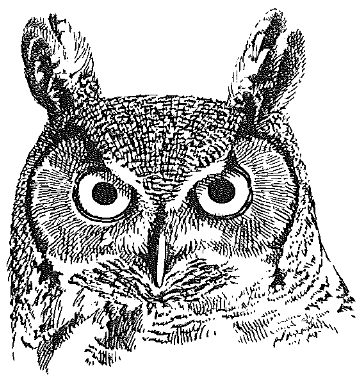
Food shortages, particularly those that occur suddenly, can cause high mortality in some raptors; the Barn Owl is notably susceptible to starvation from winter food shortages (Keith, 1964; Marti and Wagner, 1985; Taylor, 1994), but feeding them in the wild is essentially impossible because they kill and eat small mammals. Although providing extra food is a technique used to manage wild animals, including some birds (Archibald, 1978), this procedure is difficult or impossible to use in helping most raptors because, with few exceptions, they catch and kill the food they eat.

Vultures, being scavengers, are the raptors most amenable to supplemental feeding by humans, but feeding stations for vultures in South Africa did not provide any clear evidence that the extra food helped with vulture survival or reproduction (Friedman and Mundy, 1983). The results of feeding wild California Condors were similar; a program to supplement condors in the Sespe Condor Sanctuary in California provided one large mammal carcass (mostly mule deer, *Odocoileus hemionus*) per week for two years. The project was expensive because it took 6.5 man hours per week to get the carcasses to the feeding site and much more time to acquire, transport, and store the food (Wilbur et al., 1974). Of the 83 carcasses provided, condors definitely fed on 47 and probably on 27 more. However, evidence was weak that the feeding increased condor productivity.

Many eagles will also feed on carrion and artificial feeding has been attempted with mixed results. Providing meat for Wahlberg's Eagles (*Aquila wahlbergi*) in South Africa failed to induce non-breeding pairs to breed, and did not induce earlier laying or increase egg size or clutch size (Simmons, 1993). On the other hand, supplemental feeding in winter using slaughterhouse offal, dead whole domestic animals, and road-killed deer may have helped reverse a downward population trend in White-tailed Sea Eagles (Helander, 1978, 1985). The success at 10 nests of White-tailed Sea Eagles increased significantly, but the overall impact on nesting success appeared to have been limited (Helander, 1985). Providing salmon carcasses to breeding Bald Eagles in Alaska produced higher off-spring survival than in areas without extra food (Hansen, 1987). In contrast, a large-scale, four-year winter feeding project of Bald Eagles in Maine, costing about $25,000 per year, produced little if any improvement in reproduction even though at least 203 banded eagles used the food (McCollough et al., 1994).

Thus, it appears that supplemental feeding is a technique not having much potential to help wild raptors. For those species that will eat carrion, providing food may be worthwhile if winter food supply declines, or to lure eagles and vultures away from contaminated food sources (McCollough et al., 1994).





REHABILITATION

The rehabilitation of injured or sick raptors with the purpose of returning them to the wild has become a popular and widespread practice at many centers in North America, Europe, Africa, and Australia (Redig and Duke, 1995; Csermely, 2000a; Fajardo et al., 2000). Over 250 such centers exist in the United States alone (Redig and Duke, 1995) and almost 3,000 rehabilitation permits are held in the U.S. The major goal of these centers is the conservation of raptor populations by returning birds to the wild that would otherwise die, but secondary benefits include providing non-releasable birds for breeding projects and zoos; research on diagnosis and treatments of injuries, diseases, and toxins; and educating and raising the interest of the public about raptors and their problems (Engel, 1980; Ducey and Hancock, 1981; Redig and Duke, 1995).

Many raptors are treated and released by these centers; nearly 14,000 were received by just 32 U.S. rehabilitation programs from the inception of the programs through 1994 (Redig and Duke, 1995). From 40–60% of birds that enter rehabilitation programs are eventually released to the wild (Duke, 1980; Hyslop, 1995), and many released raptors have survived for years in the wild, entering or re-entering breeding populations (Hamilton et al., 1988; Ingram, 1988; Martell et al., 1991; Redig and Duke, 1995). However, it is still not clear if rehabilitation is helping conserve raptor populations (Csermely, 2000a). Redig and Duke (1995) concluded that, at least, rehabilitation does no harm to raptor populations and clearly is beneficial in the educational and research opportunities that arise in conjunction with rehabilitation.

Evaluation of the success of returning rehabilitated raptors to the wild is difficult. Martell et al. (2000) used banding data to conclude that rehabilitation can be successful in this regard; they estimated that 85% of

1,500 released birds were successfully rehabilitated. A radio-tagging study in Italy found that orphaned Long-eared Owls and Tawny Owls could cope with life in natural habitats without prior experience there (Csermely 2000b), and Fajardo et al. (2000) concluded that a very high mortality occurred in released Barn Owls within four months of release, but after that mortality was about equal to that of wild owls.

Caring for and treating injured or sick raptors can require a large commitment of time and money. These birds must be cared for and fed daily, and the facilities, medicines, and food can be expensive. Additionally, in the United States and elsewhere, state and federal permits are required to hold protected wildlife in captivity even for rehabilitation purposes. Information about required state permits can be obtained by contacting a state's wildlife or natural resource agency. The United States Fish and Wildlife Service issues federal permits through the Assistant Regional Director of Law Enforcement in each of its five regional offices.

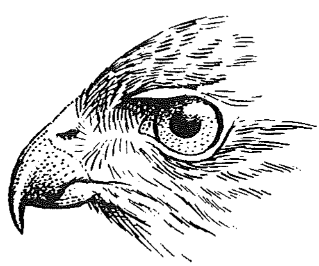
The Raptor Center at the University of Minnesota (http://www.raptor.cvm.umn.edu) lists the following basic guidelines for caring for and releasing rehabilitated raptors to the wild.

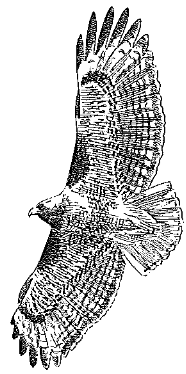
1. All birds should be subjected to a period of active physical condtioning in the 3–4 weeks preceding release. Chaplin (1989) described the procedure and provides performance levels to be met before raptors should be released. Holz and Naisbitt (2000) also emphasized the need for physical conditioning of raptors before they are released.
2. Any recognizable visual deficiency is grounds for retaining a raptor in captivity and ultimately denying its release unless the defect can be corrected. Unilaterally blind birds should not be released. A visual system evaluation should be part of a pre-release examination. This check should include examination of the interior of the eye with an ophthalmoscope. Owls are prone to suffer detached retinas from head injuries.
3. No raptor should be released to the wild if missing an entire foot.
4. No raptor should be retained in captivity if missing an entire foot without an extremely good reason, such as rarity. Personnel responsible for the management of the bird should be aware of the inevitability of the development of bumblefoot in the remaining foot and the difficulty in successfully treating such a condition.

5. Raptors should be released with good feathers. Broken feathers should be replaced by molting or imping.
6. Medical and surgical procedures as well as long-term convalescence of raptors should occur where the chances for success are optimized. This may require the birds completing parts of their recovery at different facilities, depending on the need.
7. Because of their continuing endangered and/or threatened status and the need to collect information about injury, toxicity, and mortality along with the more complex medical and surgical problems encountered in them, Peregrine Falcons and Bald Eagles should be cared for at larger centers that have a wide range of facilities, equipment, and highly experienced personnel available to care for them.
8. Good record keeping is essential. Rehabilitation records are the only source of information available that even approaches giving dimension to the various kinds of injuries and problems that raptors encounter.

More information on raptor rehabilitation can be found in McKeever (1987), Redig et al., (1993), Arent and Martell (1996), and Csermely, 2000a).

The best way to become involved with raptor rehabilitation is to volunteer at the nearest wildlife rehabilitation center. By volunteering a person can learn animal handling and rehabilitation techniques inexpensively and without the need to obtain personal permits or to maintain a full-time commitment. The National Wildlife Rehabilitators Association (NWRA) can help newcomers learn about rehabilitation and find the nearest rehabilitation center. NWRA has a site on the World Wide Web (http://www.nwrawildlife.org) and can be reached at 14 North 7th Avenue, St. Cloud, MN 56303-4766. Many centers that specialize in raptor rehabilitation also use volunteers for education programs, both on site and off, to raise the public awareness of raptors and their problems in the modern world.





COLLISIONS

What Are the Hazards?

Humans have added many hazards to the world of raptors–vehicles, fences, powerlines, towers, and windows; collisions with these objects cause 32% of human-related bird deaths (Banks, 1979). Although huge numbers of birds die this way each year, the risks to raptors are not always the same as for other birds; radio and television towers kill thousands of passerine birds during migration (Banks, 1979; Shire et al., 2000) but few raptors (Avery and Clement, 1972; Crawford, 1978; McNeil et al., 1985). The difference may lie in that diurnal raptors migrate by day, allowing them to see the towers, and owls, migrating at night, may be able to see and avoid the obstacles even in the dark.

Power lines—Electrical transmission lines kill raptors by collision (Avery et al., 1978; Hebert et al., 1995) and electrocution (see below). Raptors may be vulnerable to colliding with wires because of their high-speed flying while chasing prey (Bevanger, 1994), and, although raptors are infrequently reported as victims of powerline collisions, any deaths are important because raptor populations are much smaller than those of most other species (Avian Power Line Interaction Committee, 1996). In Norway, an eight-year study of raptor mortality found that utility structures were the chief cause of mortality for the Northern Goshawk (*Accipiter gentilis*), White-tailed Eagle, and Eagle Owl (*Bubo bubo*), but also caused deaths in 12 other hawk and owl species. Herren (1969) believed that powerline collisions may have been a major factor in eliminating the Eagle Owl from its former range in Sweden. Nobel (1995), on the other hand, thought that raptors might suffer less mortality than other birds because of their visual acuity, maneuverability, and non-flocking tendencies; no raptors were found among 611 birds found dead under power transmission lines in Venezuela (McNeil et al., 1985).

Fences—Wire fences also are hazards to low-flying raptors, (Emerson, 1904; Nero, 1974; Fitzner, 1975; Evans et al. 1999; Gillihan, 2000), but apparently to a lesser degree than utility structures because they are much closer to the ground.

Wind Electrical Generation—Windmills for electrical generation are much less a source of avian collisions than other tall, stationary objects. However, a farm of turbines on lattice towers literally closes off Altamont Pass in California, and in a survey there 119 raptors, mostly American Kestrels, Golden Eagles, and Red-tailed Hawks, were killed in two years. Fifty-two percent were killed by the wind turbines, 11% by collisions with wires, and the remaining 26% by unknown causes (Orloff and Flannery, 1993). Other studies, though, found little or no raptor mortality at wind turbines (Byrne, 1983; Kirtland, 1985).

Windows—Glass windows in buildings are another major hazard to birds; estimates of the numbers of birds killed annually in the United States range as high as 975 million (Klem, 1981). Windows that are transparent and invisible, particularly if positioned so that they appear to provide a clear path through a building, are a definite hazard, but also are reflective widows that mirror the exterior habitat or sky (Klem, 1989). Even though relatively few raptors compared to passerines are killed by striking windows (Dunn, 1993), those losses may be important to birds that exist in limited populations. Accipiters, particularly Sharp-shinned Hawks (*Accipiter striatus*), seem to be most vulnerable to mortality through window collisions (Klem, 1981; Dunn, 1993; Bevanger and Overskaug, 1995). In fact, the first report of a bird killed in the United States by striking a window was a Sharp-shinned Hawk (Nuttall, 1832). These hawks are attracted to passerine birds using bird feeders that are often positioned close to windows in houses. Accipiters are also adapted for flying through restricted passages in heavy cover, putting them at greater risk of being killed in trying to reach lighted areas behind or reflected in glass (Snyder, 1946).

Vehicular Collisions—Vehicles, both land-based cars, trucks, and trains, and airplanes kill many birds (Banks, 1979; Stone et al., 2001). Owls, particularly Barn and Long-eared owls, seem to be vulnerable to collisions with automobiles (Kerlinger and Lein, 1988; Bevanger and

Overskaug, 1995; Baudvin, 1997; Newton et al., 1997; Massemin and Zorn, 1998). Species like Barn Owls that hunt in low coursing flights often cross roads at heights that bring them into the path of vehicles, and the availability of voles (*Microtus* spp.) in grasses planted along highways may attract them to roads, increasing the likelihood of automobile collision (Baudvin, 1997). Massemin and Zorn (1998) found that large numbers of Barn Owls were killed on roads that crossed open fields and on embanked highways; the owls may cross the raised roads without increasing their hunting height, bringing them into the path of vehicles.

Raptors also collide with aircraft, mostly at airports when airplanes are landing or taking off. Raptors are attracted to airports because airports often have large open areas with abundant prey populations, perches, and freedom from molestation by people (Solman, 1973; Bloom, 1991).At the Toronto, Ontario, airport, 17% of bird/airplane strikes involved raptors (McIlveen et al., 1993) and 13% of strikes at the Kauai, Hawaii airport were with owls (Linnell et al., 1996). The U.S. Air Force incurred nearly $500,000,000 in damage to aircraft and 33 human fatalities from bird strikes since 1986, 69% of which were with waterfowl and raptors (Lovell and Dolbeer (1999).

What Can Be Done to Reduce Collisions?

Relatively little has been done to reduce some forms of collision mortality for birds. In the case of fences and wind turbines, this may be because those hazards appear to cause little mortality. For radio and television towers and tall buildings, the lack of progress in preventing collision appears to be because no adequate solution has been discovered. Recommendations to reduce bird mortality from wind-energy facilities include avoiding placing such facilities in known migration corridors and areas of high bird concentration, using fewer larger turbines instead of many smaller ones, using tubular support towers rather than lattice ones (to eliminate raptor perching places), and painting blades to make them more visible (Orloff and Flannery, 1993; AWEA, 1995).

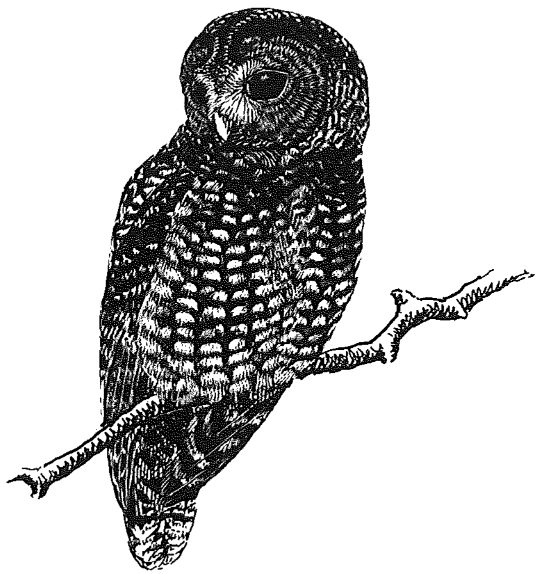
As indicated above, power lines, windows, and vehicles kill large numbers of birds, and more effort has been exerted to reduce this mortality. Reasons for heightened attempts to reduce these forms of mortality are, in the case of windows and power lines, the high public visibility of these deaths, and, in the case of vehicle collisions, the high economic cost and danger to humans of bird/aircraft collisions. Diminishing collisions between raptors and aircraft has been attempted primarily by capturing and removing raptors from airports. At the Toronto, Ontario, airport, 1,350 raptors of 11 species were captured, banded, and released elsewhere (McIlveen et al., 1993). Eliminating hunting perches and cover attractive to raptor prey species are other techniques that may lessen the risk of raptor/aircraft collisions. The U.S. Air Force developed a bird avoidance model to help minimize bird strikes by predicting and avoiding flight routes where collisions are more likely to occur (Lovell and Dolbeer, 1999).

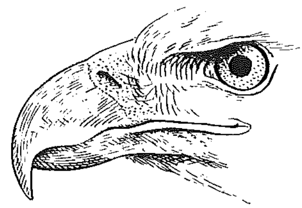
Klem (1990) tested various window coverings to reduce bird collisions, but completely covering windows with white cloth or with a 8 x 10 cm (3 x 4 in) mesh of 2.5-cm (1 in) wide cloth strips were the only effective techniques. Larger cloth meshes, horizontal or vertical cloth strips, falcon silhouettes, and owl silhouettes were not effective (Klem, 1990). Dunn (1993) found that placing plastic garden protection screening over windows could also prevent mortality.

It appears that much of the raptor mortality at windows results from the predators chasing birds feeding at feeders placed near windows. Thus, the elimination of items that attract songbirds (bird feeders, waterers, and vegetation that provides food or cover) from near windows may reduce raptor mortality (Klem,1990). Installing windows in new or remodeled buildings at an angle so that they reflect the ground instead of the surrounding habitat and sky may also reduce raptor mortality (Klem,1990).

Reducing bird mortality from powerline collision is mostly beyond the reach of individuals and conservation groups. However, the public can seek to influence utility company policies for reducing powerline hazards to raptors and assist by reporting birds killed by powerline collision to federal or state conservation agencies or to the power company that owns the lines. Raptor enthusiasts can also help power companies to design new power lines that reduce the danger to raptors. Bevanger (1999) provides methods to study mortality of birds from collisions with power lines.

One strategy that holds some promise is to make power lines more visible to birds (Janss and Ferrer, 1998). Techniques tried include attaching yellow aviation balls (Morkill and Anderson, 1993), yellow spirals, or yellow fiberglass swinging plates (Brown and Drewien, 1995) to powerlines. All three of these markers significantly reduced bird collisions with wires. In Spain, red spirals of PVC plastic reduced collisions by birds by 60% (Alonso and Alonso, 1999). Placing models of raptors on electrical transmission towers has been proposed to reduce bird collisions, but these models might attract raptors and actually increase their collisions (Janss et al., 1999). The Avian Power Line Interaction Committee (1996) provides the most extensive guide to the factors influencing bird collisions with power lines and ways to fix old lines and design new ones to reduce bird hazards.





ELECTROCUTION

What Are the Hazards?

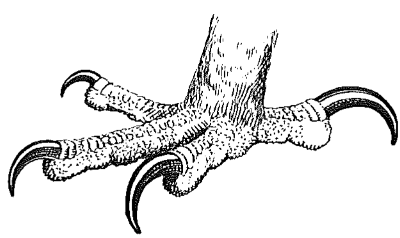
Electrocution is a greater predicament for raptors than collisions with wires because electrical transmission poles, towers, and wires make attractive perching and nesting sites. Significant raptor mortality from electrocution has been reported in North America (Harmata et al., 1999; Melcher and Suazo; 1999, Harness and Wilson, 2000), Europe (Ferrer et al., 1991; Bevanger, 1994; Janss and Ferrer, 2001; Real and Mañosa, 2001), and Africa (Ledger, 1980; Boshoff and Basson, 1993; Kruger, 1999; van Rooyen and Ledger, 1999; van Rooyen, 2000), and probably occurs undetected or unreported elsewhere.

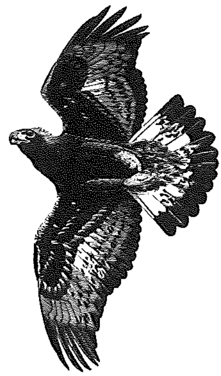
Electrocution occurs when a bird simultaneously touches two phase conductors or a conductor and a ground wire (Bevanger, 1994). Most electrocutions occur on distribution lines (34 kV or less) rather than on transmission lines (69 kV or more) because clearances between wires on distribution lines are less and distribution lines have an array of pole-mounted equipment, such as transformers and capacitors which are often connected to the conductors with un-insulated wires (Harness and Wilson, 2000). Larger species–Red-tailed Hawks, Ferruginous Hawks, and particularly Golden Eagles–are vulnerable to electrocution because their wingspans are large enough to bridge the distance between two wires (Avian Power Line Interaction Committee, 1996; Harness and Wilson, 2001). Damp weather greatly enhances the risk of electrocution because wet feathers are much better conductors (Nobel, 1995). Smaller raptors are rarely electrocuted except on un-insulated connectors between pole-mounted transformers and conductor wires.

What Can Be Done about Electrocution?

In the early 1970s, Idaho Power Corporation, with the assistance of Morley Nelson, began to look for ways to protect eagles from electrocution on their power-transmission lines (Nelson, 1978), and utility companies and government agencies soon began to work together to identify the causes and find solutions to electrocution problems (The Avian Power Line Interaction Committee, 1996).

As is the case with power line collision, protecting raptors from electrocution by power lines is mostly beyond the reach of individuals and conservation groups. However, the public can also assist in this problem by reporting birds killed by power line electrocution to federal or state conservation agencies or to the power company that owns the lines. It is important to be specific in reporting where the electrocutions occurred, the species of raptor, and, if known, the weather conditions under which the electrocution took place. Bevanger (1999) provides methods to study mortality of birds from electrocution. The Avian Power Line Interaction Committee (1996) presents an extensive coverage of the causes of raptor electrocution by power lines and the most comprehensive recommendations for preventing raptor electrocution through modification of existing structures and designing new ones.





HUMAN DISTURBANCE

What Is Human Disturbance?

The preceding chapters clearly document that humans have done much to conserve raptors. The need for this conservation is, though, mostly the result of human persecution and disturbance. Raptors have suffered at the hands of humans more than most other birds (Newton, 1990), and state and federal wildlife agencies considered human disturbance to be the second most important threat to raptors (LeFranc and Millsap, 1984). Human disturbance includes any human venture that interferes with the ability of raptors to undertake important activities like incubating eggs, feeding young, roosting, and foraging (Fyfe and Olendorff, 1976). Even though some raptors tolerate or even benefit from human enterprises (Bloom and McCrary, 1996; Gehlbach, 1996; Rosenfield et al., 1996; Love and Bird, 2000), much human activity has been detrimental (Levenson and Koplin,1984; Fernández and Azkona, 1993). Sometimes the effect may be delayed; raptors exposed to disturbance may nest successfully in the year of disturbance but not return to the area in the next breeding season (White and Thurow, 1985).

Sensitivity to human activity varies not only among species (Bechard et al., 1990; Holmes, 1994) and seasons of the year (Holmes, 1994), but even within raptor species; Poole (1981) found that Osprey can become habituated to humans and nest successfully in close proximity. However, Osprey nesting in more remote locations may be vulnerable to disturbance by occasional influxes of people. In another example, Red-tailed

Hawk populations responded differently to humans approaching their nests in relation to the length of time that European settlers occupied various areas of North America (Knight et al., 1989).

Aside from direct persecution, the human endeavors most likely to disturb raptors are recreation, defined as acts of amusement or entertainment which take place outdoors including consumptive and non-consumptive activities (Knight and Skagen, 1988), and natural-resource harvesting. Boyle and Samson (1985) reviewed 536 published references concerned with the effects of non-consumptive outdoor recreation on wildlife. In 166 papers containing original data, hiking and camping, boating, wildlife observation and photography, off-road vehicle use, swimming and shore recreation, and rock climbing were all represented as creating negative impacts on wildlife.

Water-based recreation–fishing, hunting, boating, and even wildlife viewing–can be disturbing to raptors that use aquatic habitats for foraging. Stalmaster and Kaiser (1998) found that Bald Eagles wintering on the Skagit River in Washington were significantly disturbed by human recreation. Eagles that were feeding and standing on the ground were most sensitive to humans, and motorized boating, especially fishing, was highly disturbing to eagles. Eagles did habituate to a degree as the season progressed, becoming less easily disturbed. On another river in Washington, the presence of anglers caused fewer eagles to feed and forced eagles to shift their feeding from early morning to afternoon (Knight et al., 1991). In Florida, on the other hand, Wood (1999) concluded that recreational boating did not negatively affect Bald Eagle activity.

Hiking, camping, wildlife observation, and photography can cause nesting raptors to flush from their nests, engendering nest abandonment, disruption of feeding, and increased egg and nestling mortality through exposure to adverse weather or predation (Swenson, 1979; Fraser et al., 1985; White and Thurow, 1985). Humans on foot have been found to be very disturbing to raptors (Ritchie, 1987; Grubb and King, 1991; Holmes et al. 1993). Heavy off-road vehicle use caused Bald Eagles to abandon a winter roost (Wood, 1980), and recreational rock climbing has been implicated in the disturbance of cliff-nesting raptors on three continents (Olsen and Olsen, 1980; Brücher and Wegner, 1988; Cymerys and Walton, 1988). Humans camped near Bald Eagle nests caused a pronounced change in eagle time budgets (Steidl and Anthony, 2000), and Bald Eagle winter distributions along the Colorado River in Arizona were inversely correlated with human activity (Brown and Stevens (1997).

Several investigations found that prolonged industrial or transportation disturbance caused population declines in raptors (Boeker and Ray, 1971; Craighead and Mindell, 1981; Bednarz, 1984). On the other hand, low-level aircraft flights seem to have little effect on raptor behavior. Military training flights produced insignificant changes in Osprey reproduction (Thomas, 1999), and Spotted Owls (*Strix occidentalis*) were disturbed more by ground-based disturbance (chain saws) than they were by helicopter overflights (Delaney et al., 1999).

Resource harvesting such as logging can have serious impacts, especially on raptors that require old-growth forests (Forsman and Meslow, 1985), but also on species that use younger forests (Bryant, 1986; Duncan, 1997). Surface mining causes adverse impacts on raptor species by destroying nesting and feeding habitat. Agricultural activities are more difficult to characterize because in some ways they can be beneficial to raptors and other wildlife, but in other ways they can be detrimental. In areas where urban sprawl is occurring, preserving agricultural land instead of converting it to housing developments certainly is favorable to wildlife. Initial observations have found that well managed cattle ranches provide good support for Aplomado Falcons (*Falco femoralis*) (J.P. Jenny, pers. commun.). In Florida, Crested Caracaras (*Caracara cheriway*) rarely nested on lands managed primarily as natural areas, but were often found nesting on private lands with improved pastures and cattle grazing (Morrison and Humphrey, 2001). Postovit and Postovit (1987) stated that farming can have greater adverse impacts than ranching because of extensive habitat changes for farms which may remove nesting and feeding areas for many species. Ranching has fewer conflicts with raptors, but the impact of grazing can be detrimental in certain habitats of the western United States (Saab et al., 1995; Belsky et al., 1999), and cattle can damage isolated nest trees.

Ground-based military training has been examined recently as another potential disturbance factor to raptors. Weapons firing did produce some local short-term reduction in raptor activity (Schueck et al., 2001), but overall, military training exercises did not significantly adversely affect raptors (Brown et al., 1999; Lehman et al., 1999; Schueck et al., 2001).

What Can Be Done about Human Disturbance?

Education is potentially a powerful tool for mitigating human disturbance of raptors. State and federal resource agencies, Audubon Society chapters, nature centers, and other similar groups can play a strong role in helping people alter their behavior in a manner favorable to the welfare of raptors. Education alone, however, will not solve all of the problems.

Both temporal and spatial, buffer zones can be effective in protecting nesting raptors from many forms of human disturbance: recreational activity, logging, mining and energy development (Marks and Ball 1981; Cline 1985, Ramakka, 1988; Postovit and Postovit, 1989; Swarthout and Steidl, 2001). Romin and Muck (1999) give detailed recommendations for reducing disturbance to raptors.

Recreational Activities—Reducing the effects of human disturbance on raptors can be difficult because outdoor recreation is rapidly expanding in today's increasingly crowded world. The most common of two general approaches to mitigating this problem is the prevention of human access to areas critical for supporting raptor populations (Voous, 1977). This may be done year around for endangered species, only during the reproductive season in areas crucial for nesting, or even for certain times each day. For example, restricting human access to Bald Eagle feeding areas from 0800–1200 hours between October and March in the Pacific Northwest allows eagles to feed undisturbed on salmon carrion (Stalmaster, 1980). A summary of spatial and temporal buffers to protect diurnal raptors from human disturbance is found in Richardson and Miller (1997).

Full-time closures usually must be done by state or federal agencies, but seasonal closures can be accomplished by citizen's groups. An excellent example of this was tried in Boise, Idaho where the Boise Climbers Alliance worked with the Idaho Department of Fish and Game, the Bureau of Reclamation, and local raptor experts to post a voluntary closure from 1 February to 1 April in some popular climbing cliffs that are also important nesting sites for Prairie Falcons and Golden Eagles (Prather, 2000). By 1 April, the coalition identified all active nest sites and maintained buffer-zone signs on climbing routes that are close enough to disturb the birds. Other areas where raptors have not nested are opened to climbers after 1 April and everything is open from 30 June until 1 February. The climbers who developed this voluntary restriction had two goals: maintaining access by climbers to the cliffs in question and protecting nesting raptors. Pyke (1998) gives advice to resource managers and climbers about reducing the impacts of climbing on raptors.

Studies at another popular rock-climbing area, Pinnacles National Monument, California, showed that the rapid increase in human climbing activity had great potential to disturb nesting raptors. Recommendations developed to reduce the conflict were:

1. Set aside certain areas for raptor nesting only.
2. Educate climbers about the importance and vulnerability of raptors nesting on the cliffs.
3. Include a statement in the climbers' guide on the order of: "Birds of prey nest on these cliffs often on or near climbing routes. These birds are federally protected and climbers should be careful not to flush them or keep them away from nests on cliffs. If a nest is encountered while climbing, abandon the route and notify a ranger as to the nest's location." (Cymerys and Walton, 1988).

The second general strategy to reduce human recreational disturbance is by devising management plans that allow humans and raptors to coexist (Olendorff and Kochert, 1977). This approach is generally the prerogative of state and federal agencies, but see the example above of how a citizen climbing group worked with such agencies to produce a plan for reducing human disturbance. Management plans to reduce disturbance require thorough information on specific raptor populations, and managers must know the effect of recreational activities on particular species. Managers need to know how different kinds of recreational activities affect raptors, at what intensities the effect occurs, when during the annual cycle activities are harmful, and what regional differences in sensitivity occur (Olendorff and Kochert, 1977).

Natural Resource Usage—Farmers, ranchers, and others who own or manage large areas of land can help in raptor conservation in ways besides the techniques listed above. Many of these strategies can be integrated into agricultural practices without much effort or interference with land use. Holroyd et al., (1995) noted that landowners in prairie lands can protect woodlots, plant windbreaks, and reduce the use of chemical pesticides, leaving vegetation and/or trees in prairie areas for raptor nesting. In many areas, small ranches and farms are being incorporated into larger ones and old homesteads are torn down. Leaving trees and other vegetation associated with old homesteads and windbreaks is highly favorable to raptors and other wildlife. Fencing around small areas to protect ground-nesting raptors can be very beneficial, as can fencing isolated nest trees in prairies to keep livestock from disturbing the birds and destroying the trees. Rotational management in which some land segments are mowed, burned, or grazed and others are left idle in each year, can benefit ground-nesting raptors such as Short-eared Owls (*Asio flammeus)* and Northern Harriers (*Circus cyaneus*) (Herkert et al., 1999).

The Natural Resources Conservation Service (U.S. Department of Agriculture) has several wildlife conservation programs which help farmers and ranchers maintain or develop wildlife habitat on their lands. The newest of these, the Wildlife Habitat Incentives Program, is a voluntary program for private lands and provides cost-sharing assistance from the federal government. Information on these programs is found on the World Wide Web (http://www.nrcs.usda.gov) or from Natural Resources Conservation Service, 14th and Independence Ave., Washington, DC 20250.

The Farm Service Agency administers the Conservation Reserve Program which provides landowners with annual payments for planting permanent vegetation on idle, highly erodable farmland. Information is on the World Wide Web (http://www.fsa.usda.gov/dafp/cepd/default.htm) or can be obtained from the local Farm Service Agency office.

Endangered species occurring on private property can present potentially greater problems for land owners, but even these can be resolved through a program known as Safe Harbor Agreements. Safe Harbor Agreements are developed between the U.S Fish and Wildlife Service and private-property owners permitting voluntarily management activities that will benefit the endangered species. At the same time these agreements assure the property owner that future land-use activities will not be subject to increased regulation if the endangered species population increases. Information on these programs can be obtained from the nearest Fish and Wildlife Ecological Services field office and on the World Wide Web (http://endangered.ws.gov/recovery/harborqa.pdf).

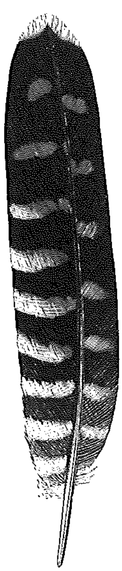
Safe Harbor agreements have been an important part of the recovery of the endangered Aplomado Falcon because release sites for captive-raised falcons were needed in Texas where 97% of the land is private. Safe

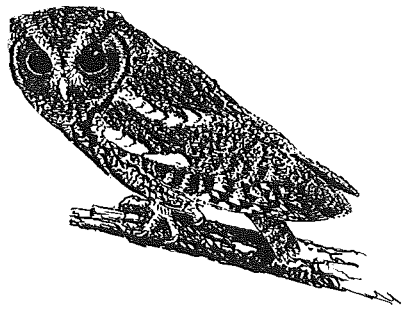
Harbor agreements made 500,000 ha (1.25 million acres) of private land available for releasing the birds and allowed biologists access to them. (Luoma, 2001).

On a smaller scale, many things done in a person's home, ranch, or farm can benefit wildlife, including raptors. Burnham (1997) listed actions individuals can take that will help with the conservation of nature. These include minimizing the use of harmful chemicals (especially certain pesticides), conserving non-renewable resources (especially petroleum and natural gas), recycling or reusing waste materials instead of disposing of them, and making informed opinions known to appropriate governmental agencies and elected representatives.

More information on developing backyard wildlife habitat is available on the World Wide Web (http://www.nrcs.usda.gov/CCS/Backyard.html) or at Natural Resources Conservation Service, 14th and Independence Ave., Washington, DC 20250.

Many people think that individual efforts in conservation are too small to matter, but if enough people make small contributions, the overall effect can be quite significant. There is truth in the words of Canadian television's Red Green, "I'm pulling for you. We're all in this together."





VOLUNTEERISM

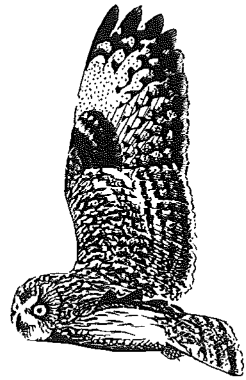
Many important programs to help raptors in the modern world suffer from having budgets insufficient to carry out their goals adequately without the help of volunteers. People who want to contribute to the welfare of raptors can make an important contribution by volunteering their services to these programs. Rehabilitation, education, and reintroduction have been mentioned above as undertakings often needing the help of volunteers, but gathering data about raptors is another possibility.

In order to make informed and sound decisions, wildlife managers need to have good scientific data on raptor populations, e.g., what is the size of the population, and is it stable, declining, or increasing? Many opportunities for participating in such research are listed periodically by the Ornithological Societies of North America on their web site (http://www.ornith.cornell.edu/OSNA/ornjobs.htm).

An area of raptor research that relies heavily on volunteers is raptor migration surveys. Information collected by migration observatories has become an important component in the state of knowledge about raptor populations by helping to understand trends in raptor populations and to identify geographic areas critical to the survival of migratory species (Bildstein, 1998). The many volunteers needed each year to gather these data are recruited by a number of raptor migration watch sites in the United States and people interested in such work can contact the major organizations listed in Table 1. Other sites are listed on the World Wide Web (http://www.nmnh.si.edu/BIRDNET/ OBSERVATORY.html) and in Zalles and Bildstein (2000). Also see the Hawk Migration Association of North America web site (http://www. hmana.org). Potential volunteers should be aware of several considerations before contacting migration study sites. Proficiency in identifying raptors often at considerable distance using binoculars and spotting scopes is a requirement; working conditions are often primitive and hours are long. Many raptor migration programs also catch and band raptors and record other information such as body measurements and molt, requiring knowledge of handling techniques safe for both the raptor and the handler.

Table 1. Major raptor migration watch sites in the United States.

Site Name	Mailing Address	Telephone/E-mail/Web Site
Cape May Bird Observatory	P.O. Box 3 Cape May Point, NJ 08212	(609) 884-2736 cmbo1@njaudubon.org www.njaudubon.org
Golden Gate Raptor Observatory	Building 201, Fort Mason San Francisco, CA 94123	(415) 331-0731 ggro@ggnpa.org www.ggro.org
Hawk Mountain Sanctuary	1700 Hawk Mountain Road Kempton, PA 19529	(610) 756-6961 info@hawkmountain.org www.hawkmountain.org
HawkWatch International	1800 S. West Temple Suite 226 Salt Lake City, UT 84115	(801) 484-6808 (800) 726-HAWK hwi@hawkwatch.org www.hawkwatch.org
Idaho Bird Observatory	Boise State University Department of Biology 1910 University Dr. Boise, ID 83725	(208) 426-3262 kalten@internetoutlet.net www.boisestate.edu
Wildcat Ridge Hawkwatch	P.O. Box 822 Boonton, NJ 07005	(973) 625-1590 Sandra_longley@merck.com www.pweb.netcom.com/~billyg/index.html

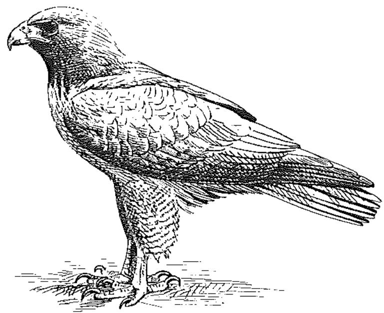


ACKNOWLEDGMENTS

I thank Bill Burnham and staff of The Peregrine Fund for their assistance in many phases of the writing and production of this manual. Thanks also to Mary Jean Cowing, Librarian, Richard Olendorff Memorial Library, without whose help many of the sources cited in this publication would have been difficult or impossible to locate. Earlier drafts of this manuscript were improved by the comments of Margaret Marti, Pat Burham, Bill Burnham, and Lloyd Kiff.

INFORMATION ARCHIVES

Most of the literature cited in this publication is widely available in academic libraries. Some, however, are unpublished reports not easily obtained. All references cited herein are available in the Richard Olendorff Memorial Library located in the Raptor Research Center, Boise State University, Boise, Idaho 83725. This library is searchable on the World Wide Web at http://ris.wr.usgs.gov/.



LITERATURE CITED

AIROLA, D.A. AND N. SHUBERT. 1981. Reproductive success, nest site selection and management of Ospreys at Lake Almanor, California, 1969–1980. *Transactions of the California-Nevada Section of the Wildlife Society* 1981:79–85.

ALONSO, J.A. AND J.C. ALONSO. 1999. Mitigation of bird collisions with transmission lines through groundwire marking. Pages 113-124 *in* M. Ferrer and G.F.E. Janss [EDS.], Birds and power lines; collision, electrocution and breeding. Quercus, Madrid, Spain.

ARCHIBALD, G.W. 1978. Supplemental feeding and manipulation of feeding ecology of endangered birds—a review. Pages 131–134 *in* S.A. Temple [ED.], Endangered birds: management techniques for preserving threatened species. University of Wisconsin Press, Madison, WI.

ARENT, L. and M. MARTELL. 1996. Care and management of captive raptors. The Raptor Center, St. Paul, MN.

ASKHAM, L. R. 1990. Effect of artificial perches and nests in attracting raptors to orchards. Pages 144–148 *in* Proceedings of the Vertebrate Pest Conference No. 14. University of California, Davis, CA.

AVERY, M. AND T. CLEMENT. 1972. Bird mortality at four towers in eastern North Dakota–fall 1972. *Prairie Naturalist* 4:87–95.

AVERY, M.L., P.F. SPRINGER, AND N.S. DAILEY. 1978. Avian mortality at man–made structures; an annotated bibliography. U.S.D.I., Fish and Wildlife Service, Washington DC.

AVIAN POWER LINE INTERACTION COMMITTEE. 1996. Suggested practices for raptor protection on power lines: the state of the art in 1996. Edison Electric Institute/Raptor Research Foundation, Washington, DC.

AWEA. 1995. Avian interactions with wind energy facilities: a summary. Prepared for the American Wind Energy Association by Colson and Associates.

BANKS, R.C. 1979. Human related mortality of birds in the United States. Special Scientific Report—Wildlife No. 215, U.S.D.I. Fish and Wildlife Service. Washington, D.C

BASE, D.L. AND G.A. SIEVER. 1987. Experimental use of artificial nesting structures for grassland raptors in the Oklahoma Panhandle. *Eyas* 10:30–31.

BAUDVIN, H. 1997. Barn Owl (*Tyto alba*) and Long-eared Owl (*Asio otus*) mortality along motorways in Bougogne-Champagne; report and suggestions. Pages 58–61 *in* J.R. Duncan, D.H. Johnson, and T.H. Nicholls [EDS.], Biology and conservation of owls of the northern hemisphere; second international symposium. U.S.D.A. Forest Service, General Technical Report NC-190, North Central Forest Experiment Station, St. Paul, MN.

BECHARD, M.J. AND J.M. BECHARD. 1996. Competition for nest boxes between American Kestrels and European Starlings in an agricultural area of southern Idaho. Pages 155–162 *in* D.M. Bird, D.E. Varland, and J.J. Negro [EDS.], Raptors in human landscapes. Academic Press Inc., San Diego, CA.

BECHARD, M.J., R.L. KNIGHT, D.G. SMITH, AND R.E. FITZNER. 1990. Nest sites and habitats of sympatric hawks (*Buteo* spp.) in Washington. *Journal of Field Ornithology* 61:159-170.

BECK, T.W. AND R.A. SMITH. 1987. Nesting chronology of the Great Gray Owl at an artificial nest site in the Sierra Nevada. *Journal of Raptor Research* 21:116–118.

BECKER, D.M. 1981. Development of artificial nest sites for Prairie Falcons. Unpublished Report, U.S.D.A. Forest Service, Custer National Forest, Billings, MT.

BEDNARZ, J.C. 1984. Effect of mining and blasting on breeding Prairie Falcon (*Falco mexicanus*) occupancy in the Caballo Mountains, New Mexico. *Raptor Research* 18:16-19.

BELLOCQ, M.I. AND F.O. KRAVETZ. 1993. Productividad de la lechuza de companario (*Tyto alba*) en nidos arificiales en agrosistemas pampeanos. *El Hornero* 13:278–282.

BELSKY, A.J., A. MATZKE, AND S. USELMAN. 1999. Survey of livestock influences on stream and riparian ecosystems in the western United States. *Journal of Soil and Water Conservation* 54:419–431.

BEVANGER, K. 1994. Bird interactions with utility structures: collision and electrocution, causes and mitigating measures. *Ibis* 136:412–425.

BEVANGER, K. 1999. Estimating bird mortality caused by collision and electrocution with power lines: a review of methodology. Pages 29-56 *in* M. Ferrer and G.F.E. Janss [EDS.], Birds and power lines; collision, electrocution and breeding. Quercus, Madrid, Spain.

BEVANGER, K. AND K. OVERSKAUG. 1995. Utility structures as a mortality factor for raptors and owls in Norway. Pages 381–392 *in* R.D. Chancellor, B.-U. Meyburg, and J.J. Ferrero [EDS.], Holarctic birds of prey. World Working Group on Birds of Prey and Owls, Berlin, Germany.

BIJLEVELD. M. 1974. Birds of prey in Europe. MacMillian Press, London, UK.

BILDSTEIN, K.L. 1998. Long-term counts of migrating raptors: a role for volunteers in wildlife research. *Journal of Wildlife Management* 62:435–445.

BIOSYSTEMS ANALYSIS, I. 1979. Report on efforts to evaluate ten potential peregrine nesting cliffs and install one artificial nesting platform on Six Rivers National Forest. Unpublished Report. San Francisco, CA.

BIRD, D.M., D.E. VARLAND, AND J.J. NEGRO. 1996. Raptors in human landscapes. Academic Press Inc., San Diego, CA.

BLOOM, P.H. 1991. An analysis of the potential hazards of diurnal raptors to aircraft at Long Beach Airport. Unpublished Report prepared for Long Beach Airport. Long Beach, CA.

BLOOM, P.H. AND S.J. HAWKS. 1983. Nest box use and reproductive biology of the American Kestrel in Lassen County, California. *Raptor Research* 17:9–14.

BLOOM, P.H. AND M.D. MCCRARY. 1996. The urban buteo: Red-shouldered Hawks in southern California. Pages 31–39 *in* D.M. Bird, D.E. Varland, and J.J. Negro [EDS.], Raptors in human landscapes. Academic Press Inc., San Diego, CA.

BOEKER, E.L. AND T.D. RAY. 1971. Golden Eagle population studies in the Southwest. *Condor* 73:463-467.

BOHM, R.T. 1977. Artificial nest platforms for raptors. *Raptor Research* 11:97–99.

BORTOLOTTI, G.R. 1994. Effect of nest-box size on nest-site preference and reproduction in American Kestrels. *Journal of Raptor Research* 28:127–133.

BORTOLOTTI, G.R., E.H. DZUS, AND J.M. GERRARD. 1988. Bald Eagle nest on an artificial tree-top platform. *Journal of Raptor Research* 22:66–67.

BOSHOFF, A. AND B. BASSON. 1993. Large raptor fatalities caused by powerlines in the Karoo, South Africa. *Gabar* 8:10–13.

BOTELHO, E.S. 1996. Behavioral ecology and parental care of breeding western Burrowing Owls (*Speotyto cunicularia hypugaea*) in southern New Mexico, USA. Ph.D. dissertation, New Mexico State University, Las Cruces, NM.

BOYCE, D.A., Jr., L. FISHER, W.E. LEHMAN, B. HIPP, AND J. PETERSON. 1980. Prairie Falcons nest on an artificial ledge. *Raptor Research* 14:46–50.

BOYCE, D.A., JR., C.M. WHITE, R.E.F. ESCANO, AND W.E. LEHMAN. 1982. Enhancement of cliffs for nesting Peregrine Falcons. *Wildlife Society Bulletin* 10:380–381.

BOYLE, S.A. AND F.B. SAMSON. 1985. Effects of nonconsumptive recreation on wildlife: a review. *Wildlife Society Bulletin* 13:110–116.

BROWN, B.T. AND L.E. STEVENS. 1997. Winter Bald Eagle distribution is inversely correlated with human activity along the Colorado River, Arizona. *Journal of Raptor Research* 31:7-10.

BROWN, W.M. AND R.C. DREWIEN. 1995. Evaluation of two power line markers to reduce crane and waterfowl collision mortality. *Wildlife Society Bulletin* 23:217–227.

BROWN, B.T., G.S. MILLS, C. POWELS, W.A. RUSSELL, G.D. THERRES, AND J.J. POTTIE. 1999. The influence of weapons-testing noise on Bald Eagle behavior. *Journal of Raptor Research*. 33: 227-232.

BRÜCHER, H. AND P. WEGNER. 1988. Artificial eyrie management and the protection of the Peregrine Falcon in West Germany. Pages 637–641 *in* T.J. Cade, J.H. Enderson, C.G. Thelander, and C.M. White [EDS.], Peregrine Falcon populations: their management and recovery. The Peregrine Fund, Inc., Boise, ID.

BRYANT, A.A. 1986. Influence of selective logging on Red-shouldered

Hawks, *Buteo lineatus*, in Waterloo region, Ontario, 1953–1978. *Canadian Field-Naturalist* 100:520–525.

BULL, E.L., M.G. HENJUM, AND R.G. ANDERSON. 1987. Nest platforms for Great Gray Owls. Pages 87–90 *in* R.W. Nero, R.J. Clark, R.J. Knapton, and R.H. Hamre [EDS.], Biology and conservation of northern forest owls. U.S.D.A. Forest Service, General Technical Report RM-142, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.

BURNHAM, W.A. 1990. Raptors and people. Pages 170–189 *in* I. Newton [ED.], Birds of prey. Facts on File, New York, NY.

BURHAM, W.A. 1997. A fascination with falcons. Hancock House Publishers, Blaine, WA.

BYRNE, S. 1983. Bird movements and collision mortality at a large horizontal axis wind turbine. *Transactions of the California-Nevada Section of the Wildlife Society* 1983:76–83.

CADE, T.J. 1986. Propagating diurnal raptors in captivity: a review. *International Zoo Yearboo*k 24/25:1–20.

CADE, T.J. 2000. Progress in translocation of diurnal raptors. Pages 343–372 *in* R.D. Chancellor and B.-U. Meyburg [EDS.]. Raptors at risk. Hancock House Publishers, Blaine, WA.

CADE, T.J., J.H. ENDERSON, AND J. LINTHICUM. 1996. Guide to management of Peregrine Falcons at the eyrie. The Peregrine Fund, Inc., Boise, ID.

CADE, T.J., J.H. ENDERSON, C.G. THELANDER, AND C.M. WHITE. 1988. Commentary: the role of organochlorine pesticides in peregrine population changes. Pages 463-468 *in* T.J. Cade, J.H. Enderson, C.G. Thelander, and C.M. White [EDS.]. Peregrine falcon populations: Their management and recovery. The Peregrine Fund, Inc., Boise, ID.

CADE, T.J. AND C.G. JONES. 1993. Progress in the restoration of the Mauritius Kestrel. *Conservation Biology* 7:169–175.

CALL, M.W. AND J.R. TIGNER. 1991. Artificial nesting structures for Ferruginous Hawks (*Buteo regalis*) in Wyoming. Unpublished report, private wildlife consultant, Afton, Wyoming, and U.S.D.I. Bureau of Land Management, Rawlins, WY.

CANNINGS, R.J. 1987. Breeding biology of Northern Saw-whet Owls in southern British Columbia. Pages 193–198 *in* R.W. Nero, R.J. Clark, R.J. Knapton, and R.H. Hamre [EDS.], Biology and conservation of northern forest owls. U.S.D.A. Forest Service, General Technical Report RM-142, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.

CAREY, A.B. AND H.R. SANDERSON. 1981. Routing to accelerate tree-cavity formation. *Wildlife Society Bulletin* 9:14–21.

CHAPLIN, S. B. 1989. Guidelines for exercise in rehabilitated raptors. *Journal of International Wildlife Rehabilitation Council* 12:17–20.

CHRISTENSEN, R.C. 1972. Raptor predation on pocket gopher populations by the use of hunting perches. MS thesis, Brigham Young University., Provo, UT.

CLAYTON, K.M. AND J.F. SCHMUTZ. 1999. Is the decline of Burrowing Owls *Speotyto cunicularia* in prairie Canada linked to changes in Great Plains ecosystems? *Bird Conservation International* 9:163-185.

CLINE, K. 1985. Bald eagles in the Chesapeake: a management guide for landowners. National Wildlife Federation, Washington, DC. in cooperation with U.S.D.I. Fish and Wildlife Service, Delaware Division of Fish and Wildlife, Maryland Forest, Park, and Wildlife Service, and Virginia Commission of Game and Inland Fisheries.

COHN, J.P. 1993. The flight of the California Condor. *BioScience* 43:206–209.

COLLINS, C.T. AND R.E. LANDRY. 1977. Artificial nest burrows for Burrowing Owls. *North American Bird Bander* 2:151–154.

COLVIN, B.A. 1983. Nest boxes for Barn Owls. Publication 346, Ohio Department of Natural Resource, Columbus, OH.

CRAIGHEAD, F.C., JR. AND D.P. MINDELL. 1981. Nesting raptors in western Wyoming, 1947 and 1975. *Journal of Wildlife Management* 45:865-872.

CRAWFORD, J.D. AND H.R. POSTOVIT. 1978. Artificial nesting sites as a Prairie Falcon management technique. *North Dakota Academy of Science* 31:100.

CRAWFORD, R.L. 1978. Autumn bird casualties at a northwest Florida TV tower: 1973–1975. *Wilson Bulletin* 90:335–345.

CSERMELY, D. 2000a. Rehabilitation of birds of prey and their survival after release. A review. Pages 303-311 *in* J.T. Lumeij, J.D. Remple, R.T. Redig, M. Lierz, and J.E. Cooper. [EDS.], Raptor biomedicine III;

including bibliography of diseases of birds of prey. Zoological Education Network, Lakeworth, FL.

CSERMELY, D. 2000b. Behaviour of hand-reared orphaned Long-eared Owls and Tawny Owls after release in the wild. *Italian Journal of Zoology* 67:57-62.

CURLEY, E.M., R. BOWMAN, AND D.M. BIRD. 1987. Nest site characteristics of boxes occupied by starlings and kestrels. *Raptor Research* Report 6:160–164.

CYMERYS, M. AND B.J. WALTON. 1988. Raptors of the Pinnacles National Monument: past and present nesting and possible impacts of rock climbers. Unpublished Report, Santa Cruz Predatory Bird Research Group, University of California, Santa Cruz, CA.

DELANEY, D.K., T.G. GRUBB, P. BEIER, L.L. PATER, AND M.H. REISER. 1999. Effects of helicopter noise on Mexican Spotted Owls. *Journal of Wildlife Management* 63:60-76.

DEWAR, S.M. AND C.R. SHAWYER. 1996. Boxes, baskets and platforms. The Hawk and Owl Trust, London, UK.

DOREMUS, J. 1991. Raptor use of nest boxes in the Snake River Birds of Prey Area. Pages 208–210 *in*. K. Steenhof [ED.], Snake River Birds of Prey Area Annual Report. U.S.D.I., Bureau of Land Management, Boise, ID.

DUCEY, J. AND B. HANCOCK. 1981. Raptor rehabilitation—a positive conservation approach. *Nebraska Bird Review* 49:58–64.

DUCKETT, J.E. 1991. Management of the Barn Owl (*Tyto alba javanica*) as a predator of rats in oil palm (*Elaeis quineensis*) plantations in Malaysia. Pages 11–23 *in* R.D. Chancellor and B.-U. Meyburg [EDS.], Birds of Prey Bulletin No. 4. World Working Group on Birds of Prey and Owls, Berlin, Germany.

DUKE, G.E. 1980. University of Minnesota raptor research and rehabilitation program. Pages 149–157 *in* T.N. Ingram [ED.], Raptor rehabilitation—eagle nesting biology: Proceedings of Bald Eagle Days, 1980. Eagle Valley Environmentalists, Inc., Apple River, IL.

DUNCAN, J.R. 1997. Great Gray Owl (*Strix nebulosa nebulosa*) and forest management in North America: A review and recommendations. *Journal of Raptor Research* 31:160–166.

DUNN, E.H. 1993. Bird mortality from striking residential windows in winter. *Journal of Field Ornithology* 64:302–309.

ELLIS, L.E. AND J. KELLETT. 1970. Experiment with artificial nests. *Florida Naturalist* 43:148–149.

EMERSON, W.O. 1904. Destruction of birds by wires. *Condor* 6:37–38.

ENDERSON, J.H., C.M. WHITE, AND U. BANASCH. 1995. Captive breeding and releases of Peregrines *Falco peregrinus* in North America. Pages 437–444 *in* R.D. Chancellor, B.-U. Meyburg, and J.J. Ferrero [EDS.], Holarctic birds of prey. World Working Group on Birds of Prey and Owls, Berlin, Germany.

ENGEL, J.M. 1980. Value of raptor rehabilitation to endangered and threatened species. Pages 159–160 *in* T.N. Ingram [ED.], Raptor rehabilitation—eagle nesting biology: Proceedings of Bald Eagle Days, 1980. Eagle Valley Environmentalists, Inc., Apple River, IL.

EVANS, I.M., R.W. SUMMERS, L. O'TOOLE, D.C. ORR-EWING, R. EVANS, N. SNELL, AND J. SMITH. 1999. Evaluating the success of translocating Red Kites *Milvus milvus* to the UK. *Bird Study* 46:129-144.

EWINS, P.J. 1994. Artificial nest structures for Ospreys. A construction manual. Canadian Wildlife Service., Environmental Conservation Branch, Toronto, Ontario, Canada.

EXO, K.M. 1992. Population ecology of Little Owl *Athene noctua* in central Europe: a review. Pages 64–75 *in* C.A. Galbraith, I.R. Taylor, and S. Percival [Eds.], The ecology and conservation of European owls. Joint Nature Conservation Committee, United Kingdom Nature Conservation No. 5. Peterborough, UK.

FAJARDO, I., G. BABILONI, AND Y. MIRANDA. 2000. Rehabilitated and wild Barn Owls (*Tyto alba*); dispersal, life expectancy and mortality in Spain. *Biological Conservation* 94:287-295

FAMINOW, C.W. 1997. Predator-resistant nestboxes for Burrowing Owls. *Alberta Naturalist* 27:8.

FERNÁNDEZ, C. and P. AZKONA. 1993. Human disturbance affects parental care of Marsh Harriers and nutritional status of nestlings. *Journal of Wildlife Management* 57:602–608.

FERRER, M., M. DE LA RIVA, AND J. CASTROVIEJO. 1991. Electrocution of raptors on power lines in southwestern Spain. *Journal of Field Ornithology* 62:181–190.

FITZNER, R.E. 1975. Owl mortality on fences and utility lines. *Raptor Research* 9:55–57.

FORREN, J.D. 1981. Artificial perch use by raptors on reclaimed surface mines in West Virginia. M.S thesis, West Virginia University, Morgantown, WV.

FORSMAN, E.D. AND E.C. MESLOW. 1985. Old-growth forest retention for spotted owls—how much do they need?. Pages 58–59 *in* R.J. Gutierrez and A.B. Carey [Eds.], Ecology and management of the Spotted Owl in the Pacific Northwest. U.S.D.A. Forest Service, General Technical Report PNW-185, Portland, OR.

FRASER, J.D., L.D. FRENZEL, AND J.E. MATHISEN. 1985. The impact of human activities on breeding Bald Eagles in north-central Minnesota. *Journal of Wildlife Management* 49:585–592.

FRIEDMAN, R. AND P.J. MUNDY. 1983. The use of "restaurants" for the survival of vultures in South Africa. Pages 345–355 *in* S.R. Wilbur and J.A. Jackson [Eds.], Vulture biology and management. University of California Press, Berkeley, CA.

FYFE, R.W. AND H.I. ARMBRUSTER. 1977. Raptor research and management in Canada. Pages 282–293 *in* R.D. Chancellor [Ed.], World Conference on birds of prey. Report of proceedings. International Council for Bird Preservation, London, UK.

FYFE, R.W. AND R.R. OLENDORFF. 1976. Minimizing the dangers of nesting studies to raptors and other sensitive species. Canadian Wildlife Service Occasional Paper 23.

GANO, R.D. AND J.A. MOSHER. 1983. Artificial cavity construction–an alternative to nest boxes. *Wildlife Society Bulletin* 11:74–76.

GARNER, D.J. AND B.S. MILNE. 1997. A study of the Long-eared Owl *Asio otus* using wicker nesting baskets. *Bird Study* 45:62–67.

GARY, H.L. AND M.J. MORRIS. 1980. Constructing wooden boxes for cavity-nesting birds. U.S.D.A. Forest Service, Rocky Mountain Forest and Range Experiment Station, Research Note Rm-381. Fort Collins, CO.

GEHLBACH, F.R. 1994. Nest-box versus natural-cavity nests of the Eastern Screech-Owl: an exploratory study. *Journal of Raptor Research* 28:154–157.

GEHLBACH, F.R. 1996. Eastern Screech Owls in suburbia: a model of raptor urbanization. Pages 69–74 *in* D.M. BIRD, D.E.VARLAND, and J.J. NEGRO [Eds.], Raptors in human landscapes. Academic Press Inc., San Diego, CA.

GILLIHAN, S.W. 2000. Barbed wire fence fatal to Burrowing Owl. *Journal of the Colorado Field Ornithologists* 34:220-221.

GLINSKI, R.L., T.G. GRUBB, AND L.A. FORBES. 1983. Snag use by selected raptors. Pages 130–133 *in* Snag habitat management. U.S.D.A. Forest Service General Technical Report RM-99, Tempe, AZ.

GRUBB, T.G. 1980. An artificial Bald Eagle nest structure. U.S.D.A. Forest Service, Rocky Mountain Forest and Range Experiment Station, Research Note RM-383, Tempe, AZ.

GRUBB, T.G. 1995. Constructing Bald Eagle nests with natural materials. U.S.D.A. Forest Service., Rocky Mountain Forest and Range Experiment Station, Research Note, RM-RN-535, Tempe, AZ.

GRUBB, T.G. AND R.M. KING. 1991. Assessing human disturbance of breeding Bald Eagles with classification tree models. *Journal of Wildlife Management* 55:500–511.

HALL, T.R., W.E. HOWARD, AND R.E. MARSH. 1981. Raptor use of artificial perches. *Wildlife Society Bulletin* 9:296–298.

HAMERSTROM, F. 1979. ...But what can I do?. *Defenders* 54:268–269.

HAMERSTROM, F., F.N. HAMERSTROM, AND J. HART. 1973. Nest boxes: an effective management tool for kestrels. *Journal of Wildlife Management* 37:400–403.

HAMILTON, L.L., P.J. ZWANK, AND G.H. OLSEN. 1988. Movements and survival of released, rehabilitated hawks. *Journal of Raptor Research* 22:22–26.

HANSEN, A.J. 1987. Regulation of Bald Eagle reproductive rates in southeast Alaska. *Ecology* 68:1387–1392.

HARMATA, A.R., G.J. MONTOPOLI, B. OAKLEAF, P.J. HARMATA, AND M. RESTANI. 1999. Movements and survival of Bald Eagles banded in the greater Yellowstone ecosystem. *Journal of Wildlife Management* 63:781-793.

HARNESS, R.E. AND K.R. WILSON. 2000. Raptor electrocutions and outages—a review of rural utility records spanning 1986–1996. Pages 765–771 *in* R.D. Chancellor and B.-U. Meyburg [EDS.], Raptors at risk. Hancock House Publishers, Blaine, WA.

HARNESS, R.E. AND K.R.. WILSON. 2001. Electric-utility structures associated with raptor electrocutions in rural areas. *Wildlife Society Bulletin* 29:612-623.

HARRIS, R.D. AND L. FEENEY. 1989. Restoration of habitat for Burrowing Owls *Athene cunicularia*. *Proceedings annual meeting Society Ecological Restoration* 1:251–259.

HAYWARD, G.D., R.K. STEINHORST, AND P.H. HAYWARD. 1992. Monitoring Boreal Owl populations with nest boxes: Sample size and cost. *Journal of Wildlife Management* 56:777–785.

HEBERT, E., E. REESE, AND L. MARK. 1995. Avian collision and electrocution: an annotated bibliography. California Energy Commission, Staff Report. P700–95-001.

HELANDER, B. 1978. Feeding White-tailed Sea Eagles in Sweden. Pages 47–56 *in* B.T.A. Geer [ED.], Bird of prey management techniques. British Falconers' Club. Conf. on Bird of Prey Management Techniques. Wadham College, Oxford, UK.

HELANDER, B. 1985. Winter feeding as a management tool for White-tailed Sea Eagles in Sweden. Pages 421–428. *in* I. Newton and R.D. Chancellor [EDS.], Conservation studies on raptors, I.C.B.P.,Technical Publication No.5, Cambridge, UK.

HENDERSON, C.L. 1984. Woodworking for wildlife, homes for birds and mammals. Minnesota Department of Natural Resources, St. Paul, MN.

HENNY, C.J. 1977a. Birds of prey, DDT, and tussock moths in Pacific Northwest. *Transactions of the North American Wildlife and Natural Resources Conference* 42:397–411.

HENNY, C.J. 1977b. Research, management, and status of the osprey in North America. Pages 199–222 *in* In R.D. Chancellor [ED.], World Conference on Birds of Prey, Report of proceedings. International Council for Bird Preservation, London,UK.

HENNY, C. AND L.J. BLUS. 1981. Artificial burrows provide new insight into Burrowing Owl nesting biology. *Raptor Research* 15:82-85.

HERKERT, J.R., S.A. SIMPSON, R.L. WESTEMEIER, T.L. ESKER, AND J.W. WALK. 1999. Response of Northern Harriers and Short-eared Owls to grassland management in Illinois. *Journal of Wildlife Management* 63:517-523.

HERREN, H. 1969. The status of the Peregrine Falcon in Switzerland. Landscape. Pages 231–238 *in* J.J. Hickey [ED.], Peregrine Falcon populations: their biology and decline. University of Wisconsin Press, Madison, WI.

HIGHHOUSE, W. 1989. American Kestrel nesting box project in Warren County. *Pennsylvania Birds* 3:132.

HOLMES, T.L. 1994. Behavioral responses of grassland raptors to human disturbance. MS Thesis, Colorado State University, Fort Collins, CO.

HOLMES, T.L., R.L. KNIGHT, L. STEGALL, AND G.R. CRAIG. 1993. Responses of wintering grassland raptors to human disturbance. *Wildlife Society Bulletin* 21:461–468.

HOLROYD, G.L., I. SHUKSTER, D. KEITH, AND L. HUNT. 1995. A landowner's guide, prairie raptors. Ministry of Environment, Canadian Wildlife Service, Edmonton, Alberta, Canada.

HOLZ, P. AND R. NAISBITT. 2000. Fitness level as a determining factor in the survival of rehabilitated raptors released back into the wild - preliminary results. Pages 321-325. *in* J.T. Lemeij, J.D. Remple, P.T. Redig, M. Lierz, and J.E. Cooper [EDS.], Raptor biomedicine III. Zoological Education Network Inc., Lake Worth, FL.

HOUSTON, C.S. 1982. Artificial nesting platforms for Ferruginous Hawks. *Blue Jay* 40:208–213.

HOUSTON, C.S. AND F. SCOTT. 1992. The effect of man-made platforms on osprey reproduction at Loon Lake, Saskatchewan. *Journal of Raptor Research* 26:152–158.

HOWARD, R.P. 1980. Artificial nest structures and grassland raptors. Pages. 117–123. *in* R.P. Howard and J.F. Gore [EDS.], A workshop on raptors and energy developments. U.S.D.I. Fish and Wildlife Service and the Idaho Chapter of the Wildlife Society, Boise, ID.

HUSS, M. J., J. C. BEDNARZ, D. M. JULIANO, AND D. E. VARLAND. In press. The efficacy of inoculating fungi into conifer trees to promote cavity excavation by woodpeckers in managed forests in western Washington. Proceedings from the symposium on the ecology and management of dead wood in Western Forests. Reno, NV.

HYSLOP, C. 1995. Bird trends: a report on results of national and regional ornithological surveys in Canada. *Bird trends*, No. 4, winter 1994/95.

INGRAM, K. 1988. Survival and movements of rehabilitated raptors. Pages 277–281 *in* R.L. Glinski, B.G. Pendleton, M.B. Moss, M.N. LeFranc Jr., B.A. Millsap, and S.W. Hoffman [EDS.], Proceedings of the southwest raptor management symposium and workshop. Scientific and

Technical Series No.11, National Wildlife Federation, Washington, DC.

IVANOVSKI, V.V. 2000. Construction of artificial nests as conservation measure for rare birds of prey. *Buteo* 11:131-138.

JACOBS, E.A. 1995. American Kestrel reproduction and dispersal in central Wisconsin. *Journal of Raptor Research* 29:135–137.

JAMES, P.C. AND R.H.M. ESPIE. 1997. Current status of the Burrowing Owl in North America: an agency survey. Pages 3–5 *in* J.L. Lincer and K. Steenhof [EDS.], The Burrowing Owl, its biology and management including the proceedings of the first international Burrowing Owl symposium, Raptor Research Report No. 9, Raptor Research Foundation, Inc.

JANSS, G.F.E. AND M. FERRER. 1998. Rate of bird collision with power lines: effects of conductor-marking and static wire-marking. *Journal of Field Ornithology* 69:8–17.

JANSS, G.F.E. AND M. FERRER. 2001. Avian electrocution mortality in relation to pole design and adjacent habitat in Spain. *Bird Conservation International* 11:3-12.

JANSS, G.F.E., A. LAZO, AND M. FERRER. 1999. Use of raptor models to reduce avian collisions with powerlines. *Journal of Raptor Research* 33:154–159.

JOHNSON, D.H. 1987. Barred Owls and nest boxes—results of a five-year study in Minnesota. Pages 129–134 *in* R.W. Nero, R.J. Clark, R.J. Knapton, and R.H. Hamre [EDS.], Biology and conservation of northern forest owls. U.S.D.A. Forest Service, General Technical Report RM-142, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.

JONES, C.G., W. HECK, R.E. LEWIS, Y. MUNGROO, AND T.J. CADE. 1991. A summary of the conservation management of the Mauritius Kestrel *Falco punctatus* 1973–1991. *Dodo* 27:81– 99.

JONES, C.G., W. HECK, R.E. LEWIS, Y. MUNGROO, G. SLADE, AND T. CADE. 1994. The restoration of the Mauritius Kestrel *Falco punctatus* population. *Ibis* 137:S173–S180.

JUILLARD, M. AND J. BEURET. 1983. L'amenagement de sites de nidification et son influence sur une population de chouettes effraies, *Tyto alba*, dans le nord-ouest de la Suisse. *Nos Oiseaux* 37:1–20.

KAHILA, G., S. AVIEL, AND E. TCHERNOV. 1994. Reproductive cycle of the Barn Owl (*Tyto alba*) in nesting boxes. *Israel Journal of Zoology* 40:100.

KAY, B.J., L.E. TWIGG, T.J. KORN, AND H.I. NICOL. 1994. The use of artificial perches to increase predation on house mice (*Mus domesticus*) by raptors. *Wildlife Research* 21:95–106.

KEITH, A.R. 1964. A thirty-year summary of the nesting of the Barn Owl on Martha's Vineyard, Massachusetts. *Bird Banding* 35:22–31.

KEITH, J.O. 1966. Insecticide contaminations in wetland habitats and their effects on fish-eating birds. *Journal of Applied Ecology, Supplement.* 3:71–85.

KERLINGER, P. AND M.R. LEIN. 1988. Causes of mortality, fat condition, and weights of wintering Snowy Owls. *Journal of Field Ornithology* 59:7–12.

KIFF, L. 2000. The California Condor recovery programme. Pages 307–319 in *in* R.D. Chancellor and B.-U. Meyburg [EDS.]. Raptors at risk. Hancock House Publishers, Blaine, WA.

KIRTLAND, K. 1985. A study of collisions of migrating birds with wind machines. Unpublished report, Wind implementation monitoring program, Sierra Madre Consultants.

KIRVEN, M.N., W.E. LEHMAN, AND R.N. LEHMAN. 1983. Results of the 1983 Peregrine Falcon nest site improvement project on the Ukiah District. Unpublished report, U.SD.I. Bureau of Land Management, Ukiah, CA.

KLEM, D., JR. 1981. Avian predators hunting birds near windows. *Proceedings of the Pennsylvania Academy of Science* 55:90–92.

KLEM, D., JR., 1989. Bird–window collisions. *Wilson Bulletin* 101:606–620.

KLEM, D., JR. 1990. Collisions between birds and windows: mortality and prevention. *Journal of Field Ornithology* 61:120–128.

KLÖS, U. 1983. Breeding owl species at the West Berlin Zoo. *International Zoo Yearbook* 23:100–102.

KNIGHT, R.L., D.E. ANDERSEN, M.J. BECHARD, AND N.V. MARR. 1989. Geographic variation in nest-defence behaviour of the Red-tailed Hawk *Buteo jamaicensis*. *Ibis* 131:22–26.

KNIGHT, R.L., D.P. ANDERSON, AND N.V. MARR. 1991. Responses of an avian scavenging guild to anglers. *Biological Conservation* 56:195–205.

KNIGHT, R.L. AND S.K. SKAGEN. 1988. Effects of recreational disturbance on birds of prey: a review. Pages 355–359 *in* R.L. Glinski, B.G. Pendleton, M.B. Moss, M.N. LeFranc Jr., B.A. Millsap, and S.W. Hoffman [EDS.], Proceedings of the southwest raptor management symposium and workshop. Scientific and Technical Series No.11, National Wildlife Federation, Washington, DC.

KÖNIG, C. 1995. Ecology and population of Pygmy Owls *Glaucidium passerinum* in the black forest (SW Germany). Pages 447–449 *in* R.D. Chancellor, B.-U. Meyburg, and J.J. Ferrero [EDS.], Holarctic birds of prey. World Working Group on Birds of Prey and Owls, Berlin, Germany.

KORPIMÄKI, E. 1987. Selection for nest-hole shift and tactics of breeding dispersal in Tengmalm's Owl *Aegolius funereus. Journal of Animal Ecology* 56:185–196.

KRUGER, R. 1999. Towards solving raptor electrocutions on Eskom distribution structures in South Africa. MEM Thesis, University of the Orange Free State, Bloemfontein, South Africa..

LEDGER, J.A. 1980. Plea to save Africa's birds from electrocution—focus on ESCOM research committee's work. *Megawatt* 63:11–13.

LEFRANC, M.N., JR. AND B.A. MILLSAP. 1984. A summary of state and federal agency raptor management programs. *Wildlife Society Bulletin* 12:274–282.

LEHMAN, R.N., K. STEENHOF, M.N. KOCHERT, AND L.B. CARPENTER. 1999. Effects of military training activities on shrub-steppe raptors in southwestern Idaho, USA. *Environmental Management* 23:409-417.

LESLIE, R. 1994. Raptors and the modern forest. *The Raptor* 21:26–29.

LEVENSON, H. AND J.R. KOPLIN. 1984. Effects of human activity on productivity of nesting Ospreys. *Journal of Wildlife Management* 48:1374–1377.

LIEBERMAN, A., J.V. RODRIGUEZ, J.M. PAEZ, AND J. WILEY. 1993. The reintroduction of the Andean Condor into Colombia, South America: 1989-1991. *Oryx* 27:83-90.

LINNELL, M.A., M.R. CONOVER, AND T.J. OHASHI. 1996. Analysis of bird strikes at a tropical airport. *Journal of Wildlife Management* 60:935–945.

LIPSBERGS, J. 1993. Artificial nests built on spruce to attract the White-tailed Eagle (*Haliaeetus albicilla*). *Ring* 15:274–280.

LOVE, O.P. AND D.M. BIRd. 2000. Raptors in urban landscapes: a review and future concerns. Pages 425–434 *in* R.D Chancellor and B.-U Meyburg (EDS.), Raptors at risk. World Working Group on Birds of Prey and Owls. Berlin, Germany.

LOVELL, C.D. AND R.A. DOLBEER. 1999. Validation of the United States Air Force bird avoidance model. *Wildlife Society Bulletin* 27:167-171.

LUMSDEN, H.G. 1976. Choice of nest boxes by Starlings. *Wilson Bulletin* 88:665–666.

LUNDBERG, A. AND B. WESTMAN. 1984. Reproductive success, mortality and nest site requirements of the Ural Owl, *Strix uralensis*, in central Sweden. *Annales Zoologici Fennici* 21:265–269.

LUOMA, J.R. 2001. Safe. *Wildlife Conservation* May/June:31-35, 65.

MARKS, J.S. AND I.J. BALL. 1981. Impacts of surface mining on burrowing owls: Recommendations for monitoring and mitigation. Unpublished report, U.S.D.I. Fish and Wildlife Service, Montana Cooperative Wildlife Research Unit, Missoula, MT.

MARTELL, M.S., J. GOGGIN, AND P.R. REDIG. 2000. Assessing rehabilitation success of raptors through band returns. Pages. 327-334 *in* J.T. Lemeij, J.D. Remple, P.T. Redig, M. Lierz and J.E. Cooper [EDS.], Raptor biomedicine III. Zoological Education Network Inc., Lake Worth, FL.

MARTELL, M., P. REDIG, J. NIBE, G. BUHL, AND D. FRENZEL. 1991. Survival and movements of released rehabilitated Bald Eagles. *Journal of Raptor Research* 25:72–76.

MARTI, C.D. 1988. The Common Barn-Owl. Pages 535–550 *in* W.J. Chandler [ED.], Audubon wildlife report 1988/1989. Academic Press, San Diego, CA.

MARTI, C.D. 1997. Flammulated Owls (*Otus flammeolus*) breeding in deciduous forest. Pages 262–266 *in* J.R. Duncan, D.H. Johnson, and T.H. Nicholls [EDS.], Biology and conservation of owls of the northern hemisphere; second international symposium. U.S.D.A. Forest Service, General Technical Report NC-190, North Central Forest Experiment Station, St. Paul, MN.

MARTI, C.D. AND P.W. WAGNER. 1985. Winter mortality in Common Barn-Owls and its effect on population density and reproduction. *Condor* 87:111–115.

MARTI, C.D., P.W. WAGNER, AND K.W. DENNE. 1979. Nest boxes for the management of Barn Owls. *Wildlife Society Bulletin* 7:145–148.

MASSEMIN, S. AND T. ZORN. 1998. Highway mortality of Barn Owls in northeastern France. *Journal of Raptor Research* 32:229–232.

MAYER, P.M. AND G.T. ALLEN. 1987. Reinforced artificial aeries for Prairie Falcons. *Wildlife Society Bulletin* 15:207–209.

MCCOLLOUGH, M.A., C.S. TODD, AND R.B. OWEN. 1994. Supplemental feeding program for wintering Bald Eagles in Maine. *Wildlife Society Bulletin* 22:147–154.

MCILVEEN, W.D., M. WERNAART, AND D. BREWER. 1993. Update on the raptor relocation program at Pearson International Airport, 1989–1993. *Ontario Bird Banding* 25/26:64–70.

MCKEEVER, K. 1987. Care and rehabilitation of injured owls. W.F. Rannie, Beamsville, Ontario, Canada.

MCNEIL, R., J.R. RODRIGUEZ SR., AND H. OUELLET. 1985. Bird mortality at a power transmission line in northeastern Venezuela. *Biological Conservation* 31:151–165.

MELCHER, C. AND L. SUAZO. 1999. Raptor electrocutions; the unnecessary losses continue. *Colorado Field Ornithologist Journal* 33:221–224.

MERETSKY, V.J., M.F.R. SNYDER, S.R. BEISSINGER, D.A. CLENDENEN, AND J.W. WILEY. 2000. Demography of the California Condor; implications for reestablishment. *Conservation Biology* 14:957-967.

MIKKOLA, H. 1983. Owls of Europe. Buteo Books, Vermillion, SD.

MØLLER, A.P. 1994. Facts and artefacts in nest-box studies: implications for studies of birds of prey. *Journal of Raptor Research* 28:143–148.

MORKILL, A.E. AND S.H. ANDERSON. 1993. Effectiveness of yellow aviation balls in reducing sandhill crane collisions with powerlines. Pages 21–1 through 21–17 *in* J.W. Huckabee [ED.], Proceedings: avian interactions with utility structures, international workshop. Electric Power Research Institute, Inc., Palo Alto, CA.

MORRISON, J.L. AND S.R. HUMPHREY. 2001. Conservation value of private lands for Crested Caracaras in Florida. *Conservation Biology* 15:675-684.

NELSON, M.W. 1978. Preventing electrocution deaths and the use of nesting platforms on powerlines. Pages 42-46 *in* T.A. Geer [ED], Bird of prey management techniques. British Falconers' Club. Conf. on Bird of Prey Management Techniques. Wadham College, Oxford, UK.

NERO, R.W. 1974. Great gray owl impaled on barbed wire. *Blue Jay* 32:178-179.

NERO, R.W. 1982. Building nests for Great Gray Owls. *Sialia* 4:43–48.

NEWTON, I. 1979. Population ecology of raptors. Buteo Books, Vermillion, SD.

NEWTON, I. 1990. Human impacts on raptors. Pages 190–207 *in* I. Newton [ED.] . Birds of prey. Facts on File, New York, NY.

NEWTON, I., I. WYLLIE, AND L. DALE. 1997. Mortality causes in British Barn Owls (*Tyto alba*), based on 1,101 carcasses examined during 1963–1996. Pages 299–307 *in* J.R. Duncan, D.H. Johnson, and T.H. Nicholls [EDS.], Biology and conservation of owls of the northern hemisphere; second international symposium. U.S.D.A. Forest Service, General Technical Report NC-190, North Central Forest Experiment Station, St. Paul, MN.

NOBEL, T.A. 1995. Birds and power lines: Selected interaction and management issues in the electric utility industry. MS thesis, Prescott College, Prescott, AZ.

NUTTALL, T. 1832. A manual of the ornithology of the United States and of Canada,. Volume1. Hilliard and Brown, Cambridge, MA.

OLENDORFF, R.R. 1993. Status, biology, and management of Ferruginous Hawks: a review. Raptor Research and Technical Assistance Center., Special Report, U.S.D.I., Bureau of Land Management, Boise, ID.

OLENDORFF, R.R. AND M.N. KOCHERT. 1977. Land management for the conservation of birds of prey. Pages 294–307 *in* R.D. Chancellor [ED.], World Conference on Birds of Prey, report of proceedings. International Council for Bird Preservation, London, UK.

OLENICK, B.E. 1990. Breeding biology of Burrowing Owls using artificial nest burrows in southeastern Idaho. MS thesis, Idaho State University, Pocatello, ID.

OLSEN, J. AND P. OLSEN. 1980. Alleviating the impact of human disturbance on the breeding Peregrine Falcon. II. Public and recreational lands. *Corella* 4:54–57.

ORLOFF, S.G. AND A.W. FLANNERY. 1993. Wind turbine effects on avian activity, habitat use, and mortality in the Altamont Pass and Soleano County Wind Resource Areas. Pages 22–1 through 22–14 *in* J.W. Huckabee [ED.], Proceedings: avian interactions with utility structures, international workshop. Electric Power Research Institute, Inc., Palo Alto, CA.

ORR, D.J. AND R.J. ANDERSON. 1993. Use of artificial nest boxes by peregrine falcons at electric power generating facilities. Pages 24–1 through 24–10 *in* J.W. Huckabee [Ed.], Proceedings: avian interactions with utility structures, international workshop. Electric Power Research Institute, Inc., Palo Alto, CA.

PAGEL, J.E. 1989. Use of explosives to enhance a Peregrine Falcon eyrie. *Sialia* 23:176–178.

PASA, J.P. 1988. Alternative nest box designs using PVC materials. Wildlife Resource Notes *Information Exchange Bulletin* 6:3–4, U.S. Army Corps of Engineers, Washington, DC.

PETTY, S.J. 1985. A negative response of Kestrels *Falco tinnunculus* to nestboxes in upland forests. *Bird Study* 32:194–195.

PETTY, S.J. 1987. Design and use of a nestbox for Tawny Owls, *Strix aluco*, in upland forests. *Quarterly Journal of Forestry* 81:103–109.

PETTY, S.J., G. SHAW, AND D.I.K. ANDERSON. 1994. Value of nest boxes for population studies and conservation of owls in coniferous forests in Britain. *Journal of Raptor Research* 28:134–142.

PIETIÄINEN, H. 1988. Breeding season quality, age, and the effect of experience on the reproductive success of the Ural Owl (*Strix uralensis*). *Auk* 105:316–324.

PIETIÄINEN, H. 1989. Seasonal and individual variation in the production of offspring in the Ural Owl *Strix uralensis*. *Journal of Animal Ecology* 58:905–920.

PLENSNÍK, J. 1990. Long-term study of some urban and extra-urban populations of the Kestrel (*Falco tinnunculus* L.). Pages 453–458 *in* Bird Census and Atlas Studies. Charles University, Vinicná, Czech Republic.

POMAROL, M. 1996. Artificial nest structure design and management implications for the Lesser Kestrel (*Falco naumanni*). *Journal of Raptor Research* 30:169–172.

POOLE, A. 1981. The effects of human disturbance on Osprey reproductive success. *Colonial Waterbirds* 4:20–27.

POSTOVIT, H.R. AND B.C. POSTOVIT. 1987. Impacts and mitigation techniques. Pages 183–213 *in* B.G. Pendleton, B.A. Millsap, K.W. Cline, and D.M. Bird [EDS.], Raptor management techniques manual. National Wildlife Federation, Washington, DC.

POSTOVIT, H.R. AND B.C. POSTOVIT. 1989. Mining and energy development [raptor implications], Pages 167–172 *in* B.G. Pendleton [ED.], Proceedings of the western raptor management symposium and workshop. National Wildlife Federation, Washington, DC.

POSTUPALSKY, S. 1978. Artificial nesting platforms for ospreys and bald eagles. Pages 35–45 *in* S.A. Temple [ED.], Endangered birds: management techniques for preserving threatened species. University of Wisconsin Press, Madison, WI. Proceedings of the symposium on management techniques for preserving endangered birds, University of Wisconsin, Madison, WI.

POSTUPALSKY, S. 1979. Bald Eagles using man-made nests. Pages 124–128, *in* T.N. Ingram [ED.], Wintering eagles: proceedings of '79 Bald Eagle days. Eagle Valley Environmentalists, Inc., Apple River, IL.

POSTUPALSKY, S., J.M. PAPP, AND L. SCHELLER. 1997. Nest sites and reproductive success of Barred Owls (*Strix varia*) in Michigan. Pages 325–337. *in* J.R. Duncan, D.H. Johnson, and T.H. Nicholls [EDS.], Biology and conservation of owls of the northern hemisphere; second international symposium. U.S.D.A. Forest Service, General Technical Report NC-190, North Central Forest Experiment Station, St. Paul, MN.

POULIN, R.G. 1999. Burrowing owl nest box; construction and installation procedures. Saskatchewan Environment and Resource management; Fish and Wildlife Branch, Regina, SK, Canada.

PRATHER, S. 2000. Rock climbers lend a hand to feathered friends. *Idaho Statesman* February 6:1B, 3B.

PROUDFOOT, G.A. AND S.L. BEASOM. 1997. Food habits of nesting Ferruginous Pygmy-Owls in southern Texas. *Wilson Bulletin* 109:741–748.

PYKE, K. 1998. Raptors & climbers; guidance for managing technical climbing to protect raptor nest sites. Access Fund, Boulder, CO.

RAMAKKA, J.M. 1988. Impacts and mitigation of mineral development on raptors in the Southwest. Pages 335–340. *in* R.L. Glinski, B.G. Pendleton, M.B. Moss, M.N. LeFranc Jr., B.A. Millsap, and S.W. Hoffman [EDS.], Proceedings of the southwest raptor management symposium and workshop. Scientific and Technical Series No.11, National Wildlife Federation, Washington, DC.

REAL, J. AND S. MAÑOSA. 2001. Dispersal of juvenile and immature Bonelli's Eagles in northeastern Spain. *Journal of Raptor Research* 35:9-14.

REDIG, P.T., J. E. COOPER, D. REMPLE, AND B.HUNTER.1993. Raptor biomedicine. University of Minnesota Press. Minneapolis, MN.

REDIG, P.T. AND G.E. DUKE. 1995. The effect and value of raptor rehabilitation in North America. *Transactions of the North American Wildlife and Natural Resources Conference* 60:162–172.

RHODES, L.I. 1972. Success of Osprey nest structures at Martin National Wildlife Refuge. *Journal of Wildlife Management* 36:1296–1299.

RICHARDSON, C.T. AND C.K. MILLER. 1997. Recommendations for protecting raptors from human disturbance: a review. *Wildlife Society Bulletin* 25:634–638.

RITCHIE, R.J. 1987. Response of adult Peregrine Falcons to experimental and other disturbances along the trans-Alaska pipeline system, Sagavanirktok River, Alaska, 1985, 1986. Unpublished Report, Alyeska Pipeline Service Company, Anchorage, AL.

ROMIN, L.A. AND J.A. MUCK. 1999. Utah field office guidelines for raptor protection from human and land use disturbances. U.S. Fish and Wildlife Service, Utah Field Office, Salt Lake City, UT.

ROPPE, J.A. AND M.N. NELSON. 1982. Raptor use of nesting platforms: a case study. Unpublished Report, Pacific Power and Light Company, Portland, OR and Tundra Films, Boise, ID.

ROSENEAU, D.G., P.J. BENTE, AND J.D. WOOLINGTON. 1987. Prefabrication and installation of artificial nests and nesting structures, direct relocation of nesting pairs, and coning of natural nests. L.G.L. Alaska Research Associates, Inc., Anchorage, AK.

ROSENFIELD, R.N., J. BIELEFELDT, J.L. AFFELDT, AND D.J. BECKMANN. 1996. Urban nesting biology of Cooper's Hawks in Wisconsin. Pages 41–44 *in* D.M. Bird, D.E. Varland, and J.J. Negro [EDS.], Raptors in human landscapes. Academic Press Inc., San Diego, CA.

SAAB, V.A., C.D. BOCK, T.L. RICH, AND D.S. DOBKIN. 1995. Livestock grazing effects in western North america. Pages 311–353 *in* T.E. Martin and D.M. Finch [EDS.], Ecology and management of Neotropical migrating birds: synthesis and review of critical issues. Oxford University. Press, New York, NY.

SARRAZIN, F., C. BAGNOLINI, J.L. PINNA, AND E. DANCHIN. 1996. Breeding biology during establishment of a reintroduced Griffon Vulture *Gyps fulvus* population. *Ibis* 138:315-325.

SARRAZIN, F., C. BAGNOLINI, J.L. PINNA, E. DANCHIN, AND J. CLOBERT. 1994. High survival estimates of Griffon Vultures (*Gyps fulvus fulvus*) in a reintroduced population. *Auk* 111:853-862.

SCHMUTZ, J.K., R.W. FYFE, D.A. MOORE, AND A.R. SMITH. 1984. Artificial nests for Ferruginous and Swainson's Hawks. *Journal of Wildlife Management* 48:1009–1013.

SCHUECK, L.S., J.M. MARZLUFF, AND K. STEENHOF. 2001. Influence of military activities on raptor abundance and behavior. *Condor* 103:606-615.

SCHULZ, T.A. AND D. YASUDA. 1985. Ecology and management of the Common Barn Owl (*Tyto alba*) in the California Central Valley. Page 15 *in* Raptor Research Foundation symposium on the management of birds of prey. Sacramento, CA.

SCOTT, L. 1970. Great Horned Owls occupy artificial nesting site. *Blue Jay* 28:123.

SHIRE, G.G., K. BROWN, AND G. WINEGARD. 2000. Communication towers: a deadly hazard to birds. American Bird Conservancy, Washington, DC.

SHUTT, L.J. AND D.M. BIRD. 1985. Influence of nestling experience on nest-type selection in captive kestrels. *Animal Behaviour* 33:1028–1030.

SIMMONS, R.E. 1993. Effects of supplementary food on density-reduced breeding in an African eagle: adaptive restraint or ecological constraint?. *Ibis* 135:394–402.

SKEEN, J.E., G.A. SIEVERT, AND D.L. BASE. 1987. Grassland raptor nesting platforms in the Oklahoma Panhandle. Presented at the Oklahoma Ornithological Society, Murray State College, Tashoningo, OK..

SMITH, B.W. AND J.R. BELTHOFF. 2001. Effects of nest dimensions on use of artificial burrow systems by Burrowing Owls. *Journal of Wildlife Management* 65:318-326.

SMITH, E.D. 1985. Construction of artificial nesting sites for Prairie Falcons. *Wildlife Society Bulletin* 13:543–546.

SNYDER. L.L. 1946. "Tunnel fliers" and window fatalities. *Condor* 48:278.

SNYDER, N.F.R. AND H.A. SNYDER. 1989. Biology and conservation of the California Condor. *Current Ornithology* 6:175–267.

SOLMAN, V.E.F. 1973. Birds and aircraft. *Biological Conservation* 5:79–86.

SOUTHERN, H.N. 1970. The natural control of a population of Tawny Owls (*Strix aluco*). *Journal of Zoology, London* 162:197–285.

STAHLECKER, D.W. AND H.J. GRIESE. 1979. Raptor use of nest boxes and platforms on transmission towers. *Wildlife Society Bulletin* 7:59–62.

STALMASTER, M.V. 1980. Management strategies for wintering Bald Eagles in the Pacific Northwest. Pages 49–67 *in* R.L. Knight, G.T. Allen, M.V. Stalmaster, and C.W. Servheen [EDS.], Proceedings of the Washington Bald Eagle Symposium. Nature Conservancy, Seattle, WA.

STALMASTER, M.V. AND J.L. KAISER. 1998. Effects of recreational activity on wintering Bald Eagles. *Wildlife Monographs* 137:1–46.

STEENHOF, K. 1991. Use of nest boxes by American Kestrels in southwestern Idaho. Pages 201–204 *in*. K. Steenhof [ED.], Snake River Birds of Prey Area Annual Report. U.S.D.I, Bureau of Land Management, Boise, ID.

STEIDL, R.J. AND R.G. ANTHONy. 2000. Experimental effects of human activity on breeding Bald Eagles. *Ecological Applications* 10:258-268.

STONE, W.B., P.E. NYE, AND J.C. OKONIEWSKI. 2001. Bald Eagles killed by trains in New York State. *Journal of Raptor Research* 35:64-65.

SUTTON, G.M. AND J.D. TYLER. 1979. On the behavior of American Kestrels nesting in town. *Bulletin of the Oklahoma Ornithological Society* 12:25–29.

SWARTHOUT, E.C.H. AND R.J. STEIDL. 2001. Flush responses of Mexican Spotted Owls to recreationists. *Journal of Wildlife Management* 65:312-317.

SWENSON, J.E. 1979. Factors affecting status and reproduction of Ospreys in Yellowstone National Park. *Journal of Wildlife Management* 43:595–601.

SYKES, P.W. AND R. CHANDLER. 1974. Use of artificial nest structures by Everglade Kites. *Wilson Bulletin* 86:282–284.

TAYLOR, I. 1994. Barn owls: predator-prey relationships and conservation. Cambridge University Press, Cambridge, UK.

TAYLOR, I.R., A. DOWELL, AND G. SHAW. 1992. The population ecology and conservation of Barn Owls *Tyto alba* in coniferous plantations. Pages 16–21 *in* C.A. Galbraith, I.R. Taylor, and S. Percival [EDS.], The ecology and conservation of European owls. Nature Conservation No. 5, Joint Nature Conservation Committee, Peterborough. UK.

THOMAS, P.W. 1999. The effects of low-level flying military aircraft on the reproductive output of Osprey in Labrador and northeastern Québec. MS Thesis, McGill University, Montreal, Québec., Canada.

TOLAND, B.R. AND W.H. ELDER. 1987. Influence of nest-box placement and density on abundance and productivity of American Kestrels in central Missouri. *Wilson Bulletin* 99:712–717.

TWEDT, D.J. AND J.L. HENNE-KERR. 2001. Artificial cavities enhance breeding bird densities in managed cottonwood forests. *Wildlife Society Bulletin.* 29:680-687.

U.S. FISH AND WILDLIFE SERVICE. 1996. California Condor recovery plan, third revision. Portland, OR.

U.S. FISH AND WILDLIFE SERVICE. 1999. A spectacular summer for birds. *Endangered Species Bulletin* 24:24–25.

VALKAMA, J. AND E. KORPIMÄKI. 1999. Nestbox characteristics, habitat quality and reproductive success of Eurasian Kestrels. *Bird Study* 46:81-88.

VAN ROOYEN, C.S. 2000. Raptor mortality on powerlines in South Africa. Pages 739–750 *in* R.D. Chancellor and B.-U. Meyburg [EDS.], Raptors at risk. Hancock House Publishers, Blaine, WA.

VAN ROOYEN, C.S. AND J. A. LEDGER. 1999. Birds and utility structures: developments in southern Africa. Pages 205-229 *in* M. Ferrer and G.F.E. Janss [EDS.], Birds and power lines; collision, electrocution and breeding. Quercus, Madrid, Spain.

VOOUS, K.H. 1977. Three lines of thought for consideration and eventual action [to protect raptors], Pages 343–347 *in* R.D. Chancellor [ED.], World Conference on Birds of Prey, Report of proceedings. International Council for Bird Preservation, London,UK.

WARBURTON, T. 1983. Breeding and reintroduction of the Barn Owl *Tyto alba. International Zoo Yearbook* 23:88–95.

WEAVER, J D. AND T J. CADE. 1988. Falcon propagation. A manual on captive breeding. The Peregrine Fund, Inc., Boise, ID.

WHITE, C.M. AND T.L. THUROW. 1985. Reproduction of Ferruginous Hawks exposed to controlled disturbance. *Condor* 87:14–22.

WIDÉN, P. 1994. Habitat quality for raptors: a field experiment. *Journal of Avian Biology* 25:219–223.

WIEMEYER, S.N. 1987. Propagation of captive Eastern Screech Owls. *Journal of Raptor Research* 21:49–56.

WILBUR, S.R., W.D. CARRIER, AND J.C. BORNEMAN. 1974. Supplemental feeding program for California Condors. *Journal of Wildlife Management* 38:343–346.

WILLIAMS, R.S.R. 1993. Long-eared Owls in East Anglia 1993. *The Raptor* 21:63–66.

WILMERS, T.J. 1982. Kestrel use of nest boxes on reclaimed surface mines in West Virginia and Pennsylvania. M.S thesis, West Virginia University, Morgantown, WV.

WOOD, B. 1980. Winter ecology of Bald Eagles at Grand Coulee Dam, Washington. Pages 195–204 *in* R.L. Knight, G.T. Allen, M.V. Stalmaster, and C.W. Servheen [EDS.], Proceedings of the Washington Bald Eagle Symposium. Nature Conservancy, Seattle, WA.

WOOD, P.B. 1999. Bald eagle response to boating activity in northcentral Florida. *Journal of Raptor Research* 33:97-101.

ZALLES, J.I. AND K.L. BILDSTEIN. 2000. Raptor watch; a global directory of raptor migration sites. Bird Life Conservation Series No.9. BirdLife International, Cambridge, UK and Hawk Mountain Sanctuary, Kempton, PA.

ZIESEMER, F. 1980. Breeding density and breeding success of Barn Owls (*Tyto alba*) in a study area before and after the erection of nest boxes. *Die Vogelwelt* 101:61–66.

ZIMMER, M. 1994. Artificial Great Horned Owl nest. *South Dakota Birds Notes* 46:49.