J. Raptor Res. 27(1):53–96

Abstracts of Presentations Made at the Annual Meeting of the *Raptor Research Foundation, Inc.*, Held at Bellevue, Washington, on 11–15 November 1992

Spotted Owl Symposium

Organizers: Michael W. Collopy, *U.S. Bureau of Land Management, 3200 SW Jefferson Way, Corvallis, OR 97331,* and Bruce G. Marcot, *Pacific Northwest Forest & Range Experiment Station, USDA Forest Service, 333 SW First Ave., Portland, OR 97208*

Single-species Versus Ecosystem Management: Lessons for the Future

Anthony, R.G. *Oregon Cooperative Wildlife Research Unit, Oregon State University, Corvallis, OR 97331-3803*

The spotted owl/old-growth issue has often been portrayed by the news media as owls versus people or jobs versus conservation of older coniferous forests. Actually, the spotted owl serves as an indicator species for late-successional forests to many environmentalists and managers. However, we know from basic ecological principles that different species occupy different ecological niches, therefore a single species cannot possibly represent all the requirements of a host of other species. Such is true for the spotted owl. The Northern Spotted Owl Recovery Team was charged with considering other species and older-forest ecosystems in developing a recovery plan for the northern spotted owl. In fulfilling this charge, we emphasized species that were listed federally as threatened or endangered, candidates for federal listing, state sensitive or species of special concern, and those associated with older forests. A list of 350+ species of plants and animals that occur within the range of the northern spotted owl was assembled. This list is comprised of 24 species of birds, 18 mammals, 26 amphibians and reptiles, 28 fish, 58 mollusks, 59 arthropods, 144 vascular plants, and 8 fungi and lichens. Five species are listed federally as threatened or endangered, and 155 species are candidates for federal listing. At the state level, over 100 species are listed as threatened or endangered, or designated as sensitive or species of special concern. More than 100 species are narrowly or broadly endemic to the Pacific Northwest and 190+ are associated with older forests. This effort also substantiated the importance of riparian ecosystems as approximately one-third (130+) of the species are associated with riparian areas. In addition, the 28 species of fish include approximately 800 stocks that are considered at risk and may become candidates for listing. Eighteen priority species were identified, of which the marbled murrelet and the numerous fish stocks were considered the highest priority. Information on the distribution, biology, and habitat relationships of the priority species and the ecology of riparian ecosystem was used to influence the location of some of the conservation areas for the owl. However, the extent to which this exercise could be carried out was influenced by economics and the preponderance of non-biologists on the recovery team. Consequently, the recovery plan for the northern spotted owl cannot be portrayed as a conservation plan for late-successional forests in the Pacific Northwest.

Listing, Critical Habitat Designation, and Development of the Northern Spotted Owl Recovery Plan

Bart, J. and R. Holthausen. *Spotted Owl Recovery Team, U.S. Fish and Wildlife Service, 911 NW 11th Ave, Portland, OR 97232*

The northern spotted owl (*Strix occidentalis caurina*) was listed as a threatened species by the U.S. Fish and Wildlife Service in 1990. Following the listing, the Fish and Wildlife Service, acting under court order, designated critical habitat for the species. Concurrently, the Department of the Interior named a team to begin work on a Recovery Plan for northern spotted owls. This Recovery Plan was published as a draft in May 1992, and a final draft is expected in early 1993. The basic principles underlying the Plan are based on the 1990 report of the Interagency Scientific Committee. It recommends the establishment of 196 Designated Conservation Areas (DCAs) on federal lands, and contains guidelines for silviculture and salvage operations within those DCAs. It also contains a series of recommendations to provide dispersal habitat in the federal forest matrix between DCAs. It recognizes the contribution that can be made to recovery by private lands, and suggests ways for the contribution to be made more effective. Major issues that must be dealt with before publication of the final Plan include: 1) a consideration of demographic data which indicate an accelerating decline in the spotted owl population; 2) a review of models that might be used to evaluate the Recovery Plan and other options; and 3) a detailed description of the procedures that could be used to continually update the Plan based on new information. Success of the final Plan will depend on close coordination among federal and state agencies.

Prey Ecology and Northern Spotted Owl Diet

Carey, A.B. *Pacific Northwest Research Station, USDA Forest Service, 3625 93rd Avenue, SW, Olympia, WA 98502*

Mammals constitute 90% of the spotted owl's diet; dietaries vary locally and seasonally, but are consistent annually at larger geographic scales. *Glaucomys sabrinus* (GLSA) is the single most important prey, accounting for 16–46% of the prey items consumed. GLSA is the only species to

occur with a frequency of >15% in all parts of the owl's range. In western hemlock and Douglas-fir forests, GLSA constitutes 47–58% of the biomass consumed, 3–4 times other species. In fall and winter, GLSA comprises 60–72% of biomass consumed. *Peromyscus* spp. and juvenile lagomorphs are 12–18% and 7%, respectively, of summer diets. In mixed-conifer forests in the southern part of the owl's range, *Neotoma fuscipes* may be up to 70% of the biomass consumed, and GLSA as little as 14%. Other species (% items consumed) are important locally: *Phenacomys longicaudus* (0–25%), *Neotoma cinerea* (0–15%), *Lepus americanus* (0–10%), *Clethrionomys* spp. (0–21%), *Peromyscus* spp. (5–31%), and *Thomomys mazama* (0–10%). There appears to be a definite selection of prey based on (1) nocturnality—otherwise *Tamiasciurus* and *Tamias* would be common prey; (2) mass of 100–400 g—adult lagomorphs are generally not taken and shrews, voles, and mice are low in frequency in diets relative to their abundance in the forest; (3) arboreality—GLSA is arboreal, *Neotoma* spp. are semi-arboreal, and *Phenacomys longicaudus* (27 g) is strictly arboreal and more frequently taken when available than the semi-arboreal *Peromyscus* (20 g) and the terrestrial *Clethrionomys* (23 g); arboreality probably relates to detectability of the prey; and (4) social behavior—the colonial *N. fuscipes* is locally concentrated in large numbers whereas the male-harem *N. cinerea* is locally concentrated in small numbers; *P. longicaudus* is also colonial, whereas *Peromyscus, Clethrionomys,* and GLSA are not. These characteristics seem to outweigh abundance: GLSA densities (mean number per ha ± standard error) in old growth are 0.21 ± 0.09 in the North Cascades of Washington, 0.5 ± 0.2 on the Olympic Peninsula, 2.3 ± 0.3 in the Western Cascades in Oregon, and 1 9 ± 0.1 in the Oregon Coast Ranges and Klamath Mountains, yet GLSA constitutes a greater percentage of the diet in Washington than in southwestern Oregon. But GLSA is probably the most consistently available nocturnal species weighing 100–300 g in old-growth western hemlock and Douglas-fir forests. GLSA reaches its highest densities in old growth (3.7/ha) and is more than twice as abundant in old forest than other types in Washington and southwestern Oregon. The amount of old forest encompassed by spotted owls in their home ranges reflects the biomass of the medium-sized prey (GLSA and *Neotoma* spp.) in old growth. Spotted owls can depress GLSA population densities by almost 50% in areas intensively used for foraging.

A PRIVATE LANDOWNER'S HABITAT CONSERVATION PLAN: THE SIMPSON TIMBER COMPANY HCP

DILLER, L.V. *Simpson Timber Company, Box 1169, Arcata, CA 95521*

In July 1990, the listing of the northern spotted owl (*Strix occidentalis caurina*) as threatened under the federal Endangered Species Act prohibited "taking" of the species. In response to this listing, the California Board of Forestry adopted regulations to avoid a take of the owls. Among other things, these regulations required retention of 500 acres of spotted owl habitat within a 985-acre (0.7-mile) circle centered on a known pair. High densities of owls (gross density approximately 1 pair/1000 acres) in and adjacent to merchantable timber stands in northern California of Simpson Timber Company created a situation in which continuing timber harvest and avoiding a take were not possible. This prompted Simpson to seek a permit from the U.S. Fish and Wildlife Service to allow take of spotted owls incidental to its timber harvest operations. As part of the permit application, the company drafted a Habitat Conservation Plan (HCP) for the owl. Intensive surveys and analysis of nesting sites and stands indicated that spotted owls on and adjacent to Simpson property were recolonizing and successfully reproducing in stands as early as 35–45 years following harvest. The results of these studies were used to project future owl habitat and develop the major premise of the HCP: that even when timber harvest was accounted for, potential owl habitat would more than double over a 30-year planning period. In addition, the plan included several other conservation strategies including setting aside 39 areas totalling 13 000 acres where timber harvest would not occur, establishing a 35 000 acre "Special Management Area" that would maintain at least 20 pairs of owls and where "no take" of owls would occur, continuing the spotted owl research program, and managing stands to accelerate the development of future owl habitat.

DEMOGRAPHIC STUDIES OF NORTHERN SPOTTED OWLS

FORSMAN, E.D. *USDA Forest Service, Forestry Sciences Laboratory, 3200 SW Jefferson Way, Corvallis, OR 97331*

Between 1985 and 1987, 5 different demographic studies were initiated to determine population parameters of northern spotted owls. These studies include the Willow Creek Study in northwestern California, Medford BLM Study in southwestern Oregon, Rosenburg BLM and H. J. Andrews Studies in western Oregon, and the Olympic Peninsula Study in western Washington. All 5 studies used mark-recapture techniques to assess age and sex-specific survival rates. Fecundity was assessed by counting the number of young that left the nest. Population growth rates (lambda) were calculated based on birth and death rates of females. Estimates of lambda indicated that populations in all 5 study areas were declining. Furthermore, a meta-analysis in which estimates from all 5 areas were examined together, indicated a decreasing trend in annual adult female survival. This suggested that the rate of population decline was accelerating. Although the results of these analyses are alarming, I believe that they should be viewed with caution. A number of potential biases exist that could make things look worse than they really are. Probably the biggest concern is that survival rates may be

underestimated if significant undetected emigration occurs. Emigration is probably most problematic with respect to juvenile survival estimates because juveniles disperse considerable distances from their natal sites. It is also likely that some emigration of adults and subadults occurs as well. To better understand population trends of spotted owls, we need more years of data and we need to develop methods to test the magnitude of possible biases in mark-recapture estimates. One way to determine the extent of undetected emigration is to compare survival estimates from radio-marked and color-banded samples. This will be very expensive and time-consuming as it will involve radio-marking large samples of owls.

DENSITY OF NORTHERN SPOTTED OWLS

FRANKLIN, A.B. *Humboldt State University, Arcata, CA 95521, and Department of Fishery and Wildlife Biology, Colorado State University, Fort Collins, CO 80523.* J.P. WARD. *Department of Biology, Colorado State University, Fort Collins, CO 80523*

Density is a useful measure for estimating population size, monitoring spatial and temporal population trends, and examining mechanisms of population regulation. We examined density estimates for northern spotted owls from 10 study areas on public lands distributed throughout northern California, Oregon and Washington. Density was estimated based on banded individuals on these study areas which ranged from 300 to 1000 km^2 in size. Densities on individual study areas were measured over periods ranging from 2 to 8 years. Crude density (number of owls/km^2 of total area) ranged from 0.067 to 0.250 owls/km^2. We tested hypotheses concerning temporal and spatial trends in density estimates. Trends in density appeared stable while there appeared to be geographic differences. We also evaluated density estimates from public lands with those from private lands managed for timber production. We discuss the problems inherent in accurately estimating density and the utility of density in monitoring programs. We also discuss considerations for estimating density such as sampling design, study area size, and survey effort.

MANAGEMENT ACTIVITIES ON PRIVATE TIMBERLANDS AND INDUSTRY-SUPPORTED RESEARCH ON NORTHERN SPOTTED OWLS

IRWIN, L.L. *National Council of the Paper Industry for Air and Stream Improvement, P.O. Box 458, Corvallis, OR 97339*

Private timberlands owners in the Pacific Northwest and northern California have developed various approaches to managing their lands relative to legal obligations and voluntary contributions for protecting the northern spotted owl as a federally listed threatened species. Such activities depend upon the size and continuity of the private forests as well as the owner's objectives. Many private owners contract for annual surveys to locate owls, and some companies evaluate nest-site conditions and monitor reproduction success on their lands. Such activities may be used to schedule timber harvests to avoid locations with owls, or they may support development of habitat conservation plans, or HCPs. For example, one company in northern California (Simpson) recently had an HCP approved by the Fish and Wildlife Service for operations on their lands Another company maintains a computerized database of the status of all owls on their lands or on adjacent lands that may affect their operations. The same company is developing a GIS-based process for predicting other owl locations based upon conditions of known sites in managed forests. In many other cases, private companies survey their lands to determine if planned timber operations do not contain spotted owls. Several private companies support research on their lands to learn more about owl habitat requirements, and some have implemented case-history experiments with innovative forestry practices or special techniques (e.g., nest boxes) that may accommodate owls. In addition, a consortium of companies that purchase federal timber support cooperative research on owl populations and habitat relationships. The goal of much of the industry-supported research is to develop new technology that may support forest management alternatives that account for habitat needs of the owl while minimizing costs to wood production. Examples of topics that are being investigated in cooperation with federal agencies will be presented.

PREDATORS, COMPETITORS, AND MOBSTERS: INTERSPECIFIC INTERACTIONS INVOLVING NORTHERN SPOTTED OWLS

JOHNSON, D.H. *Oregon Department of Fish and Wildlife, 7118 NE Vandenberg Avenue, Corvallis, OR 97330-9446*

Interactions between spotted owls and other wildlife species can be placed into four main groups: prey, predators, competitors, and species which are involved in mobbing behaviors ("mobsters"). This presentation offers a review of the latter three groups and offers results of my recently completed study on spotted owls, great horned owls, and forest landscape patterns in the Central Oregon Cascades. Predators on spotted owls include the great horned owl, goshawk, red-tailed hawk, and common raven. Although Cooper's hawks have been observed in unsuccessful predation attempts, it seems possible that juvenile owls may be taken. Spotted owl mortality caused by avian predation is significant: a query of researchers has indicated that 40% of 91 adult/subadult and 25% of 60 juvenile radio-marked spotted owl deaths were attributable to avian predation; an additional 25% of adult/subadult and 37% of juvenile owls died of undetermined causes; it seems likely that avian predation was involved in at least some of these deaths, as well. The primary competitor of spotted owls is the barred owl. The barred owl outcompetes spotted

owls in several different ways. For example, barred owls are slightly heavier in body mass than spotted owls, take a wider variety of prey, have smaller home ranges which they defend more rigorously, and are more diurnal in their activity patterns. Barred owls seldom "lose" in territorial interactions with spotted owls. Barred owls have continued to expand their range in the Pacific Northwest and now can be found in several hundred locations in Washington, some 260 locations in Oregon, and 17 locations in California. A wide range of species have been observed to mob spotted owls. Mobbing species may frequently make physical contact with spotted owls, ruffling the owl's feathers or, in some instances, knocking spotted owls from their perches. The following species have been observed to mob spotted owls: hermit thrush, Swainson's thrush, varied thrush, Cooper's hawk, black-capped and mountain chickadees, red-breasted nuthatch, rufous hummingbird, dark-eyed juncos, hermit warbler, golden-crowned kinglet, Steller's jay, gray jay, northern pygmy owl, and sharp-shinned hawk. The latter four species have more commonly been observed making physical contact with spotted owls. Great horned owls have been identified as the primary predator on spotted owls. As old-growth forests become fragmented through logging or natural processes, it is hypothesized that great horned owls become established and increase in numbers as this new niche is created. I conducted a nocturnal survey in 1989 and 1990 to locate great horned owls and spotted owls throughout the range of forest fragmentation levels in the Central Cascades of Oregon. Forest fragmentation levels ranged from landscapes (>500 ha in size) containing intact stands of mature/old-growth forest (0% fragmentation) to landscapes containing younger stands with no mature/old-growth forest (100% fragmentation). Six survey visits were made to each of 469 calling stations located along 28 roadside survey routes. Relative abundance for great horned owls and spotted owls was 0.069 and 0.139 owls/road km, respectively. Thirteen habitat/landscape variables within 500-ha circular landscape plots surrounding great horned owl, spotted owl, and random points were assessed. Significant differences existed between great horned owl and spotted owl landscapes for six variables: great horned owl landscapes contained more shrub/forb and shelterwood, less mature/old-growth and mature/old-growth interior habitat, had a higher linear edge-to-mature/old-growth area ratio, and were higher in elevation than spotted owl landscapes. The greatest number of great horned owl responses were associated with landscapes containing 10–20% old forest. Great horned owl responses generally declined with increasing amounts of old forest, and few (11%) great horned owls were detected in landscapes containing ≥70% old forest. The majority (62%) of spotted owls were detected within landscapes containing ≥60% old forest. Spotted owl responses generally declined with declining amounts of old forest and few (7%) spotted owls were detected within landscapes containing ≤20% old forest.

INVENTORY AND MONITORING PROGRAMS FOR NORTHERN SPOTTED OWLS

LINT, J.B. *Bureau of Land Management, 777 Garden Valley Blvd., Roseburg, OR 97470*

The annual inventory and monitoring of northern spotted owls has become a tradition for many wildlife biologists working for federal and state agencies, universities, private consultants and private timber companies in the Pacific Northwest. Current survey programs are founded on the efforts of biologists that began the search for owls over two decades ago. Pioneer work by Eric Forsman in Oregon and Gordon Gould in California was instrumental in developing and refining standard survey techniques essential to conducting an inventory. In the 1970s, the Forest Service and Bureau of Land Management took the inventory lead by surveying for spotted owl occurrence on lands they administered. This provided the first operational extension of the work of Forsman and Gould. Through the 1970s and early 1980s, agency surveys focused on locating territorial owls to provide basic information for planning timber sales and making land use planning decisions. Survey work for the 1980s decade turned to monitoring owl response to land use decisions and incremental inventory of lands not previously surveyed. During this time period, the use of offered prey called 'mousing' and the implementation of banding added new dimensions to the inventory and monitoring programs. The listing of the spotted owl as a federal threatened species in 1990 accentuated the importance of ongoing work and set in motion intensive efforts by government and private interests to inventory proposed timber sale areas to ensure compliance with the Endangered Species Act. Through inventory and monitoring, knowledge has been gained on the distribution of owls, the relationship of occurrence to forest condition, dispersal movements and reproductive success. The programs, although productive, were not without shortcomings. Some local programs were keyed to finding owls, but lacked clear objectives and plans for data analysis. On a regional scale, poor coordination between agencies, lack of a central data storage and retrieval system and inconsistent formats for data recording were detractions. Fortunately these problems have been identified. The future affords the opportunity to learn from past experience and to establish a single, cooperative spotted owl inventory and monitoring program with common goals and objectives.

HISTORY OF CONSERVATION PLANNING FOR THE NORTHERN SPOTTED OWL

MESLOW, E.C. *Oregon Cooperative Wildlife Research Unit, Oregon State University, Corvallis, OR 97331-3803*. C.R. BRUCE. *Oregon Department of Fish and Wildlife, 170 NE Vandenberg Ave., Corvallis, OR 97330-9446*. B. MARCOT. *Pacific Northwest Forest and Range Experiment Station, USDA Forest Service, 333 SW First Ave., Portland, OR 97208*

Conservation planning for the Northern Spotted Owl began in 1973 when the bird was given top priority by the newly formed Oregon Endangered Species Task Force. In 1977 the Task Force recommended maintaining 400 pairs on public lands in the state with 300 acres of old forest reserved per pair. Washington (1978) and California (1981) joined in conservation planning efforts. While the acreage reserved per owl pair increased with time, the operative paradigm remained focused on 1–3 pair management units until 1988. In 1989, the Interagency Spotted Owl Scientific Committee was jointly established by the directors of the four federal wildlife/land managing agencies and charged with developing a scientifically credible Northern Spotted Owl management plan. The committee's product provided for a series of 20 pair conservation areas spaced to facilitate dispersal, with intervening "forest matrix" lands managed to provide habitat sufficient to support dispersal. The draft Northern Spotted Owl Recovery Plan utilizes the same basic construct.

DISPERSAL AND SURVIVAL OF JUVENILE NORTHERN SPOTTED OWLS

MILLER, G. *U.S. Fish and Wildlife Service, 2600 SE 98th Ave., Suite 100, Portland, OR 97266*. E.D. FORSMAN. *USDA Forest Service, Pacific Northwest Forest and Range Experiment Station, 3200 SW Jefferson Way, Corvallis, OR 97331*. D.H. JOHNSON. *Oregon Department of Fish and Wildlife, 170 NE Vandenberg Avenue, Corvallis, OR 97330-9446*

With the federal listing of the spotted owl as a threatened species, highlighted by the Interagency Scientific Committee's Conservation Strategy for the Northern Spotted Owl and the Spotted Owl Recovery Planning process, the importance of juvenile dispersal information has become much more apparent. Prior to 1982, information on the dispersal ecology of juvenile northern spotted owls was limited. Since that time, three general "sources" of study can be identified that have addressed the dispersal topic. (1) In 1982, radiotelemetry studies, using backpack transmitters, were initiated in Washington, Oregon, and California to gather information on juvenile dispersal. Between 1982 and 1985, 6 juveniles in Washington, 32 in Oregon and 23 in California were followed during dispersal. A summary of first-year survival, distance dispersed, and habitat use is provided. (2) Between 1985 and 1987, intensive banding studies were initiated in Washington, Oregon, and California, providing the opportunity to band several hundred juvenile spotted owls. A summary of dispersal distances and survival estimates obtained from the band return (resighting) data is also provided. (3) In 1991, a new radiotelemetry study, using tail-mounted transmitters, was initiated in Oregon and Washington to provide additional information on juvenile survival estimates. Preliminary results from that study for 1991 and 1992 are reported. A comparison of the three sources of information is discussed. An overview of how all of the information on juvenile dispersal and survival has been incorporated into the Interagency Scientific Committee's Conservation Strategy for the Northern Spotted Owl and the Northern Spotted Owl Recovery Planning process is also discussed.

NORTHERN SPOTTED OWL LITIGATION REVIEW

ROWLAND, M.J. *Institute for Environmental Studies, FM-12, University of Washington, Seattle, WA 98195*

Principal court cases affecting the northern spotted owl will be reviewed. These cases include: *Northern Spotted Owl vs. Hodel*: A suit against the US Fish and Wildlife Service for failure to list the spotted owl under the Endangered Species Act (ESA) and failure to designate critical habitat for the owl. The agency was ordered to reconsider its failure to list the owl, and the owl ultimately was listed. The court also ordered the agency to designate critical habitat. *Seattle Audubon Society vs. Robertson*: A suit challenging the US Forest Service's spotted owl management plan for failure to comply with the National Forest Management Act (NFMA) and the National Environmental Policy Act (NEPA). The court ruled that the Forest Service's plan did not meet the requirements of either law, ordered the agency to prepare another plan, and enjoined further timber sales in spotted owl habitat until a legally adequate plan is in place. *Bureau of Land Management vs. US Fish and Wildlife Service*: A petition by the Bureau of Land Management (BLM) for an exemption for 44 timber sales in Oregon from the requirements of the ESA. The Endangered Species Committee granted an exemption for 13 of the sales, the first exemption ever granted under the ESA after a full hearing. *Portland Audubon Society vs. Bureau of Land Management*· A suit against the BLM for failure to follow NEPA requirements in managing the spotted owl. The court found that the BLM had violated NEPA and enjoined timber sales in spotted owl habitat pending the agency's compliance with NEPA.

HABITAT USE AND SELECTION BY NORTHERN SPOTTED OWLS

WAGNER, F.F. AND J.A. THRAILKILL. *Oregon Cooperative Wildlife Research Unit, Oregon State University, Corvallis, OR 97331*

The habitat requirements of the Northern Spotted Owl form the crux of the controversy surrounding its conservation. This paper briefly summarizes habitat use and selection studies from the literature and describes one example in some detail. Habitat use and selection for foraging and roosting have been primarily determined from locations of radio-marked owls. These studies compare proportionate use to proportionate availability at the stand condition (broad seral stage) level. The number of studies

that have occurred throughout much of the range of the Northern Spotted Owl often use differing classifications of habitat types. A strong recurring pattern is evident, however. When old growth is classified as a separate habitat type, it is consistently used more than expected. Early seres receive little use and are consistently used less than expected. Mid-seral and mature forest receive ambiguous use: there are relatively few instances of use in excess of availability, but proportionate use appears to increase with successional development/age. A number of observations of Northern Spotted Owls associated with young or managed forest stands have been noted. An example is given for habitat use and selection within a landscape dominated by structurally complex intermediate aged forest and partial-cut older forest. The use of broad seral stages did not differ from the general pattern found in other studies. Compared to unentered old growth, proportionate use was markedly reduced in relatively light partial cuts (salvage) 25 years after entry. Stands in which partial cutting removed 30–40% or more of basal area received little use 10–20 years after entry were consistently used less than expected. We also discuss the need to link habitat use to population response in order to infer habitat quality or suitability.

ASSOCIATIONS BETWEEN PREY ABUNDANCE, FOREST STRUCTURE, AND HABITAT USE PATTERNS OF SPOTTED OWLS IN CALIFORNIA

ZABEL, C.J. H.F. SAKAI AND J.R. WATERS. *Pacific Southwest Forest and Range Experiment Station, USDA Forest Service, 1700 Bayview Drive, Arcata, CA 95521*

At least 6 hypotheses have been proposed to explain the association between spotted owls (*Strix occidentalis*) and old-growth forests. Here we will address the hypothesis that selection of older forests by spotted owls is related to higher prey abundance in these habitats. Woodrats (*Neotoma* spp.) are the dominant prey of northern spotted owls (*S. o. caurina*) in the Klamath Province of northwestern California. The abundance of dusky-footed woodrats (*N. fuscipes*) was estimated to determine which habitats supported the highest densities. Woodrats averaged over 80 animals/ha in sapling/brushy pole timber stands and <1 woodrat/ha in all other seral stages. Sapling/brushy pole timber stands were seldom used by foraging spotted owls despite the high densities of woodrats that occurred there. However, these stands may be source areas for woodrats that subsequently disperse or move through older stands where spotted owls forage. Several radio-tagged woodrats moved short distances (<52 m) from their nest sites in sapling/pole timber stands into adjacent old-growth stands at night, then subsequently returned to their nests. In a previous study, woodrats were reported to be significantly more abundant at edges of older stands and sapling/brushy stands than in old conifer stands with a hardwood understory or old conifer stands with poor understory development. We examined use of habitat edges by owls by comparing the distribution of distances from edges between owl foraging locations and random locations. Where owls preyed predominantly on woodrats, they foraged significantly closer to edges than expected by chance. Where owls preyed predominantly on flying squirrels, use of edges was not different from random locations. Northern flying squirrels (*Glaucomys sabrinus*) are the primary prey of California spotted owls (*S. o. occidentalis*) on the Lassen National Forest (NF) in northeastern California. Spotted owls on the Lassen NF foraged infrequently in stands that had been shelterwood-logged and undergone intensive site preparation, and they used stands with large-diameter trees and dense canopy cover more than their availability. We tested the hypothesis that flying squirrel density was less in shelterwood-logged and second-growth fir (*Abies* spp.) stands than in nearby old-growth fir stands. Mean flying squirrel density was significantly less in shelterwood-logged than in old-growth and second-growth stands Although squirrel density did not differ significantly between old-growth and second-growth stands, mean density was 40% greater in old-growth than in second-growth stands. Spores of hypogeous fungi sporocarps (truffles) and arboreal lichens were the most frequently observed food types in flying squirrel stomach and fecal samples. We sampled truffles on each grid that was trapped for flying squirrels. Truffle availability (proportion of sample plots on which truffles were found) was significantly correlated with flying squirrel density. Fungus composition varied among the 3 stand types, and more genera were found in old- and second-growth stands than in shelterwood-logged stands. Arboreal lichens were more abundant in old-growth than in second-growth stands. Other habitat variables such as potential nest-site availability and understory cover were less closely associated with flying squirrel density. These data indicate that flying squirrel density was associated with forest structure, and that variation in availability of truffles and lichens explained much of this association The hypothesis that spotted owls select older forests for foraging because prey abundance is higher in these habitats is not supported by data from woodrats, at least for California forests. Woodrats were most abundant in sapling/pole timber stands. These results suggest that where spotted owls in California forests prey on woodrats, they infrequently use younger stands for reasons other than low prey abundance. As suggested elsewhere, high tree densities and homogeneous canopies in second-growth forests may reduce flight maneuverability and the ability of owls to capture prey. However, where woodrats are the dominant prey of spotted owls, silvicultural procedures that maintain or enhance woodrat populations adjacent to suitable spotted owl habitat may benefit spotted owls. This hypothesis needs to be tested. Flying squirrel density patterns were consistent with spotted owl habitat use patterns, at least between shelterwood-logged and old-growth fir stands. Results were less clear for even-aged second-growth

stands. Because such stands are rare on the landscape, we were unable to adequately examine how frequently they are used by spotted owls. Flying squirrel density was greater in old-growth than in second-growth stands, but density varied greatly among stands. This problem needs further research.

BURROWING OWL SYMPOSIUM

ORGANIZER: JEFFREY L. LINCER, *Biosystems Analysis, Inc., 13220 Evening Creek Drive South, Suite 119, San Diego, CA 92128*

ECOLOGY OF THE BURROWING OWL IN PAMPEAN AGROSYSTEMS OF ARGENTINA

BELLOCQ, I. *Faculty of Forestry, University of Toronto, 33 Willcocks St., Toronto, Ontario, Canada M5S 3B3*

A general approach to the ecology of Burrowing Owls in Pampean agrosystems of Argentina was made: 1) to record basic information on habitat use, food habits, hunting habitat, differential predation on rodents, feeding strategy, mortality factors, and breeding biology; 2) to examine the reproductive success and needs of conservation; and 3) to examine regulatory effects on rodent populations. The Burrowing Owl is the most abundant owl in Pampean agrosystems. It is a generalist predator and its diet strongly depends on the availability of alternative prey. Borders of cultivated fields are the most common hunting habitats, where they showed differential predation on rodent species. The Burrowing Owl showed a sigmoidal functional response to the abundance of rodent populations; and this might contribute to the biological control of rodents in Pampean agrosystems. Nests are built in areas with relatively low disturbance. Mean clutch size was 4.8 ± 1.2 eggs, mean hatching per nest was 3.5 ± 2.4, and reproductive success was as low as 0.3 fledges per brood. Brood size affected growth of chicks. Main mortality factors of eggs were agricultural practices and predation, while illnesses and human predation were the main mortality factors of chicks. The low reproductive success may negatively influence the near future of Burrowing Owl populations in Pampean agrosystems. More studies should be done to provide more information (especially on mortality factors and population dynamics) before considering possible strategies for management and conservation.

THE BURROWING OWL IN THE AMERICAS: ITS TAXONOMY AND HISTORICAL DISTRIBUTION

CLARK, R.J. *Department of Biology, York College of Pennsylvania, York, PA 17405-7199*

The Burrowing Owl was originally placed in the Genus *Strix* (1782) and then placed in the Genus *Athene* (1822) followed by being separated into a monotypic Genus *Speotyto* in 1842. It was later again included within *Athene* (1967–88) and again suggested as being properly placed in the monotypic Genus *Speotyto* in 1990. Evidences for these recommendations are reviewed. There are 18 commonly recognized geographic races of *Athene cunicularia* with two races having become extinct in historical times The geographic distribution of these races is also reviewed The above discussions are based on the literature, and an extensive bibliography is presented.

RESULTS OF THE 1991 CENSUS OF BURROWING OWLS IN CENTRAL CALIFORNIA: AN ALARMINGLY SMALL AND DECLINING POPULATION

DESANTE, D.F., E. RUHLEN, S. AMIN AND K.M. BURTON. *The Institute for Bird Populations, P.O. Box 1346, Point Reyes Station, CA 94956-1346*

The Institute for Bird Populations, with the help of volunteers from 13 local Audubon Society chapters and ornithological organizations, conducted a census of Burrowing Owls in the San Francisco Bay Area and the central part of California's Central Valley during the period May 15–June 30, 1991. A random stratified sample of 198 of the 1792 5-km by 5-km UTM blocks in this 43 425-km^2 census area, along with 82 additional blocks that were not randomly chosen but were thought to contain breeding owls sometime during the preceding decade, were censused. A total of 328 pairs of owls was found at a total of 264 breeding locations in 73 blocks. These data suggest that the total breeding population of Burrowing Owls in the census area may be as low as 925 pairs, and that up to 69.4% of the 504 previously suspected breeding pairs and 65.6% of the 355 previously suspected breeding locations may have disappeared during the past decade. The data also suggest that the disappearance rate was greater in the Bay Area than in the Central Valley, and that the disappearance rate in both regions, but especially in the Central Valley, is accelerating. Loss of breeding habitat appears to be one major cause for this pronounced population decline. The fact that the number of breeding pairs per breeding location also appears to be declining, particularly in the Central Valley, suggests that other factors may also be contributing to the decline. We suggest that unless concerted efforts to reverse this population decline are initiated quickly, Burrowing Owls may be extirpated from central California within about 50 years. Possible errors in these results, and methods for determining the extent of these errors in the 1992 and 1993 censuses, are discussed.

SITE FIDELITY IN BURROWING OWLS

FEENEY, L.R. *1330 Eighth Street, Alameda, CA 94501*

An effort to dislocate a pair of Burrowing Owls in San Joaquin County, California from a development site during the early winter of 1991–92 and subsequent monitor-

ing revealed strong site fidelity of the birds. Site loyalty in Burrowing Owls has been exhibited in other San Francisco Bay Area relocation projects as well. Examples of Burrowing Owl site fidelity during dislocation or relocation efforts are presented and discussed raising questions regarding these efforts as an effective method of removing Burrowing Owls from proposed development or other sites. A comparison is made between the Burrowing Owl and other bird species, whose tenacity to nesting and wintering sites has been studied with results available in the literature, in order to relate possible implications of site fidelity in Burrowing Owls. With a growing concern for decreasing populations of Burrowing Owls, relocation has become one method of mitigating habitat losses. Site fidelity is an important consideration for developing successful mitigation proposals.

ECOLOGICAL CONSIDERATIONS FOR MANAGEMENT OF BREEDING BURROWING OWLS IN THE COLUMBIA BASIN

GREEN, G.A. *EBASCO Environmental, 10900 NE 8th Street, Bellevue, WA 98004*. R.G. ANTHONY. *Oregon Cooperative Wildlife Research Unit, Oregon State University, Corvallis, OR 97331*

Burrowing Owls inhabiting the Columbia Basin of Oregon and Washington rely largely on badgers to excavate nest burrows; however, badgers are also a major predator of Burrowing Owl nests. To avoid badger predation through early detection, Burrowing Owls in the Columbia Basin select burrows with good horizontal visibility provided by surrounding short vegetation or, when the average vegetation height is >5 cm by elevated perches. Burrowing Owls will also line their nest burrows with livestock dung, if available, presumably to mask odors of nest occupants from mammalian predators. Burrowing Owls also select sites characterized by a high percentage (40–50%) of bare ground, where prey (*Heteromyid* rodents and ground-dwelling arthropods) populations are presumably high. Abandonment of nest sites tends to occur when distances between nest sites are less than 110 m, an important consideration when placing artificial nest boxes. Furthermore, small nest boxes can become overcrowded by growing broods, often forcing movements of all or part of the brood to auxiliary burrows, increasing the susceptibility of nestlings to predation or abandonment. Therefore, several aspects of Burrowing Owl nesting ecology, including predator avoidance, intraspecific competition, prey selection, and brood development, should be understood before designing a program for managing nesting habitat.

RECOVERY PLAN FOR THE BURROWING OWL IN CANADA

HJERTAAS, D.G. *Saskatchewan Natural Resources, 3211 Albert Street, Regina, SK, Canada, S4S 5W6*

The population of Burrowing Owls nesting in Canada has been in decline since the mid-1900s. The Burrowing Owl, extirpated from British Columbia, now being reintroduced, is listed as endangered in Manitoba and has experienced major declines in Alberta and Saskatchewan. Habitat loss is considered a significant cause of decline although elevated mortality from pesticides, vehicle collisions and unknown causes is also a major problem. The National Population goal is set at 2700 breeding pairs. Principal management actions recommended in the plan and some results of these efforts will be discussed in three priority groups. Priority 1: 1) Management to reduce mortality and increase productivity on breeding grounds. 2) Protection and management of nesting habitat. Priority 2: 3) Population monitoring. 4) Population management on migration and wintering grounds. Priority 3: 5) Eliminate negative effects of pesticides. Priority 4: 6) Release programs.

BURROWING OWLS, BIODIVERSITY, AND BOMBS

JAMES, P.C. *Saskatchewan Museum of Natural History, Wascana Park, Regina, SK, Canada S4P 3V7*

The Burrowing Owl is a species of the grasslands and, as such, is coming under increasing pressure from agricultural activity. While not yet an endangered species, it is symptomatic of the increasing global assault against biodiversity by people. The threats to biodiversity are numerous, but all result from the continuing non-sustainable use of the planet's resources. Only 7% of the world's military budget is needed to reverse this. As students of biodiversity, biologists must also become champions of biodiversity.

OPERATION BURROWING OWL IN SASKATCHEWAN: THE FIRST FIVE YEARS

JAMES, P.C. *Saskatchewan Museum of Natural History, Wascana Park, Regina, SK, Canada S4P 3V7*

Habitat loss is a serious problem for prairie wildlife in Canada. Operation Burrowing Owl was initiated in 1987 as a private stewardship program to protect owl habitat through landowner recognition, to increase awareness of the owl as a threatened species, to conduct an annual census of the Saskatchewan population, and to place nest boxes in areas to facilitate research and breeding. Landowners with owls sign a voluntary agreement to preserve the nesting site for five years. In return, they receive a gate sign, an annual newsletter, and a survey form on which to report the number of owls. As of 1991, the program had a membership of 499, with 647 pairs of owls protected on over 40 000 acres of habitat. However, despite this protection, the population has declined rapidly with 46% of the members no longer having owls on their property. While Operation Burrowing Owl may not have halted this decline, it has considerably raised the awareness of this and other endangered species among farmers.

PARAMETERS OF A DECLINING BURROWING OWL POPULATION IN SASKATCHEWAN

JAMES, P.C. *Saskatchewan Museum of Natural History, Wascana Park, Regina, SK, Canada S4P 3V7*

A declining population of Burrowing Owls was studied on the heavily cultivated Regina Plain of Saskatchewan from 1986 to 1992 by trapping adults and chicks. Information is presented on age, breeding, mortality, breeding dispersal, natal dispersal, and mate fidelity in the population. In no year did chick production offset annual adult mortality, hence, the observed decline. Chick production seemed to be consistent with historical records suggesting that mortality in the population is currently too high.

DEMOGRAPHY AND POPULATION DYNAMICS OF THE BURROWING OWL

JOHNSON, B.S. *2321 Evenstar Lane, Davis, CA 95616*

I used deterministic, age-structured analytic models to 1) examine the demographic causes of projected and observed declines in the size of a color-marked, Burrowing Owl population, and 2) predict persistence time for the population. Estimates of Burrowing Owl demographic parameters were calculated from direct observations and from genetic analyses of reproductive success, and represented a range of possible values. Comparison of theoretical expectations (based on actual demographic traits) with the real dynamics of the population over ten years showed that the population declined to reproductive extinction in half the time predicted by the models. This discrepancy suggests that stochastic variation in demographic traits, possibly caused by weather, along with stochastic and deterministic changes in genetic structure, also contribute to the dynamics and persistence of Burrowing Owl populations.

REPRODUCTIVE SUCCESS, RELATEDNESS, AND MATING PATTERNS IN A COLONIAL BIRD, THE BURROWING OWL

JOHNSON, B.S. *2321 Evenstar Lane, Davis, CA 95616*

I used DNA fingerprinting to characterize patterns of mating, genealogies, and reproductive success in a wild population of color-marked, Burrowing Owls in Davis, California. This study was designed to evaluate whether behavioral assessments of individual reproductive performance and mating system agreed with estimates obtained by genetic analysis, and to measure the degree of genetic relatedness in a highly social resident aggregation of Burrowing Owls. The data revealed important discrepancies between patterns suggested by inference and those documented by direct genetic measurement. DNA fingerprints showed that in 20% of cases, genetically determined parent-offspring relationships and those suggested by direct behavioral observations disagreed. These differences were due to nestling movements and brood mixing, extra-pair fertilizations (which resulted in at least 5–10% of offspring), polygamy, and possibly intraspecific brood parasitism. These previously undocumented aspects of Burrowing Owl mating biology collectively resulted in alloparenting by 37% of the adult owls. Most of these behaviors can be expected to enhance within-population genetic heterogeneity and contribute to variation in individual reproductive success. However, analysis of multilocus fingerprint similarity suggested that the Davis Burrowing Owl population is inbred due to small deme size rather than nonrandom mating. Because inbreeding enhances selection between groups at the expense of opposing selection within groups, it can be expected to counter the effects of brood mixing and unequal reproductive contributions, and facilitate the evolution of Burrowing Owl social behavior.

SURVEY TECHNIQUE FOR BURROWING OWLS IN BADLANDS NATIONAL PARK, SOUTH DAKOTA

MARTELL, M., J. NIBE AND P.T. REDIG. *The Raptor Center at the University of Minnesota, 1920 Fitch Ave., St Paul, MN 55108*

Accurate counts of raptor populations are necessary for successful management, research and conservation programs. A method to efficiently and accurately make repeatable counts of breeding Burrowing Owls (*Athene cunicularia*) has not been available to wildlife managers. We attempted to develop such a census technique for Burrowing Owls in Badlands National Park. During June and July (incubation and hatching season in this area) of 1991 transects were established on five separate prairie dog towns within the park. Points, 300 m apart along the transect, were visited for ten minutes and owls were looked and listened for. Surveys were repeated an average of five times. In 1992, using the same techniques, surveys were repeated on the two towns on which we found owls in 1991, and were done twice on eight other towns in the park. Data were analyzed using the area occupied method We were able to establish a census technique for Badlands National Park which can be carried out by Park biologists with a minimum of training. Results can be compared between years, and form a framework for management of Burrowing Owls in the Park. We believe that this technique has application to other areas of the country where Burrowing Owls nest in semi-colonial situations.

REPRODUCTIVE ECOLOGY OF THE BURROWING OWL, *ATHENE CUNICULARIA FLORIDANA*, IN DADE AND BROWARD COUNTIES, FLORIDA

MEALEY, B.K. *Falcon Batchelor Bird of Prey Center, Museum of Science, 3280 South Miami Avenue, Miami, FL 33129*

During 1988 and 1990, a reproductive study of the ecology of the Burrowing Owl was conducted to determine sea-

sonality and reproductive success at the Miami International Airport and private residences in Dade and Broward counties, Florida. Reproductive data for each of the three years (1988–90) reveal a higher reproductive success rate (54%) for 1990 than 1989 (40%) and 1988 (40%). Owls using previously used burrows had a higher success in fledging young (63%) than newly excavated burrows (19%). T-tests were conducted on several appendage measurements of male and female owls to determine sexual dimorphic traits. Metatarsus lengths of males and females were different ($t = 2.36$, $P = 0.02$). As of 1990, 197 owls had been banded in the study areas. In 1989, 75% and in 1990, 83% of the banded adults were found on the same territory. Only four of 129 banded nestlings have been reencountered in the study sites. The owls' nesting sites are primarily located in residential areas. Management will involve educating home owners concerning landscaping techniques and their effects on the Burrowing Owl population.

MATE AND TERRITORY FIDELITY AND NATAL DISPERSAL IN AN URBAN POPULATION OF FLORIDA BURROWING OWLS (*ATHENE CUNICULARIA FLORIDANA*)

MILLSAP, B.A. *Nongame Wildlife Program, Florida Game and Fresh Water Fish Commission, 620 S. Meridian St., Tallahassee, FL 32399-1600.* C. BEAR. *Audubon Society of Southwest Florida, 1619 SW 33rd Terrace, Cape Coral, FL 33914*

From 1986 to the present we studied an urban population of Florida Burrowing Owls on a 32 km^2 study area in Cape Coral, Lee County, Florida. This paper uses data collected from 1987 to 1989. During this period, the number of breeding pairs varied from 129 to 190; a total of 617 nesting attempts was monitored. In 1987 and 1988, 476 owls, about 25% of breeding adults and 20% of nestlings, were banded. All banded breeding adults were identified in subsequent years, and 207 individuals were reencountered during the study period. Reencounter rates between years averaged 68% for adult males, 58% for adult females, and 20% for one-year-old owls. Reencountered adults typically remained on the same territory between years (87% of males and 69% of females). Nearly all pairs (95%), where both adults survived between years, remained paired. Natal dispersal distances averaged 81.4 m for males and 531 m for females. Data from additional years will be included in the oral presentation.

DIURNAL AND CREPUSCULAR/NOCTURNAL FORAGING AND BEHAVIORAL DIFFERENCES OF THE WESTERN BURROWING OWL

PEZZOLESI, L.S.W. *Department of Range and Wildlife Management, Texas Tech University, Lubbock, TX 79409.* D.L. PLUMPTON. *U.S. Fish and Wildlife Service Field Office, Rocky Mountain Arsenal, Bldg. 613, Commerce City, CO 80022.* R.S. LUTZ. *Department of Range and Wildlife Management, Texas Tech University, Lubbock, TX 79409*

During the nesting seasons of 1990 and 1991, diurnal time budgets of Burrowing Owls (*Speotyto cunicularia hypugaea*) in Colorado were studied. In 1992 a night-vision scope was used to collect comparable observational data during darkness. Due to the change in foraging responsibility of having young to feed, diurnal and crepuscular/nocturnal behaviors were split into prehatch and posthatch seasons and compared separately. We used foraging theory predictions to also investigate foraging behavior between these two periods. Preliminary investigation of prehatch behaviors indicated comfort movements (i.e., preening, stretching, etc.) ($P = 0.005$), resting ($P = 0.009$), and alert ($P = 0.006$) were greater diurnally, while out-of-sight ($P = 0.002$) and feeding ($P = 0.004$) were more frequent during crepuscular/nocturnal hours. During the posthatch period, burrowing owls locomoted more nocturnally ($P = 0.0002$) and performed comfort movements more frequently diurnally ($P = 0.004$). Additionally, when the sexes were analyzed separately, females rested ($P = 0.013$) more during daylight in the posthatch period. Several predictions of foraging behavior were based on central place foraging theory: foraging bouts when an individual returned with a mammal should be longer than those when it returned with an insect, males should have longer foraging bouts than females, and males should capture proportionately more mammals than insects than females capture. As predicted, foraging bouts when an owl returned with a small mammal (mean = 327 seconds) were longer ($P = 0.0001$) than those resulting in an insect capture (mean = 205 seconds). Male foraging bouts (mean = 257 seconds) are also longer ($P = 0.0001$) than female (mean = 193 seconds). Furthermore, males take more small mammals (15%) proportionally than females (2%) take ($P < 0.05$). The information presented here has several management implications. First, males capture more small mammals than females, and both sexes capture a relatively large number of insects. Consequently, both insect and small mammal prey bases are important factors in Burrowing Owl nesting activity. Secondly, the foraging theory predictions examined held true. These predictions can now be taken into consideration when examining prey populations in relation to their location and distance from the Burrowing Owl nesting burrow.

BURROWING OWLS IN MAPIMI, MEXICO

RODRIGUEZ ESTRELLA, R. AND A. ORTEGA RUBIO. *Centro de Investigaciones Biologicas, Div. Biol. Terr., Apdo. Postal 128, La Paz 23000 B.C.S. Mexico*

Burrowing Owls (*Athene cunicularia*) are threatened throughout much of their North American distribution. This owl has declined due mainly to habitat destruction

or modification and to the control of burrowing mammals. We examine the nest site characteristics and reproductive success of Burrowing Owls during two breeding seasons in the southern portion of the Chihuahuan desert. From March to July 1985 and 1986 owls and their burrows were located searching an area of 20 000 ha using stand condition maps of the Mapimi Biosphere Reserve (Durango, Mexico; 26°29′–26°52′N, 103°58′–103°32′W). Nesting densities were 0.15 pairs/km^2 and 0.12 pairs/km^2 in 1985 and 1986 ($N = 29$ and $N = 23$ pairs, respectively). No difference in nesting success was found in both years (60%) and productivity was also similar (2.19 and 1.63 young/successful nest, 1.52 and 0.90 young/attempt in 1985 and 1986, respectively). Burrow re-use was 55.2%. PCAs and correlation tests show that a mixture of *Prosopis, Larrea* and *Hilaria* in the vegetation of the "playas" is important in the distribution of the nests and is highly correlated with nesting success. Nests located at the *Prosopis-Hilaria* grassland vegetation produced almost 50% of the total fledglings ($\chi^2 = 7.62$; df = 1; $P < 0.01$). The highest number of fledglings is produced in kangaroo-rat and fox burrows, burrows located under grassland and clay-sand soils. The mean distances between adjacent owl nests were over 1 km, but ranged from 30 to 4167 m (mean = 1287 ± 98). The distribution of active nests in both years indicates a tendency toward regular spacing of breeding pairs. The grassland vegetation type is the habitat with more potentialities to be used by human beings in the zone as cattle raising is the most important economic activity. The management plan of this Biosphere Reserve must consider the negative effects of cattle raising on the burrows functioning as potential nests for Burrowing Owls proposing that cattle densities on the owl breeding areas be moderate.

IS THE DENSITY OF BURROWING OWLS BREEDING IN ALBERTA LIMITED BY HABITAT?

SCHMUTZ, J.K. *Department of Biology, University of Saskatchewan, Saskatoon, SK, Canada S7N 0W0*

To evaluate whether the density or distribution of breeding pairs of Burrowing Owls (*Athene cunicularia*) is determined by habitat availability, I recorded the location of agricultural fields, the density and distribution of native vegetation, and the abundance of burrows and "grasshoppers." The results were compared between nest sites and control sites located 1 km north of each nest site. If the results of this study are extrapolated to the population level, a conclusion that emerges is that in this particular area, where the dominant land use is grazing with 15% cultivation, Burrowing Owls are not limited in number or distribution by habitat availability.

OBSERVATIONS, RESIGHTINGS, AND ENCOUNTERS OF REHABILITATED, ORPHANED, AND RELOCATED BURROWING OWLS

SCHULZ, T.A. *6010 Acorn Court, Foresthill, CA 95631*

This paper describes data on the results of banded, rehabilitated, orphaned, and/or relocated Burrowing Owls Between 1981 and 1988, 16 injured or orphaned Burrowing Owls were banded and released in occupied or unoccupied burrows within an established colony on the University of California, Davis (UCD) campus in order to augment a declining population and to observe and document post-release behavior, survival, and mortality. A total of nine HY owls were fostered, and five were encountered or resighted. Two were encountered three and five days post-release due to collisions with large windows near the release site. One owl encountered 12 days post-release was retrapped at the release site. Two other fostered owls were resighted up to 28 days and 34 days post-release. These two utilized both the original release burrow and satellite burrows within 30 yards. A total of seven adult rehabilitated owls was released with one encounter 80 days post-release, dead due to collision with a vehicle approximately 200 yards from the release site. Another total of seven Burrowing Owls was relocated at distances ranging from 0.5 miles to 30 miles. Both of the two adult owls relocated at 0.5 miles on the UCD campus in December 1981 were later encountered at 426 days (dead due to collision with a vehicle) and 1310 days (retrapped near the release site). In June 1991, six other Burrowing Owls were relocated 15 and 30 miles away from a development site in Sacramento. Of the six relocated owls, five were observed between 10 and 49 days post-release. One adult female observed 10 days at the relocation site returned 15 miles to its original territory, arriving 32 days post-release. In another successful short distance relocation project, a technique using a one-way burrow exit precluded the necessity for trapping. All owls relocated themselves to artificial burrows previously placed 50 yards away. These data suggest that while some Burrowing Owls develop a strong fidelity to a relocation site, others tend to move on to other habitats after a period of adjustment at a relocation site.

COMPARISON OF SELECTED ASPECTS OF BURROWING OWL ECOLOGY AT TWO SITES IN SANTA CLARA COUNTY, CALIFORNIA

TRULIO, L.A. *Department of Geography and Environmental Studies, San Jose State University, San Jose, CA 95192-0116*

A two-year study was begun in January 1992, which investigates the effect of land use at Moffett Naval Air Station on the ecology and behavior of the base's western Burrowing Owl (*Speotyto cunicularia hypugaea*) population. These preliminary data compare reproductive and burrow choice parameters at Moffett and an adjacent site, Shoreline, a regional park. In August 1992, at least 37 adults (18 pairs and one single bird) lived on approxi-

mately 900 acres of land at Moffett. Of 15 pairs regularly observed, 73% of these (or 11 pairs) had a minimum of 27 chicks total, for an average of 2.5 chicks per brood, observed within three weeks of emergence. Shoreline had 23 owls (11 pairs and one single bird) living on 750 acres. Nine pairs of owls at Shoreline were regularly observed and seven of these (78% of pairs) had at least 21 chicks; the average of 3.0 chicks per brood was not significantly different from Moffett ($t = -0.975$; $df = 15$; $P = 0.05$). Observations indicate a difference in primary burrow location between Moffett and Shoreline birds. At Moffett, 15 of 19 primary burrow sites were located adjacent to or under a piece of cement or a fence, while four were located in a field without these features. Only one of the owl pairs at Shoreline chose burrows under cement or a fence, although such sites were available. Factors influencing this difference may be useful for enhancing burrowing owl habitat and are considered.

GENERAL SCIENTIFIC PROGRAM

CHAIR: MARK V. STALMASTER, *Stalmaster and Associates, 209 23rd Avenue, Milton, WA 98354*

ORANGE-BREASTED FALCON REPRODUCTION, DENSITY, AND BEHAVIOR IN NORTHERN CENTRAL AMERICA

BAKER, A.J. *P.O. Box 2492, Gig Harbor, WA 98335*. D.F. WHITACRE. *The Peregrine Fund Inc., 5666 W. Flying Hawk Lane, Boise, ID 83709*

The Orange-breasted Falcon (*Falco deiroleucus*) is known to occur in New World tropical forests from northern Argentina, Paraguay, and Bolivia north through Central America to Guatemala and southeast Mexico. As part of The Peregrine Fund's Maya Project, I searched for and studied nesting pairs of *F. deiroleucus* in Belize and Guatemala from mid-February through mid-June 1992. Fifty-four days were spent exploring areas for new pairs and 48 days observing at known sites. Of 13 sites (new and known from previous years) in Belize and Guatemala, 12 were visited, and 10 were occupied by Orange-breasted Falcons. Of the 10 pairs, five pairs fledged eight young with broods of one to three, one pair failed, and the productivity of four pairs is unknown. Eight of the 10 pairs occupied cliffs above either rivers or standing water surrounded by unaltered forest. Of the remaining two, one used a dry limestone sinkhole and the other an emergent Palm (*Orbignya cohune*). In two areas of Belize, groups of three pairs occurred inside diameters of 10 km, including two facing pairs <1 km apart. Nuptial behavior was well underway by mid-February and eggs were laid in the first half of March. Behavior observed included courtship, mounting, nest scraping, prey exchanges, caching, hunting, interspecific territoriality, and mock fighting between recently fledged siblings. The virtually unknown *F. deiroleucus* is certainly under pressure; a fast-growing human population, logging, slash-and-burn agriculture, and livestock grazing have and will continue to push these falcons out of suitable nesting areas. Learning more about their habitat and prey requirements will help in attempts to preserve forests and falcons in the Neotropics.

AMERICAN KESTRELS AT MCGILL UNIVERSITY: THE FIRST TWENTY YEARS

BIRD, D.M. *Avian Science and Conservation Centre of McGill University, 21,111 Lakeshore Road, Ste. Anne de Bellevue, Quebec, Canada, H9X 3V9*

Beginning with 10 pairs of captive kestrels in 1972–73, the McGill colony has been established at roughly 300 pedigreed birds. The kestrels have been used to develop procedures for artificial insemination (including frozen-thawed semen), artificial incubation, and forest renesting. A model involving *Trichinella pseudospiralis* and the kestrel has been used successfully to determine the impact of parasite load on health, reproductive performance, mate choice, and foraging behavior. Several studies have focused on endocrinology, specifically androgens, estrogens, corticosterone, luteinizing hormone, and more recently, growth hormone. Toxicological research has been aimed at DDE, PCBs, mirex, fluoride, aluminum, and fenthion. The above studies, as well as newly initiated work on paternity and inbreeding, will be summarized.

NORTHERN GOSHAWK DIETS IN PONDEROSA PINE FORESTS ON THE KAIBAB PLATEAU

BOAL, C.W. AND R.W. MANNAN. *School of Renewable Natural Resources, Biological Sciences East, University of Arizona, Tucson, AZ 85721*

Little dietary information is known for Northern Goshawks (*Accipiter gentilis*) in the southwest. We conducted 1539 hours of direct observation at 20 active goshawk nests in ponderosa pine forests on the North Kaibab Ranger District, Arizona, 1990–92. A total of 384 prey deliveries was recorded, 306 were identified to species, 63 were identified to class, and 15 were unidentifiable. Mammals and birds made up 75.1% and 24.9% of the items delivered, respectively. Golden-mantled ground squirrels (*Citellus lateralis*) and cottontail rabbits (*Sylvilagus* spp.) were the most common mammalian prey species, constituting 41.1% of all identified prey. Steller's jays (*Cyanocitta stelleri*) and northern flickers (*Colaptes auratus*) were the most common avian prey species and constituted 16.0% of all identified prey. Mean prey delivery rate was 0.25 deliveries per hour.

EFFECTS OF THE EXXON VALDEZ OIL SPILL ON BALD EAGLES

BOWMAN, T.D. *U.S. Fish and Wildlife Service, P.O. Box 768, Cordova, AK 99574*

In March 1989, the tanker *Exxon Valdez* ran aground and spilled more than 11 million gallons of crude oil, fouling shorelines from Prince William Sound to the Alaska Peninsula. About 8000 bald eagles inhabit that area. A 3-year study was initiated soon after to assess damages to bald eagles. Specific objectives were to determine effects of the spill on bald eagle reproduction and survival of adults and fledglings, conduct population surveys to assess population response, and examine eggs, prey, and blood for evidence of hydrocarbon exposure. Greatest damages to bald eagles occurred in 1989 and were manifested by direct mortality of an estimated 900 bald eagles throughout the spill area (about 10% of the population), and significantly reduced reproduction. Contamination of eggs and prey remains confirmed exposure to hydrocarbons. Reproductive failures were directly related to the extent and intensity of shoreline oiling near nests, but seem to have been limited only to Prince William Sound. The lack of observed reproductive failure in other areas was likely due to the timing of arrival, or decreased toxicity, of crude oil as the slick moved westward along the coast. Bald eagle reproduction in Prince William Sound rebounded in 1990. Population surveys in Prince William Sound did not show a significant decrease in numbers of bald eagles from 1989 to 1991, although confidence limits on estimates ranged from 13% to 30%. Survival was high for eagles radiotagged 4–5 months after the spill, and there were no differences in survival between birds from oiled and unoiled areas. The observed responses suggest that the oil spill had only a short-term effect on bald eagle populations. A population model of bald eagles in Prince William Sound indicates that the population was increasing before the spill at a rate of about 2% per year. The cumulative effects of the direct mortality and reduced productivity in 1989 will set the population in Prince William Sound back by 3–4 years, but population growth should continue.

USDA, FOREST SERVICE GOSHAWK MANAGEMENT STRATEGY

BOYCE, JR., D.A. *USFS Wildlife and Fisheries, 517 Gold Avenue SW, Albuquerque, NM 87102*

The current political atmosphere surrounding goshawks is described from a national perspective. The distribution and numbers of breeding goshawks on Forest Service lands throughout the western United States are discussed. Decisions and policy established at the regional and national level are described. The Forest Service challenge of meeting its Multiple-Use resource mandate and maintaining viable populations of Goshawks is discussed. Because of their extensive breeding range (east coast to west coast) and large territory size (about 10 square miles), the management strategies developed for goshawks have the potential to profoundly change Forest Service management practices throughout the country.

INTRODUCING THE INTERNATIONAL RAPTOR MIGRATION ATLAS PROJECT (IRMAP)

BRETT, J., L. GOODRICH, C. VIVERETTE AND K.L. BILDSTEIN. *Hawk Mountain Sanctuary, Route 2, Box 191, Kempton, PA 19529-9449*

We introduce the twin concepts of 1) a registry of sites of global significance to migrating raptors and 2) an international raptor migration atlas. The registry, loosely modeled after the Convention on Wetlands of International Importance, especially as Waterfowl Habitat (the so-called Ramsar Convention) and the Western Hemisphere Shorebird Reserve Network, is designed to champion the conservation of migratory birds of prey and their essential habitats. (Possible criteria for registry sites are offered for discussion purposes.) The atlas is designed to provide information needed to determine which sites should be listed as registry candidates. The project is housed at Hawk Mountain Sanctuary and is endorsed by the International Council for Bird Preservation and the World Working Group for Birds of Prey and Owls. A panel of internationally recognized authorities serves as a technical advisory board. Our paper presents preliminary, but significant, results of an initial international mailing and literature review of sites hosting large numbers of migrating raptors. IRMAP is gathering information on the geographic locations, environmental characteristics, monitoring efforts, and current threats to raptors associated with points of concentration along the world's major migratory corridors. To date, hundreds of sites encompassing six continents, many of which were heretofore unpublished, have been submitted. When completed, atlas data and registry candidates will be presented in a major publication that will provide an unprecedented global overview of raptor migration ecology and conservation. An appeal is made for information on sites that are not yet included in our database.

VARIATION IN SPOTTED OWL NEST SITE CHARACTERISTICS WITHIN THE WENATCHEE NATIONAL FOREST

BUCHANAN, J.B. *Washington Department of Wildlife, 600 Capitol Way North, Olympia, WA 98501.* L.L. IRWIN. *NCASI, 720 SW Fourth Street, Corvallis, OR 97339*

Spotted Owls (*Strix occidentalis caurina*) nest in a broad range of forest stand conditions in the Wenatchee National Forest (WNF). Nearly half of the known nests occur in even-aged patches or stands 65–135 years old, and 21% of the nest sites were partially harvested several decades prior to our study. A predictive model developed to distinguish between nest and random sites at the stand level correctly identified 70% of the study sites. Diagnostic evaluation of the model indicated that the low classification rate reflected variation in habitat conditions within the WNF. To identify factors that could improve the model, we developed pairs of predictive models based on north-

and south-facing slopes and on sites with and without evidence of previous partial harvest. The aspect and harvest models correctly classified 65–93% of the sites; however, none of the models were stable, as determined by cross-validation. Following this we examined variation among nest sites within the WNF by comparing mean habitat values among 4 of the 5 Fire Management Analysis Zones (FMAZ) identified by the U.S. Forest Service for fire control purposes. The FMAZ areas were defined primarily in terms of topography, annual precipitation, and estimates of fuel loading and fire frequency. We found significant differences among the FMAZ for nearly half of the 60 habitat features we compared at nest sites. It may be possible to develop predictive models within each FMAZ using the original or other models. For example, the harvest model (with a larger sample) may be useful to researchers and managers who wish to conduct adaptive management experiments in stands managed for timber and/or fire protection. The use of such models within the FMAZ framework would likely be more powerful and allow better management throughout the region.

BLACKFLY (*SIMULIUM* SPP.) INDUCED MORTALITY OF RED-TAILED HAWK NESTLINGS IN NORTHWEST WYOMING

CAIN, S.L., R.N. SMITH AND J.R. DUNK. *Grand Teton National Park, P.O. Box 170, Moose, WY 83012*

Red-tailed hawk productivity monitoring in Grand Teton National Park, Wyoming during 1990 and 1991 indicated a high proportion of nests were failing when nestlings were 2–4 weeks old. Dead nestlings found within and under nests, when adult pairs were still defensive and prey was abundant in the nest, suggested parasitism as a potential cause of mortality. In 1992, 20 occupied red-tailed territories were monitored throughout the nesting season. Eggs were laid at 18 territories and hatched at 13. Infestations of blackflies (*Simulium* spp.) were documented at all nests visited ($N = 12$) between 4–9 June when nestlings were from 3 to 20 days old. Infestation levels among nests varied from tens to thousands of flies. Flies primarily sucked blood from areas around the eyes, cere, auricular opening, and chin, but also burrowed through the down anywhere on the body. Fly activity decreased substantially during periods of cold weather. Complete brood mortality, as a result of dehydration and/or nestlings being driven from their nests, was documented at 4 nests. Circumstantial evidence indicated that blackflies caused nestling or post-fledgling mortality at 2 additional nests. Dead nestlings found at 2 more nests located late in the nesting season implicated blackfly infestations as well. In total, blackflies were believed to have caused mortality at 8 of 15 (53%) nests known to hatch young. Nestling mortality occurred in as few as 7 days after infestations began. Avian blackfly infestations and associated mortality have rarely been reported. We believe blackfly infestations may be locally important sources of red-tailed hawk mortality, especially if they are chronic, rather than acute, as has been suggested by others. Furthermore, because of 1) their small size, 2) their ephemeral presence at the nests, and 3) the wide range of nestling ages at which mortality occurs, blackfly infestations are probably undetected during many standard productivity surveys based on 2–3 nest visits during the nesting season.

FEASIBILITY OF FASTING MIGRATION IN OSPREY OF THE INTERIOR AMERICAN WEST

CANDLER, G.L. AND P.L. KENNEDY. *Department of Fishery and Wildlife Biology, Colorado State University, Fort Collins, CO 80523*

We reviewed current research on raptor migration and developed an energetics model to examine the potential importance of fasting on migration times of Osprey (*Pandion haliaetus*) migrating through the interior of North America. These piscavores fly inland over the semi-arid West and Mexico before arriving at their wintering area on the Pacific coast of southern Central America. The inter-west population also winters further north and may expend less energy during their migration than coastal Osprey, which must use powered flight to cross large water barriers. Therefore, fasting would seem to be more probable in this shorter distance, lower energy migration with limited prey availability. Our model predicts that a 1.68 kg Osprey would take 22 days, consuming 0.530 kg of fat (a fat density of 32% of lean body mass), to complete a fasting migration of 7800 km. Due to limits of daily intake, it was calculated to take 13 days of maximum energy intake to deposit this fat density. The predicted travel time for fasting migration was comparable to migration times estimated from lookout observations and banding data. If these Osprey did not fast during the entire migration, they would have to spend time foraging daily or break up their trip into several segments that are separated by stopovers to replenish their fat reserves, and we found that this would increase their migration time dramatically.

OFFSPRING SEX RATIOS OF AMERICAN KESTRELS IN SOUTHWESTERN IDAHO

CARPENTER, G.P. *RRTAC, Department of Biology, Boise State University, 1910 University Drive, Boise, ID 83725*

A two-year study of American kestrel (*Falco sparverius*) offspring sex ratios was begun in 1992. Seventy-six nest boxes in southwestern Idaho were monitored closely to identify laying and hatching sequences. Diets of selected pairs were supplemented while control pairs were not to test the effect of resource availability on sex ratio. Nestlings were weighed and measured frequently to compare differential allocation of food to mass and feather development by male and female offspring and to compare production costs of each gender. The study's theoretical basis, design, and preliminary results will be discussed.

USING GEOGRAPHIC INFORMATION SYSTEMS TO ANALYZE BALD EAGLE HABITAT USE IN THE CHESAPEAKE BAY, USA

S.K. CHANDLER, J.D. FRASER AND D.A. BUEHLER. *Department of Fisheries and Wildlife Sciences, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061.* J.K.D. SEEGAR. *U.S. Army Chemical, Research, Development and Engineering Center, Aberdeen Proving Ground, MD 21010*

We trapped bald eagles (*Haliaeetus leucocephalus*) using padded leghold traps and floating noosefish and by climbing to nests. Eagles were fitted with solar-powered radio transmitters, in a backpack configuration. The package was attached using teflon ribbon sewed near the sternum. Eagles were relocated ($N > 1000$) by using Cessna fixed-wing aircraft fitted with strut-mounted yagi antennas. We homed on the radio-signal to obtain a visual location and then plotted eagles' positions on 1:24 000 maps. UTM coordinates were digitized from the maps and stored in a file on our Micro-Vax III mini computer. We used ARC-INFO to overlay eagle locations on several different habitat data bases. We used ARC-INFO to calculate the amount of habitat available in various classes, which facilitated use vs. availability analyses. Telemetry used in conjunction with GIS databases has great potential for analyzing habitat use by raptors with very large home ranges.

THE CAPE MAY RAPTOR BANDING PROJECT: 25-YEAR SUMMARY

CLARK, W., C. SCHULTZ AND P. KERLINGER. *Cape May Bird Observatory, Box 3, Cape May Point, NJ 08212*

Since 1967, more than 81 000 migrating diurnal raptors have been captured and banded at Cape May Point, NJ, U.S.A. The research objective is to determine where these raptors are breeding and wintering, as well as their migration pathways. Data on measurements, age, sex, and condition have been gathered from the captured hawks. More than 1200 band recoveries have been reported, but only 147 previously banded raptors were captured and only 20 raptors were recaptured in subsequent years. A Common Kestrel (*Falco tinnunculus*) was captured in 1972 (second North American record). Ten Swainson's Hawks (*Buteo swainsoni*) have been captured from 1973 to present; one of these was recovered in Nova Scotia. Recovery data and most of the banding data are on computer data bases. Data are presented by species on the number banded and recovered and age and sex ratios. Published results are summarized. Captured raptors were made available to other raptor projects, including studies of the U.S. Fish and Wildlife Service, New Jersey Endangered Species and Non-game Program, New Jersey Audubon Society, University of Miami (Florida), University of Pennsylvania Veterinary School, Stockton State College, Tufts University, Utah State University, and Virginia Tech. Many raptor biologists (some from other countries) have received intensive training on capture techniques, age and sex determination, and behavior of raptors. Biologists from more than a dozen countries have observed the project operation. More than 35 000 people have attended demonstrations using banded raptors for public education, and heard our raptor conservation message. Funding is primarily from private sources, particularly from the WindSeine project of the CMBO. Most of the field work is conducted by highly qualified volunteers. Future research directions and publications are discussed.

RAPTOR EDUCATION—COMPLETING THE CIRCLE OF SPECIES SURVIVAL PLANS

CRAWFORD, JR., W.C. *World Bird Sanctuary, P.O. Box 270270, St. Louis, MO 63127*

It has been said that "All great environmental battles will be won or lost in this decade." As depressing as this sounds, there are still numerous positive aspects of conservation that are being conducted about which the public is unaware. Valuable field research is helping develop ecosystem management plans and species survival programs. Making the general public understand raptors and their place in our modern society has fallen on the shoulders of the raptor educators. Any comprehensive conservation programs for raptors must include field biologists working closely with educators. The World Bird Sanctuary (WBS) has developed an extensive education program that is designed to make the public more aware of what they must do to preserve raptors. Programs from preschool to senior citizens allow WBS to reach over 2 million people each year. Using data provided to us by field biologists, these programs are an effective tool in cooperative preservation programs for raptors. These programs, their design and complexity, will be discussed in detail.

MANAGEMENT OF A BALD EAGLE COMMUNAL ROOST IN MIXED-CONIFER FORESTS OF SOUTHERN OREGON

DELLASALA, D.A. *EBASCO Environmental, 10900 NE 8th St., Bellevue, WA 98004-4405.* R.G. ANTHONY. *U.S. Fish and Wildlife Service, Oregon Cooperative Wildlife Research Unit, Department of Fisheries and Wildlife, Oregon State University, Corvallis, OR 97331.* T.A. SPIES. *USDA Forest Service, Forestry Sciences Laboratory, 3200 Jefferson Way, Corvallis, OR 97331.* K.A. ENGEL. *EBASCO Environmental, 10900 NE 8th St., Bellevue, WA 98004-4405*

Traditional management of bald eagle communal roosts has been confined primarily to seasonal restrictions on human activity and protection from habitat alterations. However, simply prohibiting direct disturbance of roosts may not preserve essential habitat characteristics over the long-term, especially in areas where natural disturbances (e.g., fire) have historically shaped stand composition and

structure. We provide a management plan for a bald eagle (*Haliaeetus leucocephalus*) roost at the Bear Valley National Wildlife Refuge (BVR) in southern Oregon. Roost habitat was studied on 3 spatial scales of increasing size, including roost trees, vegetation surrounding roost trees (i.e., roost sites), and 4 subsections of the main roosting area (i.e., subroosts). Primary roost tree species included Douglas-fir (*Pseudotsuga menziesii*), ponderosa pine (*Pinus ponderosa*), and white fir (*Abies concolor*). Bald eagles used the largest (diameter at breast height), tallest, and oldest trees with open branching patterns. Differences in eagle use were attributed to growth rates and structural features of the 3 primary roost species. Douglas-fir was used at a younger age and was characterized by more open branching than other species. Ponderosa pine, an important species used by eagles in other areas in the region, did not receive high use at the BVR due to prior logging of the larger (>60 cm dbh) pines. When compared to unused sites, roost sites had 2–3 times as many large-diameter Douglas-fir, twice as many trees with open branching, 4 times as many snags, and greater tree height diversity. Subroost use by eagles was positively related to high densities of large Douglas-fir, low densities of late-seral white fir, and low stump densities. Mechanical thinning and prescribed fire were recommended to reduce white fir densities in portions of the roost where establishment of ponderosa pine and Douglas-fir were apparently inhibited by competition with late-seral white fir.

EFFECTS OF FOOD ON BALD EAGLE DISTRIBUTION AND MOVEMENTS ON THE NORTHERN CHESAPEAKE BAY

DELONG, JR., D., D.A. BUEHLER, T.A. MERSMANN AND J.D. FRASER. *Department of Fisheries and Wildlife Sciences, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061.* J.K.D. SEEGAR. *Chemical Research, Development and Engineering Center, Aberdeen Proving Ground, MD 21010*

We studied the effects of food on bald eagle distribution on the northern Chesapeake Bay during 1986 through 1989. We monitored the distribution of unmarked bald eagles through monthly aerial shoreline surveys, and the movements of 39 radio-tagged bald eagles through twice-weekly telemetry flights. We also monitored the distribution and abundance of fish and waterfowl which were the primary prey eaten by eagles during our study. Preliminary results indicated that annual cycles in bald eagle distribution were highly correlated with annual cycles in fish and waterfowl distribution on the study area. We subsequently initiated an experimental feeding program to test for cause/effect in this correlation. Fish were supplied daily at 2 sites on Aberdeen Proving Ground, Maryland, beginning in late September 1988. This was to simulate a non-declining food source at the time of year when fish abundance declines on the northern Bay, and bald eagles leave the study area for southern portions of the bay. The feeding program did not seem to curtail the movement of bald eagles to the southern portion of the bay, although it did have a significant impact on the distribution of eagles that remained on the study area. A greater understanding of the factors affecting bald eagle distribution, including the relative importance of each, will allow managers to more effectively manage bald eagle populations.

BREEDING BIOLOGY OF THE WHITE HAWK IN GUATEMALA

DRAHEIM, G. *RRTAC, Biology Department, Boise State University, Boise, ID 83725*

Although thirty-nine percent of the world's falconiform species are found in the rainforest, very little is known about these raptors. The White Hawk (*Leucopternis albicollis ghiesbreghti*), a medium-sized *Buteo*-like raptor, is found from southern Mexico through Belize and Guatemala. I studied this neotropical species during the 1991 and 1992 breeding seasons in Tikal National Park, Guatemala, in order to describe their general breeding biology The White Hawks begin courtship displays and nest building in February, and by mid- to late-March egg laying and incubation begin. Their stick nests were found in five different species of trees. The mean dbh of six nest trees was 70.1 cm and the nest height averaged 25.4 m above the ground. Nests averaged 43.8 × 67.3 cm across and 28.4 cm tall. Each nest contained one egg ($N = 4$) Of one hundred sixty-four prey items observed, 56% were reptiles, 20% unidentified, 14% mammals, 6% birds, 2% insects, and 2% amphibians. Prey items varied from small lizards (*Anolis* sp.) to medium-sized squirrels (*Sciurus deppei*). Prey items were delivered at a rate of 1 to 4 (mean = 1.9) times per day. The incubation period was 34–36 days ($N = 2$) and one chick fledged 88 days after hatching. Home ranges for one breeding male and one sub-adult were 208 ha and 46 ha, respectively. Although yellow is the reported eye color for this subspecies, all 20 birds located in northern Guatemala had brown eyes.

GREAT HORNED OWLS DO NOT EGEST PELLETS PREMATURELY WHEN PRESENTED WITH A NEW MEAL

DUKE, G.E., S. JACKSON AND O.A. EVANSON. *The Raptor Center, University of Minnesota, St. Paul, MN 55108*

Whether owls are able to cephalically, or even voluntarily, control pellet egestion in response to external stimuli has long been a question. It has recently been shown that meal-to-pellet interval (MPI) in one owl can be influenced by the visual presence of other owls, so some cephalic control is possible. Our objective was, therefore, to determine if Great Horned Owls could egest a pellet when presented with a new meal near the time when they would be expected to egest from a previous meal. Four owls, held individually in environmentally controlled rooms, were fed 40–60 g/kg daily at 0800 H for about 4 weeks. Mean and

standard deviation (SD) for MPI were calculated for each owl. During the next 8 weeks, each owl was fed one day per week (randomly selected) at a time equal to one SD prior to the mean MPI (i.e., prior to expected egestion time). We expected that when presented with a meal (mice) at this time, owls would a) not eat immediately, but initiate egestion and eat within 15–30 minutes, b) eat the new meal on top of the undigested remains of the previous meal still in the stomach, or c) not eat within 30 minutes and thus miss the opportunity to ingest a new meal. With one exception when we observed a, we otherwise always observed b, i.e., they ate on top of a previous meal. Pellets from these "double" meals were less than twice as heavy as pellets from a single meal, so digestion was apparently slightly better after two meals. Thus, not only do owls not miss the chance to eat a second meal because a first meal is not yet completely digested, their digestion may even be slightly more efficient when the second meal is eaten.

MOVEMENTS AND HABITAT USE BY COMMON RAVENS FROM ROOST SITES IN SOUTHWESTERN IDAHO

ENGEL, K.A. *EBASCO Environmental, 10900 NE 8th Street, Bellevue, WA 98004.* L.S. YOUNG. *Washington Department of Natural Resources, Forest Land Management Division, P.O. Box 47016, Olympia, WA 98504-7016*

Increasing conflicts between ravens and human interests in the western United States necessitate a better understanding of raven ecology, especially with respect to human land alterations. We observed daily movements and habitat use of 31 radio-marked common ravens (*Corvus corax*) from four communal roosts in the Snake River Birds of Prey Area in southwestern Idaho from April 1985 through February 1987, and recorded their activities relative to various human-related food sources (e.g., croplands, cattle feedlots, and refuse landfills). Daily maximum distances traveled from roost sites were similar ($P = 0.63$) among seasons, but not ($P < 0.01$) among roosts. Ravens from roosts located within 1 km of a concentrated human-related food source traveled shorter (all $P < 0.03$) distances from roosts than ravens that were not. Ravens spent an average of 54% of the day in agricultural land, followed by shrub (23%), grass (13%), and riparian habitats (6%). Raven use of various habitats was similar (all $P > 0.27$) among seasons. Likewise, raven use of agricultural, riparian, and shrub habitats was similar ($P > 0.06$) among roosts, although use of grass habitats was lower ($P < 0.01$) at one roost. Raven roost locations, daily movements, and habitat use were associated with human-related food sources. Raven populations may thus be managed through manipulation of raven food supplies, particularly those related to human activities.

OCCURRENCE AND NESTING HABITAT OF NORTHERN SPOTTED OWLS IN MANAGED YOUNG-GROWTH FORESTS IN NORTHWESTERN CALIFORNIA

FOLLIARD, L.B. *College of Forestry, Wildlife and Range Sciences, University of Idaho, Moscow, ID 83843.* L.V. DILLER. *Simpson Timber Company, P.O. Box 1169, Arcata, CA 95521.* K.P. REESE. *College of Forestry, Wildlife and Range Sciences, University of Idaho, Moscow, ID 83843*

From 1989 through 1992, approximately 120 000 ha of managed, young-growth forests were surveyed for northern spotted owls (*Strix occidentalis caurina*) in coastal northern California. To date, 169 owl sites have been identified and over 500 birds banded (including 197 juveniles). The relative density of owl sites was greatly influenced by the amount of acreage of forest >45 years old. The region with the highest density (about 0.46 owl sites/km^2) had 37% of the landscape in this older age class. Habitat analysis of 60 nesting pairs revealed that owls nested in stands that varied from pure conifer to those dominated by hardwoods, with no apparent selection for a particular cover type. The median nest stand age was 59 years, with 83% of pairs nesting in stands 35–80 years old. On average, conifer nest stands were dominated by trees 53–90 cm dbh in size. Although the density was low, there was a higher density of large (>90 cm dbh) conifers ($P = 0.010$) in nest stands in comparison with randomly selected stands. In general, hardwood nest stands had smaller trees than conifer stands. In comparison with old-growth forest structure, the most distinctive difference was the low density of trees >90 cm dbh in these managed stands. Favorable conditions in the redwood (*Sequoia sempervirens*)/Douglas-fir (*Pseudotsuga menziesii*) coastal region such as rapid tree growth rates and an abundant prey base, make these second-growth forests suitable spotted owl habitat at an early age. Development of spotted owl habitat in this region can occur at an accelerated rate following timber harvest in comparison with other regions of the species' range.

ANALYSIS OF PESTICIDE EXPOSURE RISK TO RED-TAILED HAWKS WINTERING IN ALMOND ORCHARDS IN CALIFORNIA

FRY, D.M., B.W. Wilson, N.D. Ottum, J.T. Yamamoto and R.W. Stein. *Department of Avian Sciences, University of California, Davis, CA 95616.* J.N. SEIBER, M.M. MCCHESNEY AND E. RICHARDSON. *Department of Environmental Toxicology, University of California, Davis, CA 95616*

Red-tailed Hawks (*Buteo jamaicensis*) become exposed to organophosphate (OP) pesticides while wintering in the central valley of California. Previous work on birds trapped by M. Hooper, P. Dietrich, and E. Littrell showed exposure associated with OP dormant spraying in almond orchards. This study extends that work by examining winter home ranges of hawks, pesticide use within home ranges, and documentation of exposure through analysis of foot washes, feather samples, and feces. The exposure risk from

the four principal OP compounds used on almonds was estimated by correlating: 1) residues on hawks with spray application timing relative to capture of birds and 2) correlations with serum cholinesterase depression. The probable routes of exposure to the birds include dermal absorption through feet and ingestion of residues from prey and during preening. This work was supported by the Almond Board of California.

TELEMETRY VIA SATELLITES FOR RAPTOR STUDIES

M.R. FULLER, D.H. ELLIS AND S.S. KLUGMAN. *U.S. Fish and Wildlife Service, Patuxent Wildlife Research Center, Laurel, MD 20708*. W.S. SEEGAR. *Chemical Research, Development and Engineering Center, Aberdeen, MD 21010*

Monitoring animal movements by satellite was first accomplished in 1970 with an elk in Wyoming. The large size of early transmitter packages restricted their use to very large animals. Miniaturization of electronic components in the 1980s allowed application of satellite telemetry to large birds. Satellite transmitters have been tested with mixed results on geese, swans, petrels, bustards, eagles, and falcons. Dramatic weight reduction in the 1980s was quickly followed by tests of a variety of transmitter shapes on captive birds. Research on attachment methods helped in selecting those methods least likely to elicit adverse behavior. Wind tunnel experiments were conducted to produce more aerodynamically efficient PTT designs. Recently, the utility of satellite tracking has been demonstrated in studies of wandering albatrosses in the Indian Ocean, migrating Bewick's swans, bald eagles, and golden eagles. Two other studies demonstrated the feasibility of tracking cranes by satellite. The types of information from these techniques will be presented and cross-referenced to a poster display and demonstration.

HABITAT SELECTION BY MEXICAN SPOTTED OWLS IN NORTHERN ARIZONA

GANEY, J.L. *USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Flagstaff, AZ 86001*. R.P. BALDA. *Department of Biological Sciences, Northern Arizona University, Flagstaff, AZ 86001*

Although the Spotted Owl (*Strix occidentalis*) has been the object of considerable attention in the Pacific Northwest, little is known about the habitat requirements of the Mexican Spotted Owl (*S. o. lucida*). We compared use of broad habitat types to availability of those types within the home ranges of eight radio-tagged Mexican Spotted Owls in northern Arizona. When all habitat types were considered, no owls used these types in proportion to availability. Use patterns differed among individuals and by activity type. All owls roosted primarily in virgin mixed-conifer forests. Owls generally foraged more than expected in virgin mixed-conifer and ponderosa pine (*Pinus ponderosa*) forests and less than expected in managed forests. Mature forests appear to be important to Spotted Owls in this region and different forest types may be used for different activities. Consequently, managers should retain virgin stands of both mixed-conifer and ponderosa pine forest where these owls occur, to provide both roosting and foraging habitat.

OBSERVATIONS AND FOOD HABITS OF NESTING GREAT BLACK-HAWKS IN TIKAL NATIONAL PARK, GUATEMALA

GERHARDT, R.P. *The Peregrine Fund, Inc., 5666 W Flying Hawk Lane, Boise, ID 83709 (EEC Biology, University of Nevada, 1000 Valley Road, Reno, NV 89512-0013)*. P.M. HARRIS. *The Peregrine Fund, Inc., 5666 W Flying Hawk Lane, Boise, ID 83709*. M.A. VASQUEZ MARROQUIN. *El Parque Nacional Tikal, El Petén, Guatemala*

Two active nests of the Great Black-Hawk (*Buteogallus urubitinga ridgwayi* Gurney) were located during the dry season in Tikal National Park, Guatemala. Nests were 20.5 m and 22 m high in mahogany (*Swietenia macrophylla*) and pucte (*Bucida bucerus*) trees, respectively. Each nest contained a single young. Direct nest observations yielded 106 prey items delivered to young; of these, lizards comprised 31%, snakes 28%, birds 13%, anurans and bats 8% each, rodents 6%, and an opossum 1%. Niche breadth (1/D) was 4.51. In terms of biomass, snakes represented 46% of the prey. Incubation time was approximately 40 days. Fledging occurred 65–70 days after hatching in the one successful nest.

THE FOOD HABITS, HOME RANGE AND BREEDING OF TWO SYMPATRIC *CICCABA* OWLS

GERHARDT, R.P. *The Peregrine Fund, Inc., 5666 W Flying Hawk Lane, Boise, ID 83709 (EEC Biology, University of Nevada, 1000 Valley Road, Reno, NV 89512-0013)*. D.M. GERHARDT. *The Peregrine Fund, Inc., 5666 W. Flying Hawk Lane, Boise, ID 83709*. N.B. GONZALEZ. *El Parque Nacional Tikal, El Petén, Guatemala*. C.J. FLATTEN. *The Peregrine Fund, Inc., 5666 W. Flying Hawk Lane, Boise, ID 83709*

Thirteen Mottled Owl (*Ciccaba virgata*) nests were studied in Tikal National Park, Petén, Guatemala. Mean clutch size was 2.15. Nine of these nests fledged a total of 16 young and young left the nest at between 27 and 33 days of age. Mean home range size was 20.8 ha (85% harmonic mean) for six radio-tagged breeding males and the density of this population was 7.5 breeding adults per km^2. Mottled Owls were found to be highly territorial, sedentary, and monogamous. Four nests of the Black-and-white Owl (*C. nigrolineata*) are also described. All were in epiphytes in large, live trees. Mean nest height was 20.5 m. Each nest contained one egg. The home range size of a single radio-tagged male was 437.3 ha (85% harmonic mean) One pair studied during three consecutive years was found to be monogamous and completely sedentary. Both species

captured large insects, including beetles (primarily scarabaeid, curculionid and cerambycid), grasshoppers (Orthopetra; Acrididae), and cockroaches (Orthoptera; Blattidae). There was little overlap in the vertebrate component of the diets of the two species: Black-and-white Owls fed on bats (especially *Artibeus jamaicensis*), while Mottled Owls ate small rodents (including *Oryzomys fulvescens* and *Sigmodon hispidus*). Quantitative analysis of food habits was based on frequency of occurrence of prey taxa in pellets. One hundred percent of Black-and-white Owl pellets contained insect exoskeletal material; 73% contained bat fur and/or bones. Ninety-eight percent of Mottled Owl pellets contained insect matter, while 56% contained vertebrate remains.

BREEDING AND WINTERING RANGES OF SHARP-SHINNED HAWKS (*ACCIPITER STRIATUS*) MIGRATING THROUGH THE CENTRAL APPALACHIANS OF NORTHEASTERN UNITED STATES: CONSERVATION IMPLICATIONS

GOODRICH, L.G. AND S. STRUVE. *Hawk Mountain Sanctuary Association, Route 2, Box 191, Kempton, PA 19529*

Hawk watches at coastal locations in eastern North America have reported precipitous declines in counts of Sharp-shinned Hawks (*Accipiter striatus*) in recent years. However, nearby Appalachian sites have only recently noted a decline. To interpret hawk count trend comparisons, we first need to determine the origin of the birds being sampled at each site. To ascertain if the birds migrating through the Appalachians originate from the same populations as those sighted along the east coast, we examined band recovery data on all Sharp-shinned Hawks banded prior to 1990 in the eastern Appalachians ($N = 212$) and compared it to that reported for Cape May, New Jersey. Band recovery data suggest that the breeding and wintering ranges of Sharped-shinned Hawks that migrate through the Appalachian flyway overlap extensively with those reported for birds banded on the coastal flyway. In contrast to central and western populations, eastern Sharp-shinned Hawks were found to winter predominately within the United States. We found no difference in wintering range among age and sex classes of Appalachian birds. Because immature birds comprise most of the coastal observations, and band recovery data suggest coastal birds and Appalachian birds originate from similar populations, we propose that recent declines reflect on inhibition of reproduction over a wide region of the northeast rather than a localized decline.

MORPHOLOGICAL DIFFERENCES OF FERRUGINOUS HAWKS (*BUTEO REGALIS*) EAST AND WEST OF THE ROCKY MOUNTAINS

GOSSETT, D.N. AND M.J. BECHARD. *RRTAC, Department of Biology, Boise State University, 1910 University Drive, Boise, ID 83725*

In 1991, the U.S. Fish and Wildlife Service (USFWS) received a petition to list the Ferruginous Hawk (*Buteo regalis*) as threatened or endangered under the Endangered Species Act. Status reviews have found that the overall population has increased in recent years. However, most of this increase has occurred in populations east of the Rocky Mountains, and some western populations may still be suffering declines. To determine if morphological and genetic differences exist between what have been speculated to be separate subpopulations, 70 adult Ferruginous Hawks were trapped at nesting areas east and west of the Rocky Mountains in 1991 and 1992. Initial analysis using multivariate analysis of variance and Duncan's multiple-range test indicates a significant morphological difference between areas (females: $P < 0.0001$, males: $P < 0.0035$, with a Bonferroni corrected significance level). Eastern populations were heavier than western populations (female mass means = 1871 g vs. 1680 g, male mass means = 1239 g vs. 1098 g, respectively). Other character means that were significantly different included third toe length, bill chord, horizontal bill, and gape width. Additional results will be discussed.

SELECTION OF PREY AND FORAGING METHODS IN BREEDING AMERICAN KESTRELS

GUERRERO-GONZALEZ, F.M. *N6789 Third Avenue, Plainfield, WI 54966*

The foraging theory predicts that the use of food and choice of foraging method by an animal are influenced by the pattern of abundance, nutritional value, and cost of capture of prey potentially available. I studied the American Kestrel's use of prey by determining presence or absence of prey items in a total of 685 pellets collected weekly from 26 breeding birds in 1991. I found four principal prey groups: insects, mammals, birds, and snakes. When insects were scarce, a higher proportion of mammals appeared in the pellets and vice versa. The presence of birds in the diet correlated with the abundance of fledglings. Finally, snakes were represented only from mid-May until early August. Results of my first year's study gave insight on the use of prey. However, some questions arose, such as: did kestrels use the most available prey?, was the choice of prey influenced by its abundance?, and finally, what foraging methods were used? I recorded hunting method, hunting success, and prey item from 22 breeding birds daily in the mornings at intervals of 30 seconds in sessions of 5–300 minutes in 1992. I also sampled three major prey populations: beetles, grasshoppers, and mice, to obtain their relative abundance throughout the seasons. The data suggest that kestrels made optimal selection of prey and foraging method. They selected the most rewarding item dependent on prey density, but whenever two prey types were abundant they switched to the one of better quality. Kestrels used perch hunting when trying for insects, and hovering and flight hunting while attempting to catch

mammals and birds. Nevertheless, the use of a method requiring less or more energy was determined by the nutritional value and/or abundance of the prey.

A COMPARISON OF NEST SITES OF THE NORTHERN GOSHAWK IN ARIZONA AND CALIFORNIA

HALL, P.A. *Northern Arizona University, School of Forestry, Box 4098, Flagstaff, Arizona 86011*

The northern goshawk is considered an indicator species for old-growth forests in the western United States by a number of state and federal agencies. Studies of the species have evoked a growing concern about the effects of forest management practices on the viability of western population, as evidenced by the recent petition to the U.S. Fish and Wildlife Service to list the species as threatened. Information on goshawk habitat requirements in Arizona is scarce and there is justifiable reticence to apply results from other vegetation zones or physiographic provinces. The object of this analysis is to identify differences and commonalities in the structural and physiognomic characteristics of nest sites in two study areas in different regions; northern Arizona ponderosa pine and northwestern California Douglas-fir. A multivariate analysis-of-variance revealed an overall significant difference between nest sites, nest trees, and nests in the two areas. These differences are based on characteristics attributable to species growth patterns and climate, such as: basal area, stem density, canopy closure, and tree height in the nest sites; nest tree height and diameter; and the position of the nest within the nest tree and nest site canopies. Multistoried canopies prevail in California while single-storied canopy structure is predominant in Arizona. However, all nest sites are park-like due to the absence of a shrubby understory. Nest sites and nest trees are comprised of the locally dominant species. The distributions of tree size classes are similar. Nest tree diameters generally fall in the two largest size classes and classify as old growth on average. There are problems extrapolating results from one study area to another. This comparison begins to identify generalizable characteristics which can be applied to goshawk management on a broader scale.

HYBRIDIZATION BETWEEN BARRED AND SPOTTED OWLS

HAMER, T.E. *Washington Department of Wildlife, 600 Capitol Way North, Olympia, WA 98504*. E.D. FORSMAN. *USDA Forest Service, Forestry Sciences Laboratory, Corvallis, OR 97331*. A.D. FUCHS AND M.L. WATERS. *Puget Power and Light Company, Bellevue, WA 98009*

We present the first records of interspecific hybridization between the Northern Barred Owl (*Strix varia varia*) and Northern Spotted Owls (*S. occidentalis caurina*). Two hybrid owls in Washington and two in Oregon were confirmed during 1989–92. One of the hybrids paired with a Barred Owl and produced young in 1990 and 1991. In addition, we confirmed the pairing of a female Barred Owl to a one-year-old male Spotted Owl, which produced at least one young in 1992. Hybrids were identified by their unique plumage, unusual vocalizations, and morphological measurements. All three adult hybrids had similar plumage characteristics and vocalizations. Body measurements of hybrids were intermediate between Barred and Spotted Owls, and sonograms of vocalizations displayed attributes of both species. Although genetic comparisons have not yet been conducted, we believe the three adult specimens we observed were all F1 crosses between Barred and Spotted Owls. Hybridization between these species and successful back-crossing by hybrids indicates that the designation of the Barred and Spotted Owl as a superspecies is appropriate.

A DISASTROUS BREEDING SEASON FOR AMERICAN KESTRELS—1992

HAMERSTROM, F.N. *6789 3rd Ave., Plainfield, WI 54966*

We have monitored 50 American Kestrel (*Falco sparverius*) nest boxes on an approximately 50 000 acre (20 234 ha) study area in central Wisconsin for 25 years (1968–92). The number of young fledged per year had risen since 1968 and then it declined since 1982. The mean number of young fledged 1968–92 was 52. The most strikingly aberrant year was this past season. Only 11 young fledged.

PEREGRINE RECOVERY IN THE ROCKY MOUNTAINS AND PACIFIC NORTHWEST

HEINRICH, W.R. *The World Center for Birds of Prey, 5666 West Flying Hawk Lane, Boise, ID 83709*

By the late 1970s no Peregrines were known to be breeding in Montana, Idaho, or Wyoming, and only small remnant populations were known to exist in Colorado, New Mexico, northern Utah, Washington, and Oregon. In 1975, The Peregrine Fund established a breeding facility in Ft. Collins, Colorado, with specific objectives to begin raising and releasing Peregrines in the Rocky Mountains. Since 1978, over 1650 Peregrines have been released in the Rocky Mountains and Pacific Northwest. The program has successfully met recovery objectives in Colorado and Utah. Additionally, since 1980 a total of 830 Peregrines have been released in Montana, Idaho, and Wyoming. In 1992, 40 known pairs produced over 73 young in those states (1.8 young per pair). Over 209 Peregrines have been released in Oregon and Washington since 1980 when only four pairs were known. Today, over 45 pairs are present. The Peregrine Fund, in cooperation with agencies in Montana, Wyoming, Idaho, Washington, and Oregon, plans to continue releasing about 130 Peregrines a year

through 1995. After that time we believe state and federal recovery objectives will have been achieved.

RECENT TRENDS IN COUNTS OF MIGRATING HAWKS FROM WESTERN NORTH AMERICA

HOFFMAN, S.W., J.C. BEDNARZ AND W.R. DERAGON. *HawkWatch International, P.O. Box 5706, Albuquerque, NM 87176-5706*

Diurnal raptors were tallied during migration periods at the Wellsville (Utah), Goshute (Nevada), Manzano (New Mexico) and Sandia (New Mexico) mountains for 6–8 years/site between 1977 and 1991. Of several variables analyzed, only the number of observers present ($P < 0.05$) significantly influenced the detection rates of raptors. We adjusted the data to standardize for the duration of sampling period and the number of observers, and applied trend analyses. Trends of 15 raptor species were examined and counts of 11 species were either slightly increasing or showed no change in numbers. Turkey Vultures and Ospreys were significantly increasing. Conversely, counts of migrant Northern Goshawks and Golden Eagles decreased at mean rate of 4.4% and 6.1% per year, respectively. Interpretation of these declines is somewhat enigmatic; however, these patterns are consistent with limited evidence that widespread alteration of forest, and possible rangeland habitats, is occurring in western North America.

NORTH AMERICAN BANDING OF GREAT HORNED OWLS

HOUSTON, C.S. *863 University Drive, Saskatoon, SK, Canada S7N 0J8*

The Great Horned Owl, widely distributed across North America, has been banded in every state except Hawaii and in all ten Canadian provinces, with 24 787 banded between 1955 and 1989. Of these, 19 073 were normal wild birds (status 3000), including 17 491 nestlings or flightless young (locals). Numbers banded annually have tended to increase from a low of 131 in 1956 to a high of 1335 in 1986. Over one thousand were also banded annually in 1972, 1976, 1981, 1983, 1987, and 1988. Of 1032 Great Horned Owl banders, 37 have banded 100 or more, at least two of them primarily dealing with rehabilitated owls. States and provinces with the most banded are Saskatchewan (6184), Alberta (1862), Ohio (1768), Wisconsin (1335), and California (1253). To date, there have been 2308 recoveries, a rate of 9.3%, unusually high for a non-game species. Another 296 recoveries are available from banding done between 1920 and 1954, much of it in Ohio, Michigan, and New York. Although a year-round resident previously considered to be non-migratory, individual owls from Alberta, Saskatchewan, Manitoba and North Dakota have travelled great distances: an Alberta owl was caught in a building in Illinois, 2057 km distant, seven months after it was banded as a nestling.

FORAGING RANGE OF RIVER NESTING BALD EAGLES

HUNT, G. *BioSystems Analysis, Inc., 303 Potrero, 29-203, Santa Cruz, CA 95060*

In a three-year study of bald eagles in Arizona, we tracked the daily movements of nine radio-tagged adults during the breeding season while simultaneously observing prey deliveries to the nest. The eagles took live and carrion fish in both riverine and lacustrine habitats. We mapped foraging range per kilometer according to the distribution of 1) perching events, 2) direct observations of foraging, and 3) telemetric data on the whereabouts of eagles in the minutes prior to nest delivery. To account for the large number of perching events near the nest that were unrelated to foraging, we weighted the range data according to the proportion of forages occurring in the nest vicinity. Foraging ranges of eagles were a measure of habitat quality and distribution: eagles were attracted to specific habitats where prey were vulnerable, and in most cases these habitats were not homogeneously distributed within the home range. Other factors affecting foraging range included distribution of strategic perches and isolation from disturbance. This study was funded by the U.S. Bureau of Reclamation.

HABITAT USE AND RELATIVE ABUNDANCE OF THE BAT FALCON IN THE SELVA LACANDONA REGION OF CHIAPAS, MEXICO

IÑIGO-ELIAS, E.E. *Department of Wildlife and Range Sciences, Program for Studies in Tropical Conservation, University of Florida, Gainesville, FL 32611-0304*

The Bat Falcon (*Falco rufigularis*) is among the most common neotropical raptors. Nevertheless, the biology and ecology of this species are poorly documented. The objectives of this study were 1) to evaluate the habitat use by this species along the Lancantún River in the southern portion of the Selva Lacandona and 2) to document seasonal, monthly, diurnal and spatial distributions along the Lacantún drainage. In order to estimate the habitat use and relative abundance, Bat Falcons were surveyed from September 1989 to August 1990 along 24 1-km walking transects (oriented perpendicularly to the river) and 11 15-km river transects along the Lacantún River. The data revealed that the mean relative abundance of the species was greatest between 0 and 100 m from the edge of the river. Bat Falcons tended to use the riparian evergreen tropical forest more often than any other natural or disturbed vegetation types. This species was more abundant during the rainy season. They were rarely detected during the breeding season, which occurs during the dry period of the year. Daily activity was highest during the early and late hours of the day. Recommendations for protecting riparian tropical forests are suggested based on the habitat used by this species. These survey techniques can be useful

for monitoring other Bat Falcon populations in other neotropical forests.

A REVIEW OF THE BALD EAGLE TRANSLOCATION PROJECT IN ALASKA

JACOBSON, M.J. *U.S. Fish and Wildlife Service, P.O. Box 021287, Juneau, AK 99802-1287*

Since 1981, over 350 nestling bald eagles (52% of production) have been removed from a study area within old growth forest of southeast Alaska for reintroduction to other states. Helicopter surveys have been used to determine nest occupancy and success in the removal and control areas. No detrimental effect on productivity within the removal area has been detected. Reintroduction projects from states receiving Alaskan bald eagles are briefly discussed.

FIELD EXPERIMENTS IN PREY SELECTION BY RESIDENT BALD EAGLES IN THE BREEDING AND NONBREEDING SEASON

JENKINS, J.M. *Technical and Ecological Services, Pacific Gas and Electric Co., 3400 Crow Canyon Road, San Ramon, CA 94583.* R.E. JACKMAN. *BioSystems Analysis, Inc., P.O. Box 776, Fall River Mills, CA 96028*

Implicit in the assumptions of modern foraging theory is that animals are capable of exercising choice in their foraging decisions. However, few empirical studies demonstrating such choice have been conducted. We devised a simple field experiment offering a choice of two prey items of unequal sizes to foraging bald eagles in the breeding and nonbreeding season. The objective of the field experiment was to determine if eagles nonrandomly selected one prey item over another, and if this choice varied between breeding and nonbreeding season. A total of 67 trials was conducted on four nesting pairs of eagles, 32 trials in the breeding season and 35 in the nonbreeding season. At each of the four territories, eagles selected the large fish during the breeding season more frequently than expected on the basis of chance. In the nonbreeding season, eagles took the large fish in about equal numbers as the small fish. However, eagles failed to take either fish 37.1% of the time during the nonbreeding season. This compares to only one instance of no response (3.1%) for breeding season trials. Mean response time was generally shorter in the breeding season than the nonbreeding season and eagles responded more quickly when they took the large fish irrespective of season. The latter result suggests that hunger level may have affected the eagle's decision to take the large fish. We conclude that eagles discriminate between large and small prey items and may alter their prey selection based upon hunger levels and increased energetic requirements of the breeding season. These results suggest additional reasons why food habits of bald eagles vary between the breeding and nonbreeding season.

HABITAT USED BY BALD EAGLES WINTERING ALONG THE SOUTH FORK BOISE RIVER, IDAHO

KALTENECKER, G. AND M.J. BECHARD. *RRTAC, Department of Biology, Boise State University, Boise, ID 83705*

Foraging and perching habitats used by bald eagles (*Haliaeetus leucocephalus*) wintering along the South Fork Boise River in southwestern Idaho were studied during the winters of 1990–91 and 1991–92. Aerial surveys showed that eagles concentrated mostly along a 25 km stretch of river located in mature cottonwood trees (*Populus trichorcarpa*) and preyed upon largescale suckers (*Catostomus macrochielus*), mountain whitefish (*Prosopium williamsoni*), and rainbow trout (*Oncorhynchus mykiss*). River and surrounding habitat characteristics were measured at each prey capture and perching site, as well as at an equal sample of random sites. River habitat type, depth, velocity, number of surrounding perches, and proximity to the nearest river habitat change were among variables measured at each site. Eagles selected deeper and slower habitats (pools) for foraging more than expected. Abundance of fish, both alive and dead, was found to be higher at pools than other habitat types. Eagles also used habitats containing more surrounding perches than were available at random. In addition to pools, transitional river habitat types (23% of use sites) were used more often than available (14% of random sites measured). Findings may aid managers in identification or protection of key foraging habitats within existing wintering areas. Results indicated the importance of pools, transitional zones, and riparian habitats containing stands of mature cottonwood trees. Recommendations for flow regimes and land-use practices along dammed, riverine habitats used by bald eagles will be made to ensure healthy riparian vegetation and the availability of mature cottonwoods.

RESPONSIVENESS OF NESTING NORTHERN GOSHAWKS TO TAPED BROADCASTS OF THREE CONSPECIFIC CALLS

KENNEDY, P.L. *Department of Fishery and Wildlife Biology, Colorado State University, Ft. Collins, CO 80523.* D.W. STAHLECKER. *Eagle Environmental, Inc., Route 7, Box 126-Z, Santa Fe, NM 87505*

We wanted to determine if broadcasting conspecific vocalizations of northern goshawks (*Accipiter gentilis*) increased their detectability during the nesting seasons, because locating nest sites of this forest-dwelling raptor is difficult and time-consuming. Consequently, we recorded responses of northern goshawks to an observer walking transects and either broadcasting alarm, wail and juvenile begging calls of goshawks or not broadcasting during 1990 in northcentral New Mexico and northcentral Arizona We sampled 215 transects at 27 northern goshawk nests during sampling periods associated with courtship, nestling, and fledgling-dependency during the nesting season.

Northern goshawk responses to taped conspecific calls were significantly ($P = 0.02$) higher than their responses to an observer without a tape. Detection rates were highest on transects with broadcasts during the nestling (73.1%) and fledgling-dependency periods (75.0%). During all sampling periods, the probability of detecting a northern goshawk was highest for observers broadcasting a conspecific vocalization within 150–200 m of the nest. During the nestling period, the alarm call elicited the highest detection rate while the wail and begging calls resulted in the highest detection rate during the fledgling-dependency period. Vocal mimics by jays (potential false positives) occurred on 16.7% of the transects. The lowest mimicry rates occurred during the nestling period. We recommend that northern goshawks be surveyed with broadcast conspecific vocalizations during brood rearing at stations that are 300 m apart on transects that are separated by 260 m, and that stations on adjacent transects be offset by 130 m.

LANDSCAPE ANALYSIS OF NORTHERN GOSHAWK HABITAT IN TWO FOREST REGIONS OF PENNSYLVANIA

KIMMEL, J.T. *Department of Biological Sciences, Eastern Kentucky University, Richmond, KY 40475.* R.H. YAHNER. *School of Forest Resources, The Pennsylvania State University, University Park, PA 16802*

We studied nesting habitat of Northern Goshawks (*Accipiter gentilis*) in Pennsylvania at the landscape level from 1988–92. Our objectives were to 1) contrast habitat "use" (i.e., habitat surrounding goshawk nests) with habitat "availability" (habitat associated with random points), 2) identify differences in habitat use between the Northern Hardwoods (NH) and the Appalachian Oak (AO) forest regions of the state, and 3) evaluate the relative importance of landscape features at varying levels of spatial scale. These levels were represented by six sizes of circular plots centered on nests and random points ranging from 10 ha (i.e., the "nest site" area) to 1960 ha (approximate "home range" area). Color infrared aerial photographs (1:58 000) and 7.5-min topographic maps were used to quantify landscape habitat variables. Univariate analyses indicated that goshawks selected nest sites ($P < 0.05$) on more gentle slopes and further from non-forest edges and medium-heavy duty roads on both forest regions ($N = 46$ and 29 nests and 37 and 38 random points in the NH and AO regions, respectively). At the "home range" level, nests were associated with more extensive forests, greater amounts of evergreen/mixed stands, and less residential land use areas. A slight preference for northerly aspects was observed for nests occurring on steeper slopes in the more southerly AO region. Differences in habitat use between forest regions (independent of habitat availability) indicated that goshawks in the NH region nested at higher topographic positions and in areas containing less conifers proximal to the nest tree. Comparison of results from logistic regression analysis of the different-sized plots suggested that nest site habitat may be more of a limiting factor in the AO region, but that potentially higher quality foraging habitat (represented by extensive forests with mixed/evergreen stands) may be important for goshawks throughout the state. Management recommendations regarding extent of forests and evergreen/mixed stands were derived from logistic regression models and will be presented.

DIFFERENTIAL SPACE USE BY MALE AND FEMALE PRAIRIE FALCONS (*FALCO MEXICANUS*): CONSEQUENCES FOR SAMPLING REQUIREMENTS TO ESTIMATE HOME RANGES

KIMSEY, B.A. AND J.M. MARZLUFF. *Greenfalk Consultants, 8210 Gantz Avenue, Boise, ID 83709*

Determining the minimum sample of location estimates (fixes) adequate to describe an animal's home range is important in developing sampling protocols. In the Snake River Birds of Prey Area, male and female adult prairie falcons have different spatial use patterns and we report that this influences the minimum number of fixes necessary to describe male and female ranges. We sampled 60 radio-tagged adult falcons throughout the 1991 and 1992 breeding seasons and determined that females remained close to the aerie until late brood-rearing and then traveled throughout a wider foraging range, whereas males traveled throughout their entire foraging range during all phases of the breeding cycle. Maximum home range size of females was, therefore, primarily determined by fixes taken during late brood rearing and post-fledgling stages, whereas male maximum home range size was determined earlier in the breeding cycle. Because of this, it is necessary to obtain most of the fixes from late in the breeding cycle in order to adequately sample a female's home range. Males can be sampled throughout the breeding cycle. The total number of fixes should not be the only criterion used to select adequately sampled home ranges; temporal distribution of fixes is also important. In particular, some females with large numbers of fixes originating early in the breeding cycle had poorly sampled home ranges, while others with fewer total fixes but with a majority late in the breeding cycle had adequately sampled home ranges. Many raptors may show similar differences in male and female spatial use patterns and these differences should be taken into account in deciding how to sample an individual's home range.

USE OF SATELLITE TELEMETRY FOR STUDY OF A GYRFALCON IN GREENLAND

KLUGMAN, S.S. AND M.R. FULLER. *U.S. Fish and Wildlife Service, Patuxent Wildlife Research Center, Laurel, MD 20708.* P.W. HOWEY. *Microwave Telemetry, Inc., Suite 120, 8945 Guilford Road, Columbia, MD 21046.* M.A. YATES. *P.O. Box 3480, Carson City, NV 89702.* J.J. OAR. *Box 3165, Howe, ID 83244.* J.M. SEEGAR. *310 Chestnut Avenue, Towson, MD 21204.* W.S. SEEGAR.

Chemical Research Development and Engineering Center, Aberdeen Proving Ground, MD 21010. W.G. MATTOX. *Greenfalk Consultants, Box 29403, Columbus, OH 43229.* T.L. MAECHTLE. *3410 East Columbia, Meridian, ID 83642*

Long-term research in Greenland has yielded 18 years of incidental sightings and 2 years of surveys and observations of gyrfalcons (*Falco rusticolus*) around Sondrestromfjord, Greenland. Gyrfalcons nest on cliffs along fjords and near rivers and lakes throughout our 2590 sq. km study area. Nestlings are present mid-June to July. In 1990, we marked one adult female gyrfalcon with a 65 g radio-transmitter to obtain location estimates via the ARGOS polar orbiting satellite system. The unit transmitted 8 hours/day every two days. We obtained 145 locations during 5 weeks of the nestling and fledgling stage of breeding. We collected 1–9 locations/day, with a mean of 4/day. We calculated home range estimates based on the Minimum Convex Polygon (MCP) and Harmonic Mean (HM methods and tested subsets of the data based on location quality and number of transmission hours per day. Home range estimated by MCP using higher quality locations was approximately 589 sq. km. Home range estimates were larger when lower-quality locations were included in the estimates. Estimates based on data collected for 4 hours/day were similar to those for 8 hours/day. In the future, it might be possible to extend battery life of the transmitters by reducing the number of transmission hours/day. A longer-lived transmitter could provide information on movements and home ranges throughout the year.

USE OF SATELLITE TELEMETRY IN MONITORING BALD EAGLE MOVEMENTS

KRALOVEC, M.L. *Glacier Bay National Park and Preserve, Gustavus, AK 99826.* M.R. FULLER. *Department of the Interior, Bureau of Land Management, Washington, DC 20240.* P.F. SCHEMPF. *Department of the Interior, U.S. Fish and Wildlife Service, Juneau, AK 99802.* M.R. VAUGHAN. *U.S. Fish and Wildlife Service, Virginia Cooperative Fish and Wildlife Research Unit, Virginia Polytechnic Institute and State University, Blacksburg, VA 24060*

Collecting data on broad-scale movements through the use of conventional radiotelemetry can be limited by inaccessible terrain, large daily movements of the marked animal, and environmental factors. However, a bird-borne satellite transmitter can circumvent these problems by allowing the researcher to reliably obtain frequent locations from a distant position. As part of a research study on bald eagle movements in Glacier Bay National Park and Preserve, we attempted to demonstrate the practical application of a bird-borne satellite transmitter in a field situation. In late summer 1991, three adult bald eagles and three nestling eagles (9–10 weeks) were fitted with satellite transmitters. To verify satellite locations, each adult was also fitted with a VHF transmitter and locations were confirmed using ground and aerial searches. All three immature eagles left the natal territory within 3–6 weeks after fledging. Each immature initially moved northeast and then traveled in a southeasterly direction where they were last located 384.4, 109.2, and 17.4 km southeast of their natal territories. Two of the three satellite marked adults traveled 95 km northeast to the Chilkat River for 6 weeks and then returned to their nest territories by 27 January 1992. The third adult remained within its nest territory. While in the study area, all three adult eagles were visually located (3–4 days/week) within a 5 km radius of each satellite location point. Satellite transmitters provided 4–5 locations per day for 229 days. As confirmed by conventional telemetry, the PTTs were effective in monitoring the broad-scale movements of these adult eagles.

OWLS OF OLD FORESTS OF THE WORLD

MARCOT, B.G. *USDA Forest Service, PNW Research Station, Spotted Owl RD&A Program, 333 SW First Ave., P.O. Box 3890, Portland, OR 97208*

A review of literature on habitat associations of owls of the world revealed that approximately 84 species of owls among 18 genera are known or suspected to be associated with old forests. Old forest is defined as old-growth or undisturbed forests, typically with dense canopies. The 84 owl species include 72 tropical and 12 temperate forms Specific habitat associations have been studied for only 12 species (7 tropical and 5 temperate), whereas 73 species (65 tropical and 8 temperate) remain mostly unstudied. Some 25 species (35% of all known or suspected old-forest-associated owls in the tropics) are entirely or mostly restricted to tropical islands. Threats to old-forest-associated owls include alteration of habitat, use of pesticides, loss of riparian gallery forests, and loss of cavity nests. Conservation of old-forest-associated owls should include 1) inventories and studies of habitat associations, particularly in poorly studied tropical and insular environments; 2) protection of specific, existing temperate, and tropical old forest tracts; and 3) studies to determine if reforestation and vegetation manipulation can restore or maintain habitat conditions.

BARN OWL REPRODUCTION AND ITS CONSTRAINTS NEAR THE LIMIT OF THE SPECIES' DISTRIBUTION

MARTI, C.D. *Department of Zoology, Weber State University, Ogden, UT 84408-2505*

I studied reproduction of the barn owl (*Tyto alba*) in irrigated farmlands of northern Utah over 16 years. Three hundred and ninety-one nesting attempts, all in man-made structures, were documented. Most barn owls began nesting at one year of age and produced one brood per year. Rarely, second broods were produced or failed first clutches were replaced. Average size of complete first clutches

(N = 275) was 7.17 eggs. Replacement (5.81, N = 16) and second clutches (5.80, N = 19) were significantly smaller than first clutches. Eighty-eight percent of all nesting attempts produced full clutches and 71% yielded at least one fledgling. Mean sizes of first (5.45) and second broods (5.37) were not significantly different but replacement broods (3.83) were significantly smaller. On average, 5.09 young fledged per first brood, 4.94 per second brood, and 3.60 per replacement brood. Second attempts were more likely to produce fledglings than either first or replacement attempts. Sixty-three percent of all eggs laid hatched and 55% produced fledglings. Of eggs that hatched, 88% survived to fledging. March 13 was the mean date for initiation of egg laying and latest second clutches hatched on October 4. Persistent snow cover and low winter temperatures significantly delayed onset of egg laying and reduced the number and success of breeding attempts annually. Clutch size, however, did not differ significantly among years or among nest sites. Most barn owls bred only once, but if both individuals of a pair survived into subsequent breeding seasons, pairs typically remained intact. Most mortality occurred in winter due to a combination of exposure and starvation.

POST-FLEDGING MORTALITY: A SURVIVAL BOTTLENECK FOR PRAIRIE FALCONS?

MCFADZEN, M. *Department of Biology, Utah State University, Logan, UT 84322.* J.M. MARZLUFF. *Greenfalk Consultants, 8210 Gantz Avenue, Boise, ID 83709*

We studied the cause and frequency of mortality on prairie falcons (*Falco mexicanus*) during the 1992 post-fledging period in Idaho's Snake River Birds of Prey Area. We instrumented 78 nestlings from 19 broods with 6-g tarsal-mount transmitters and monitored their survival until they dispersed from the natal territory. Overall, 28% (N = 22) of fledged falcons died before dispersal (mean mortality age = 41 d, range = 32.5–60.5 d). Predation by great horned owls (*Bubo virginianus*) and golden eagles (*Aquila chrysaetos*) accounted for 36.3% of the mortality and ectoparasite infestations were implicated in 18.2% of the mortality. We could not determine the causes of 45.5 percent of all mortality because carcasses were scavenged and/or decomposed. Parental attendance (% time spent in the territory) and prey delivery rates (prey items/hr) during late brood rearing (N = 11 broods) were not correlated with post-fledging mortality. There was a trend (P = 0.054) for broods that hatched later in the season to experience higher mortality than earlier hatched broods. Survivorship was not correlated with nestling weight or brood size. Post-fledging mortality is relatively high and appears to occur randomly.

STATUS OF WINTERING BALD EAGLES IN WASHINGTON WITH EMPHASIS ON THE NORTH CASCADE DRAINAGES (1982–90)

MCSHANE, M.C., AND D.A. DELLASALA. *EBASCO Environmental, 10900 NE 8th Street, Bellevue, WA 98004-4405.* R. TAYLOR. *Washington Department of Wildlife, 600 Capitol Way North, Olympia, WA 98501-1091*

The number of bald eagles nesting in Washington has recently met or exceeded the goals outlined in the Recovery Plan for most of the management zones in the state. As a result, the U.S. Fish and Wildlife Service is currently considering removing the bald eagle in Washington from the federal list of threatened species. Although the number of successful nesting pairs and productivity are probably the best way to determine the status of the bald eagle population in a given state, the ability to sustain wintering eagles has implications for breeding populations that occur well beyond state boundaries. Consequently, the objective of this paper is to summarize the status of wintering bald eagles in Washington from 1982, when the mid-winter counts were standardized, to the present (1990). Trends in peak counts for this period were evaluated for the entire state, different regions, and individual drainages or areas of high concentration. A preliminary analysis indicated that the peak winter bald eagle counts from the Skagit River represented 23% of the state total in 1989. Particular emphasis was, therefore, placed on assessing the contribution of each of four major drainages in the North Cascades (Nooksack, Skagit, Stillaguamish, and Skykomish rivers) to the overall state totals. Peak winter counts of bald eagles in the Skagit River Bald Eagle Natural Area were found to be significantly correlated to chum salmon escapement for the Skagit drainage, and a similar analysis was applied to the other drainages. Results can be applied to the management of core bald eagle wintering areas and primary prey concentrations in the state.

THE ELUSIVE CARACARA: PRELIMINARY INFORMATION FROM SOUTH CENTRAL FLORIDA

MORRISON, J.L. *Department of Wildlife and Range Sciences, 118 Newins-Ziegler, University of Florida, Gainesville, FL 32611*

Investigations were conducted on the feasibility of studying the Crested Caracara (*Polyborus plancus*) in Florida, which occurs as an isolated population and which presently is listed as threatened at both the state and federal levels. Currently, the major threat to the caracara's persistence in Florida appears to be habitat loss through conversion to citrus groves, development, and other agricultural uses. This study was initiated partly as an evaluation of the value of cattle ranches, which cover extensive areas in southcentral Florida, to native wildlife. As grassland habitats, these ranches may be some of the few remaining areas that provide suitable habitat for caracaras. Recently, a successful trapping technique has been developed, resulting in the capture and marking of several individual birds, in anticipation of further long-term studies. Data

obtained from banded and radio-tagged individuals provided preliminary information on activity patterns, foraging behavior, and interactions with other avian scavengers.

HABITAT VARIATION AND POPULATION REGULATION IN THE EUROPEAN SPARROWHAWK *ACCIPITER NISUS*

NEWTON, I. *Institute of Terrestrial Ecology, Monks Wood Experimental Station, Abbots Ripton, Huntingdon, PE17 2LS, Cambs., UK*

This paper will relate territory occupancy and breeding success in *Accipiter nisus* to the age and structure of the forest. Both measures of performance were best in young forest (20–30 years) and deteriorated as the forest aged. In forests older than 40 years, reproduction was insufficient to offset mortality. Population persistence was thus dependent on the continued presence of young forest.

HOME RANGE DISTRIBUTION AND HABITAT USAGE OF RED-TAILED HAWKS AND RED-SHOULDERED HAWKS DURING DORMANT SPRAY SEASON IN THE CENTRAL VALLEY

OTTUM, N.D., D.M. FRY, B.W. WILSON AND J.T. YAMAMOTO. *Department of Avian Sciences, University of California, Davis, CA 95616*. J.N. SEIBER AND M.M. MCCHESNEY. *Department of Environmental Toxicology, University of California, Davis, CA 95616*

Habitat usage and distribution of wintering hawks in a 52 sq. mi. area in the central valley of California were analyzed to look at pesticide exposure during the winter dormant spray season. Thirty-six Red-tailed hawks (*Buteo jamaicensis*) and four Red-shouldered hawks (*B. lineatus*) were trapped and equipped with backpack-style radio transmitters during December and January, 1990–92 near Modesto. Tagged birds were randomly located on a daily basis for daytime habitat use information and periodically located by triangulation at night to determine roost sites. The GIS program CAMRIS was used to calculate home ranges by the density surface method and grid size selection was based upon hunting behavior of the birds. Home range analysis indicated a preference of some birds to use orchards exclusively while others preferred open habitat. Of the 28 birds establishing winter ranges, 12 remained as residents. Data suggest that selection of habitat was influenced by the numbers of resident birds, orchard irrigation techniques, orchard age, and degree of human disturbance. Five radio-tagged birds are known dead: three of the deaths were due to electrocution, gunshot, and automobile collision; one band was returned from northeastern Oregon with cause of death unknown; and the last bird was decomposed too badly for diagnosis. Supported by the Almond Board of California.

DIETARY AND ENERGETIC ANALYSIS OF BAT FALCON PAIRS DURING THE BREEDING SEASON IN TIKAL, GUATEMALA

PARKER, M. *RRTAC, Department of Biology, 1910 University Drive, Boise State University, Boise, ID 83725*

Four pairs of bat falcons, *Falco rufigularis*, were observed in lowland primary rain forest in northern Guatemala's Tikal National Park during 1991. Day-long observations at all nests and daily prey remains and pellet collection at one nest revealed differences in prey species, foraging habits, and rates across the breeding season. Differences in habitat were reflected in dietary differences between nesting pairs. Seasonal precipitation offered pulses of ephemeral insect prey, which accounted for a substantial percentage of their diets, nearly exclusively during stages of brooding. Novel foraging behavior was observed and energetic costs were estimated for one pair, whose foraging flights could be observed in near entirety.

USE OF GOSHAWK STICK NESTS BY GREAT GRAY OWLS ON THE TARGHEE NATIONAL FOREST

PATLA, S.M. *Department of Biological Sciences, P.O. Box 8007, Idaho State University, Pocatello, ID 83422*

Between 1990 and 1992, over 30 new Great Grey Owl breeding territories have been documented on the Targhee National Forest in southeastern Idaho. The majority of these territories have been found in conjunction with an ongoing goshawk monitoring project and occur in Douglas-fir and mixed conifer habitat. Of 64 identified goshawk nests, 14 (22%) have been used by nesting owls. Nine of these 14 nests (64%) have been used following some level of timber harvest activity in the surrounding area. This paper will compare nest site characteristics between stick nests used by goshawks with those used by both hawks and owls. Potential effects of timber harvesting on nest site availability for both species will be discussed.

PEREGRINE FALCON RESTORATION IN THE MIDWEST: 1992 STATUS REPORT

REDIG, P.T. AND H.B. TORDOFF. *The Raptor Center and Bell Museum of Natural History, University of Minnesota, 1920 Fitch Avenue, St. Paul, MN 55108*

1992 marked the tenth year of releases of captively propagated peregrine falcons into the midwestern section of the United States. A total of 111 falcons were released at six sites, bringing the total number released over ten years to 773. States or provinces included in this assessment are Minnesota, Wisconsin, Iowa, Michigan, Illinois, Indiana, Ohio, Missouri, Nebraska, and Manitoba (Canada). Occupancy and productivity at sites occupied by returning adults were consistent with earlier projections based on population modeling. A total of 26 sites was occupied and a total of 65 young was fledged. Among this total were 13

eyases that were fostered into wild nests from domestic sources of falcons. The combined fledging success was 2.6 y/attempt and 2.96 y/successful pair. Adult survivorship, nest-site and mate fidelity, and genetic relationships were monitored by positive determination of identities of adults and DNA fingerprinting. Plans for release by hacking at several sites were preempted by territorial juvenile or adult pairs. Given the productivity and stability of this restored population, it is likely that hacking of falcons will occur at a greatly diminished level in 1993 and cease altogether thereafter.

MANAGEMENT RECOMMENDATIONS FOR THE NORTHERN GOSHAWK IN THE SOUTHWESTERN UNITED STATES

REYNOLDS, R. *Rocky Mountain Forest and Range Exp. Station, 240 West Prospect, Fort Collins, CO 80526*. R.T. GRAHAM. *1221 South Main, Moscow, ID 83843*. M.H. REISER. *Heber Ranger District, P.O. Box 968, Overgaard, AZ 85933-0968*. R.L. BASSETT. *USDA Forest Service, 517 Gold Avenue SW, Albuquerque, NM 87102*. P.L. KENNEDY. *Department of Fishery and Wildlife, Colorado State University, 241 Wagar Hall, Fort Collins, CO 80523*. D.A. BOYCE, JR. *USFS Wildlife and Fisheries, 517 Gold Avenue SW, Albuquerque, NM 87102*. G. GOODWIN. *Coconino National Forest, 2323 E. Greenlaw Lane, Flagstaff, AZ 86004*. R. SMITH. *Coronado National Forest, Federal Building, 300 West Congress, Tucson, AZ 85701*. E.L. FISHER. *USFS Wildlife and Fisheries, 517 Gold Avenue SW, Albuquerque, NM 87102*

Recommendations for managing goshawk habitat in three forest cover types (ponderosa pine, mixed conifer, and spruce-fir) are described in detail. The recommendations were developed based upon the known habitat requirements of goshawks and 14 important prey species. Although the management strategy is focused on forests in the southwestern United States, these multi-species management recommendations have the related benefit of being applied across the western landscape, not just within goshawk territories. A strength of the management approach is the recommended return to pre-settlement-like forest conditions. This entails a gentler management approach that retains large areas of mid-aged (80–120 years) to old forests (200+ years) across the landscape.

DISTRIBUTION AND HABITAT CHARACTERISTICS OF MEXICAN SPOTTED OWLS IN ZION NATIONAL PARK, UTAH

RINKEVICH, S.E. *USDA Forest Service, Dixie National Forest, 82 N. 100 E., P.O. Box 580, Cedar City, UT 84721*

Distribution, habitat characteristics, and food habits of the Mexican spotted owl (*Strix occidentalis lucida*) were investigated in Zion National Park. Two hundred and twenty-nine surveys were conducted in canyon and plateau habitat between May–August 1989 and April–August 1990. I located owls in nine different locations; each owl was associated with narrow canyons, "hanging" canyons, and cliff sites. The minimum estimated density in Zion National Park was 0.02 owls/km^2 in 1989 and 0.03/km^2 in 1990. Spotted owls were widely distributed and coincident with discontinuous habitat within the park. I used stepwise discriminant analysis to examine the habitat differences between 1) observed owl microsites and available microsites and 2) observed owl canyon habitat and available canyon habitat. Spotted owl microsites had higher humidity, more vegetation strata, narrower canyon widths, and higher percentage of ground litter than available microsites. Habitat within owl use canyons had higher humidity and higher total snag basal area than available canyon habitats. Owls may be selecting canyon habitat not only for the structural habitat features but also for the microclimate. The presence of canyons and cliffs may provide necessary refuges from high daytime temperatures that occurred in the study area. Mexican spotted owls do not appear to depend on extensive stands of old-growth forests as do northern spotted owls (*S. occidentalis caurina*) because this type of habitat is lacking in Zion Park. Seventy-one prey items were identified from 60 pellets collected from two owl territories. Mammals comprised 99.9% of estimated biomass and 80.3% of the total diet composition. Bushy-tailed woodrats (*Neotoma cinerea*) were the primary prey taken by owls. They comprised 67.3% of the estimated biomass and 40.3% by frequency of the diet. Further studies are needed to investigate the habitat requirements of the spotted owl in the northern region of its range.

RESPONSE OF GREAT HORNED OWLS TO MANIPULATIONS OF PREY DENSITIES IN THE BOREAL FOREST

ROHNER, C. *Department of Zoology, University of British Columbia, 6270 University Boulevard, Vancouver, B.C., Canada V6T 1Z4 and Kluane Lake Research Base, Mile 1054 Alaska Highway, Yukon, Canada Y1A 3V4*

Foraging theory and models of territoriality predict that an animal will travel less when food is abundant and that its home range size will decrease. This concept is often applied to interpret movement and home range data in wildlife biology, although little experimental evidence exists for larger animals. A collaborative project near Kluane Lake in the southwestern Yukon was designed to investigate the interactions of animal populations of different tropic levels in the boreal forest ecosystem. Experimental food additions to snowshoe hares and ground squirrels resulted in up to 20 times higher densities on areas of 0.5–1 km^2. Two owls on territories with increased prey levels were chosen as experimental birds and radiotelemetry was used to compare them to 4 controls. Despite the extreme contrast in prey base, no differences in movement rates and home range sizes were apparent. This suggests caution for the general use of these measures as standard management tools. Can the sampling be refined, or does the concept not apply to our organisms? This question is open at the moment. One explanation is that the predictions from theory have been derived for an animal that searches randomly through homogeneous habitat. Great horned owls

as typical perch hunters seem to be using a network of distinct hunting spots, rather than diffuse searching. The response would, therefore, not be strictly area dependent, but dependent on the specific location of these "hot spots" in the territory—a model that may also apply to other perch-hunting owls and raptors. A link to another result is interesting: during the course of a snowshoe hare cycle, the size of long-term territories was determined by intruder pressure, and not by food. Great horned owls, as a long-lived species, may try to maintain as large territories as possible in every situation.

RELATIONSHIPS OF MICROCLIMATE AND MICROHABITAT TO AMERICAN KESTREL NEST-BOX USE AND NESTING SUCCESS

ROHRBAUGH, JR., R.W. AND R.H. YAHNER. *School of Forest Resources, The Pennsylvania State University, University Park, PA 16802*

American kestrels (*Falco sparverius*) use nest-boxes in a non-random fashion and experience differential nesting success among boxes. Non-random use and differential success are presumably caused by environmental factors external to the box itself. Our objective was to determine if microclimatic and microhabitat characteristics associated with nest-boxes influenced nest-box use and nesting success. This research is important in determining how environmental factors influence the use patterns and nesting success of avian species using artificial nest sites. We measured internal reflected light intensity (IRLI), internal mean temperature (IMTE), percent nest-box concealment (NBCO), and nest-box orientation (NBOR) associated with 130 nest-boxes in southeastern Pennsylvania during 1991. We then compared these microclimatic and microhabitat characteristics to nest-box use patterns and nesting success observed during a five-year period (1987–91). The means (±SE) for IRLI, IMTE, NBCO, and NBOR were 5.9 ma (0.17), 21.7°C (0.28), 37% (3.00), and 157° (10.40), respectively. We used analyses-of-variance (ANOVA) and chi-square tests-of-independence to test for differences in microclimatic and microhabitat characteristics among levels of nest-box use and nesting success. We found nest-box use to be significantly influenced ($P \leq 0.05$) by IRLI, NBCO, and NBOR, whereas nesting success was influenced by IRLI alone. IRLI increased with increasing frequency of nest-box use ($F = 4.11$, $P = 0.02$), while NBCO decreased with increasing frequency of box use ($F = 3.02$, $P = 0.05$). Thirty-eight percent of the frequently used nest-boxes (boxes used ≥3 of 5 years) were oriented southeast ($\chi^2 = 14.64$, df = 6, $P \leq 0.025$). Nesting success increased with increasing IRLI ($F = 3.15$, $P = 0.04$). IMTE was not significantly different among levels of nest-box use or nesting success. These results will be used to develop a habitat model for the placement of nest-boxes in optimal habitat for American kestrels.

EYE COLOR OF COOPER'S HAWKS BREEDING IN WISCONSIN

ROSENFIELD, R.N. *Department of Biology, University of Wisconsin, Stevens Point, WI 54481.* J. BIELEFELDT. *Park Planning, Racine County Public Works, Sturtevant, WI 53177.* K.R. NOLTE. *Caesar Kleberg Wildlife Research Institute, Campus Box 218, Texas A&I University, Kingsville, TX 78363*

Though several authors have noted the progressive changes in eye color with age in North American accipiters, no studies have published such detailed information on eye color for a breeding population of marked birds. We use eye color recorded during 377 captures of 253 different breeding adult Cooper's Hawks (*Accipiter cooperii*) in Wisconsin over 13 years to examine the relationships of eye color with age, gender, and male fitness. In both sexes, eye color showed a progressive change from lighter yellow in younger hawks to dark orange or red in older birds. Males had darker eyes than females of the corresponding age. We found no support for the hypothesis that male fitness is associated with male eye color. We also discuss how our data on eye color are useful for elucidating aspects of the population ecology (including nest-site tenacity) of breeding Cooper's Hawks.

HOW ARE DECISIONS ABOUT THE INFLUENCE OF HUMAN ACTIVITIES ON RAPTORS INFLUENCED BY ABIOTIC FACTORS?

SCHUECK, L. AND J.M. MARZLUFF. *Greenfalk Consultants, 8210 Gantz Ave., Boise, ID 83709*

Observer motivation, visibility, and animal activity are influenced by abiotic factors such as extreme temperatures, wind, and precipitation. Therefore, counts of abundance and quantification of behavior are likely to be dependent upon prevailing abiotic factors. Failure to account for these factors in assessments of human impact can result in misleading conclusions about the severity of impact and produce dubious management recommendations. We illustrate this problem with examples from our ongoing study of the potential impacts of military training on raptor behavior in the Snake River Birds of Prey Area. We counted raptors utilizing training ranges during periods of firing and during periods without firing. Climatic conditions were measured with portable "Weather Wizard" stations and found to correlate significantly with raptor abundance. Climate varied within and between observation sessions and therefore influenced our counts of raptors to an unknown degree. We statistically controlled for weather-related bias in our analyses by using weather variables as covariates in our comparisons of raptor abundance on firing and non-firing days. These analyses allowed us to conclude that intensive military training reduced the number of raptors in the immediate training area in 3 of 4 tests. Failure to control for variation in climate reversed our conclusions in 2 of 4 tests; one significant result con-

trolling for weather was not significant when weather was not controlled and one nonsignificant result became significant. Reversal of significance was less likely in large samples pooling data from more than one year. We conclude that abiotic conditions suspected to influence observers or subjects must be identified, measured, and controlled during impact studies to prevent incorrect assessment of disturbance.

PEREGRINE POPULATION DYNAMICS IN WEST-CENTRAL GREENLAND

SEEGAR, W.S. *Chemical Research, Development and Engineering Center, Aberdeen, MD 21010.* W.R. GOULD. *Department of Statistics, North Carolina State University, Raleigh, NC 27695.* M.R. FULLER. *U.S. Fish and Wildlife Service, Patuxent Wildlife Research Center, Laurel, MD 20708.* W.G. MATTOX. *Greenland Peregrine Falcon Survey, 307 Blandford Avenue, Worthington, OH 43085.* M.A. YATES, T.L. MAECHTLE, J. OAR AND M. ROBERTSON. *Virginia Polytechnic Institute and State University, Blacksburg, VA 24061*

Peregrine falcons around Sondrestrom Fjord were studied to document their population dynamics during recovery efforts for this endangered species. Capture probabilities, survival estimates, and population estimates were obtained from color-banded adult females. Program JOLLY provided the basis for analyses and model D was selected to generate the estimates. From 1983 to 1991, our capture probability was 97.8% and the annual survival was 78.0%. The assumptions associated with these models are discussed in light of the fieldwork, birds' biology, and interpretation of results. Yearly population estimates were standardized based on sampling effort. A significant increase in the population occurred during the 9-year study.

MANAGEMENT OF THE THREATENED SOUTHEASTERN AMERICAN KESTREL IN FLORIDA: POPULATION RESPONSES TO A REGIONAL NEST-BOX PROGRAM

SMALLWOOD, J.A. *Department of Wildlife and Range Sciences, University of Florida, Gainesville, FL 32611.* M.W. COLLOPY. *U.S. Bureau of Land Management, 3200 SW Jefferson Way, Corvallis, OR 97331*

The resident population of Southeastern American Kestrels (*Falco sparverius paulus*) declined by over 80% in northcentral Florida during recent decades. Similar declines occurred throughout the state and this subspecies currently is listed as threatened in Florida. A statewide decrease in the availability of suitable cavity trees, isolated or scattered pine snags in open habitats, was closely correlated with the decline in the number of breeding pairs. The objectives of this study were 1) to evaluate the effect that increasing the availability of nesting sites has on kestrel population densities in northcentral Florida, and 2) to develop a strategy for selecting specific nest-box locations. In order to monitor population densities, kestrels were censused each August, 1989 to 1992, along 20 16-km roadside transects in northcentral Florida. In 1989, prior to erecting nest-boxes, population densities ranged from 0 to 0.83 kestrels/km^2. A total of 336 nest-boxes subsequently was erected within 10 km of 10 transects with low kestrel densities; the 10 transects with the highest initial densities served as controls. Census data from 1989 through 1992 revealed that mean densities along the control transects did not change significantly with time, while mean densities along experimental transects increased geometrically; three of the four highest densities observed in 1992 occurred along experimental transects. Recommendations for selecting nest-box locations were developed by quantifying the habitat surrounding active nest-boxes (those in which kestrels bred) and nearby inactive nest-boxes, and examining the association of kestrel occupancy rates and breeding success with vegetative structure and land use patterns.

THE EFFECT OF PREY AND WEATHER ON GOLDEN EAGLE REPRODUCTIVE RATES

STEENHOF, K. AND M.N. KOCHERT. *RRTAC, Bureau of Land Management, Boise, ID 83705*

We studied golden eagle (*Aquila chrysaetos*) populations nesting in the Snake River Canyon from 1971 through 1991, and analyzed eagle reproduction in relation to black-tailed jackrabbit (*Lepus californicus*) populations and several weather variables. The best predictor of eagle productivity was jackrabbit abundance prior to the breeding season. Winter weather (as expressed by heating degree days during December and January) was associated with eagle productivity primarily when jackrabbit populations were low; cold winter temperatures were associated with reduced numbers of eagle pairs that laid eggs. Hatching dates were inversely related to jackrabbit density, but were not associated with winter weather variables, even in low jackrabbit years. Extreme heat during brood-rearing was associated negatively with eagle nesting success in years with low jackrabbit populations.

THE USE OF MAN-MADE STRUCTURES FOR RED-TAILED HAWK NEST SUBSTRATES IN SOUTHEAST WISCONSIN

STOUT, W.E. AND R.K. ANDERSON. *University of Wisconsin–Stevens Point, Stevens Point, WI 54481.* J.M. PAPP. *Rt. 1, Box 158A, Drummond, WI 54832*

Raptors commonly nest on powerline towers in the western United States. This phenomenon usually occurs on open plains, prairie, or savannah, and is attributed to the absence of suitable nest sites. In the eastern U.S. and Canada, Osprey are the only raptor that commonly nest on powerline towers. In southeast Wisconsin, Red-tailed Hawks almost exclusively nest in deciduous trees. There is only one report of two successful Red-tailed Hawk nests on

power poles in the eastern U.S. in Polk County, Florida. A nest is successful if it fledges at least one young. We documented five successful Red-tailed Hawk nests on man-made structures (four 230-kV transmission towers and one billboard) in southeast Wisconsin in 1992. Three were successful in 1991 and two in 1990. Nests and structures were higher and closure at the nest was more open than traditional sites in the region. No overstory trees were present in a 0.04-ha circular plot centered on the nest site. Nesting Red-tailed Hawk populations in the Midwest increased over the last four decades. In 1992, sixteen redtail pairs nested in urban habitat in the metropolitan Milwaukee area of southeast Wisconsin. For this study, a nest site is considered urban if 70% or more of the land within a 1.5 km radius of the nest is being used for industrial or residential purposes. The relationship between increased Red-tailed Hawk populations and changes in land-use patterns needs to be studied and could be beneficial for the development of new raptor management techniques in urban areas. Nesting on man-made structures may compensate for, and be in response to, decreased natural nesting habitat and changes in land-use patterns such as increased urbanization and monotypic agricultural practices.

RELATIVE ABUNDANCE AND NEST SITE SELECTION OF RED-SHOULDERED HAWKS (*BUTEO LINEATUS*) NESTING WITHIN FLOODPLAIN FORESTS IN POOLS 9–11 AND 16–19 OF THE UPPER MISSISSIPPI RIVER VALLEY

STRAVERS, J.W. *Iowa Raptor Foundation, P.O. Box 32, Pella, IA 50219*. D.M. ROOSA. *Iowa Department of Natural Resources, Wallace State Office Building, Des Moines, IA 50309*

During the spring of 1992, we searched 101 areas within the Upper Mississippi River Valley for evidence of nesting Red-shouldered Hawks (RSH), which are considered endangered, threatened, or of special concern in most midwestern states. We documented or suspected RSH nesting in 27 of the 62 areas searched in Pools 9–11 (McGregor District). This district has had a comprehensive forest and wetland management plan which limited timber harvest and the construction of artificial levees since the late 1930s. In contrast, we documented or suspected RSH nesting in only five of the 42 areas searched in Pools 16–19 (Wapello District). This district has not had a comprehensive forest management plan and it has a series of elaborate levee systems restricting the river. At the active RSH nest sites we measured the distance to nearest stream, main channel of the Mississippi River, ridge, road, railroad track, human dwelling, agricultural field, levee, and logging activity. We compared RSH nest sites to random sites selected within the river valley. All RSH nesting sites were located in forest tracts where the overhead canopy was well-developed, in areas that had no logging activity for 45–55 years. All nest sites were within 200 m of a temporary pool, small stream, or the confluence of two streams. In contrast, no RSH nesting sites were found within 800 m of the main channel of the Mississippi River, nor were any found in apparently suitable forest habitats which were bordered by levees and agricultural fields.

THE U.S. FISH AND WILDLIFE SERVICE'S STATUS REVIEW OF ARCTIC PEREGRINE FALCONS

SWEM, T. AND S. AMBROSE. *U.S. Fish and Wildlife Service, 1412 Airport Way, Fairbanks, AK 99701*

Arctic peregrine falcon (*Falco peregrinus tundrius*) populations have expanded since the 1970s following restrictions on the use of organochlorines. In 1984, in response to the recovery, the U.S. Fish and Wildlife Service downlisted the status of arctic peregrines from Endangered to Threatened. Later surveys and field research have shown that the recovery has continued. In 1991, the U.S. Fish and Wildlife Service initiated a review of the status of the arctic peregrine falcons throughout North America in order to determine if delisting the subspecies is appropriate. This involved accumulating all the available data on population trends, containments, and migration counts. The purpose of this paper is to provide a brief, continent-wide, overview of the information that has been collected, and to update the RRF on the Fish and Wildlife Service's current management strategy for this subspecies.

THE USE OF SONOGRAPHIC ANALYSIS IN IDENTIFYING INDIVIDUAL PEREGRINE FALCONS (*FALCO PEREGRINUS*)

TELFORD, E.A. *8300 Gantz Ave., Boise, ID 83709*

Recordings of nesting Peregrine Falcons in the northeastern United States were made in 1989, 1990, and 1991. The "cack" call was recorded because it is a defense call and is therefore easily elicited. Sonograms were generated from the recordings and analyzed for vocal distinctions among individuals. Three frequency and three temporal variables were measured from the sonograms, and two slope variables were derived. Discriminant function analysis on a sample of 406 calls from 17 individuals was able to successfully discriminate among individuals. Multivariate analysis of variance comparing the overall variation of calls among birds to the variation within birds was highly significant ($P < 0.001$).

USE OF RAPTORS FOR BUILDING LOCAL CAPACITY FOR CONSERVATION IN LATIN AMERICA

THORSTROM, R. AND D. WHITACRE. *The Peregrine Fund, Inc., 5666 West Flying Hawk Lane, Boise, ID 83709*

In 1987, The Peregrine Fund initiated a preliminary trip to Guatemala and Belize to select research locations for the *Maya Project*—a multi-year, community-level project focusing on raptors to achieve conservation of biological diversity and development of local capacity for conservation. Training and education are critical components in

building local capacity and infrastructure in Latin America countries to manage and conserve natural resources. The Maya Project began in 1988 at Tikal National Park in northeastern Guatemala and has expanded each year to date. The project consists of research on natural history of selected raptor species, and a program of monitoring biological diversity of the forest using raptors and other fauna as ecological indicators. Species-level studies involve collecting behavioral, dietary, and telemetry data on raptors. Participants gain much experience in these techniques and receive formal training in ecology and conservation topics. In 1988 the project involved eight local park guards who assisted in the development of raptor and habitat survey techniques. In 1989, one park employee, Julio Madrid, presented a paper at the RRF/ICBP meetings in Veracruz, Mexico. The Maya Project has provided several park guards with scholarships allowing them to finish high school degrees. In 1991, species-level projects were increased; project personnel reached 39 in the park plus 25 outside the park. Julio Madrid of CECON (Centro de Estudios Conservacionistas de la Universidad de San Carlos de Guatemala) became the principal investigator on the Ornate Hawk-Eagle study. In 1991, the Maya Project facilitated participation of two local park guards and one CECON employee in the NOC (Neotropical Ornithological Congress) in Quito, Ecuador, where they presented papers on Swallow-tailed Kites, Mottled Owls, and Ornate Hawk-Eagles. In 1992, several Guatemalans became project leaders for species-level studies on Ornate Hawk-Eagles, Black Hawk-Eagles, Swallow-tailed and Plumbeous Kites, Laughing Falcons, Bicolored Hawks, Collared Forest-Falcons, Barred Forest-Falcons, Mottled Owls, and year-round censuses of raptors as well as heading teams investigating migrant and resident songbirds and vegetation. Hopefully, the training and experience in ecology, scientific research, and conservation that these local people have received will enable them to acquire jobs with the newly developing governmental and non-governmental conservation organizations in the Tikal region, where their knowledge and experience can help create a legacy of enlightened conservation efforts.

BREEDING BIOLOGY, FOOD HABITS AND HOME RANGE OF THE BARRED FOREST-FALCON (*MICRASTUR RUFICOLLIS*) IN GUATEMALA

THORSTROM, R. *The Peregrine Fund, Inc., 5666 West Flying Hawk Lane, Boise ID 83709*. C. MATEO MORALES. *Institute de Antropologia and Historia, Tikal National Park, Petén, Guatemala, C.A.*

We described the first four nests of the Barred Forest-Falcon (*Micrastur ruficollis guerilla*) in 1988 at Tikal National Park, Guatemala. We studied the breeding biology of the Barred Forest-Falcon from 1989 through 1991. Thirty-two nesting attempts were observed from 1988 through 1991. Barred Forest-Falcons are year-round residents and initiated breeding from April to early June, during the dry season. Seventy-two eggs were laid in 26 nests; average clutch size was 2.7 eggs. The incubation period was 35 days from laying of second egg to first hatch (N = 6 nests). Overall, 45% of the eggs hatched and 84% of the young fledged. A total of 1.1 young fledged per breeding attempt. Of 28 fully documented nesting attempts, 13 (46%) produced fledged young; 50% of the first nesting attempts (N = 26) produced young, and none of the second attempts was successful (N = 2). Most reproductive losses in 15 failed nests resulted from egg and female predation (N = 13). Survivability of adult breeding females was less than that for adult breeding males. Food habits were based on 587 prey deliveries during the breeding seasons. On a numerical basis, lizards made up 41% (N = 240) and birds 14% (N = 82) of the diet. Biomass estimates showed lizards (33.6%) and birds (33.1%) to be the most important prey items delivered. The 85% harmonic-mean home range estimates average 1.1 km^2 for 11 breeding males. In a 16 km^2 area centered around the main archeological ruins we located 12 breeding pairs and two non-breeding pairs. We learned from radiotelemetry that this species prefers high-ground forest for breeding and foraging; their abundance is much lower in low, open-canopy forest occurring in low-lying parts of the study area. This species has a broad geographical range, lives at high densities, at least in Tikal, occupies a small home range and utilizes mature and old-growth trees for nesting. This species may well be suited as an ecological indicator for lowland dry tropical forests or possibly other types of tropical forests.

AN INVESTIGATION OF THE GENERAL HEALTH AND CONTAMINANT LEVELS OF MIGRANT SHARP-SHINNED HAWKS IN THE EASTERN FLYWAY

VIVERETTE, C. AND L. GOODRICH. *Hawk Mountain Sanctuary, RR 2, Box 191, Kempton, PA 19529-9449*. M. POKRAS. *Tufts University School of Veterinary Medicine, 200 Westboro Road, North Grafton, MA 01536*

Hawk count stations in the northeastern United States have noted a precipitous decline in Sharp-shinned Hawks (*Accipiter striatus*) since the mid-1980s. The greatest declines have been observed at coastal sites where immature birds comprise 80% of the Sharp-shinned Hawks recorded. Inland count sites, such as Hawk Mountain Sanctuary, where adult birds comprise over 50% of total sharpshins, have only recently begun to note a corresponding decline in this species. The pattern of immatures declining before adults suggests possible widespread reproductive failures. There has been speculation that Sharp-shinned Hawk populations are being adversely impacted by consuming prey contaminated by pesticides. In the fall of 1991, Hawk Mountain conducted a preliminary assessment of the contaminant load of eastern populations of migrating Sharp-shinned Hawks. We analyzed blood samples from migrant

sharpshins and tissue samples from road and window-killed birds for organochlorines, PCBs, and heavy metals. Results from these analyses showed elevated levels of DDE in some adult carcasses. In addition, the average blood level found in adult birds has been shown to correspond to significantly elevated levels of DDE in Sharp-shinned Hawk eggs.

RESTORING OSPREY TO METROPOLITAN LAKES IN THE TWIN CITIES, MINNESOTA

VOIGHT-ENGLUND, J., M. MARTELL, H. TORDOFF AND P.T. REDIG. *The Raptor Center at the University of Minnesota, 1920 Fitch Ave., St. Paul, MN 55108*

Ospreys historically nested throughout the wooded portion of Minnesota, including the Twin Cities area. They were eliminated as a nesting species in the southern two-thirds of the state before the turn of the century, primarily due to uncontrolled shooting. Ospreys have been successfully reintroduced to portions of their former range in Minnesota through hacking programs. In 1992, a three-year program was initiated to return Osprey as a nesting species to lakes within the metropolitan area, as well as to provide city residents and visitors with the exciting opportunity to see Ospreys at close range. Hack towers were erected at two metropolitan lakes. Osprey chicks were translocated from nests in northcentral Minnesota to metropolitan hack boxes at 5½–7 weeks of age. Birds were released when they reached flight stage. A corps of volunteers (over 75 at the two sites) was enlisted to monitor the fledglings from dawn until dusk for 4 weeks after their release. Ospreys learn to fly and fish without adult supervision. The Twin Cities Ospreys have become tolerant of human activity, including canoeing and walking adjacent to the hack box. The birds use perches in areas of moderate human activity as well as perches in more secluded areas. They fish adjacent to canoes and sailboards. One of the more impressive results of this year's reintroduction was the high degree of interest exhibited by park users. Almost half of the persons visiting the monitoring stations had no previous knowledge of Ospreys and they were extremely enthusiastic about the project after viewing the birds through the monitor's spotted scope. Reintroducing Ospreys to a metropolitan area is an effective method of restoring an ecosystem, as well as educating the general public about raptors, wildlife, general ecological principles, and the human role in natural resources conservation.

USE OF RAPTORS IN MONITORING ECOLOGICAL INTEGRITY OF TROPICAL FOREST RESERVES

WHITACRE, D. *The Peregrine Fund, Inc., 5666 W. Flying Hawk Lane, Boise, ID 83709*. A.J. BAKER. *P.O. Box 2492, Gig Harbor, WA 98335*. I. CÓRDOVA M. *Parque Nacional Tikal, Petén, Guatemala*. P.M. HARRIS. *4019 Ashworth N., Seattle, WA 98103*. A.E. HERNÁNDEZ C. *Parque Nacional Tikal, Petén, Guatemala*. L.E. JONES. *22583 Veronica Dr., Salinas, CA 93908*. C. MATEO M. *Parque Nacional Tikal, Petén, Guatemala*. J. SUTTER. *22583 Veronica Dr., Salinas, CA 93908*. C. SWARTZ. *1205 Thousand Springs Grade, Wendell, ID 83355*. C.W. TURLEY. *120 S. 24th Street, Mount Vernon, WA 98273*. R. VILLEGAS P. *Apartado Postal 579, Xalapa, Veracruz, Mexico*

To achieve effective conservation within protected areas, it is important to monitor biological diversity and ecological integrity of these areas. Over the past five years, Peregrine Fund researchers have developed methods for monitoring ecological integrity of tropical forest areas, using diurnal and nocturnal raptors and selected other bird and mammal species as ecological indicators. The "Maya Project" uses a suite of census techniques to monitor ecological health of the largest area of contiguous protected lowland forest in Central America—the Maya/Calakmul/Rio Bravo biosphere reserve complex and surroundings, in Guatemala, Belize, and Mexico. At each site, 10 canopy-emergent census points (trees, Mayan temples) are used, with a combination of three census methods. A pre-dawn listening census reveals *Micrastur* spp., owls, nightjars, tinamous, primates, and other species. A mid-morning visual/aural census above the canopy reveals most diurnal raptors, as well as pigeons, doves, and parrots. These methods are supplemented by acoustical luring using distressed prey vocalizations, to increase detection rates of a few cryptic or rare species (Bicolored Hawk, Crested Eagle). These techniques yield various indices of detection rate and relative abundance which can be used to compare habitats or detect change over time. Methods are described, along with pitfalls and practical hints. Results are presented for three areas censused during two years. Differences in raptor communities among the three sites are clearly demonstrated. This suite of methods is a low-tech, flexible, and highly replicable approach to inventory and monitoring of raptors and other potential indicator species in tropical forests. Current rates of tropical forest destruction, degradation, and fragmentation argue for the widespread installation of programs for monitoring biological diversity and ecological integrity. The methods described here should be easily adapted to other sites throughout the world and can play an important role in establishment of effective monitoring programs.

POST-FLEDGING ECOLOGY OF IMMATURE BALD EAGLES. MOVEMENTS, TIMING OF MIGRATION, AND SURVIVAL

WOOD, P.B. *West Virginia Cooperative Fish and Wildlife Research Unit, P.O. Box 6125, Percival Hall, West Virginia University, Morgantown, WV 26506-6125*

Little was known about the post-fledging movements and habitat use of fledgling bald eagles prior to their first migration. Timing of initial migration and factors that influence it also were not well understood. I used a two-fold approach to address these questions. I collected ex-

tensive data on 44 radio-tagged nestlings from 1987 to 1991 and supplemented these data with intensive observations of nestlings at 2 nests in 1991 in north Florida. Fledgling eagles (birds prior to their initial migration) remained dependent on adults for food and stayed at or near the natal nest until they initiated migration at an average of 7 (4–11) weeks post-fledging. However, by 3 weeks post-fledging, they had ranged outside of the 229 m primary protection zone used in Florida. Of greater importance is the extent of the protection period which currently ends when young fledge. It should extend until fledglings initiate migration away from the natal area. Disturbance near a nest while fledglings still are dependent on adults may cause premature dispersal of young from the nesting area prior to their attaining adequate food reserves for migration. Fledglings in less than optimum physical condition when initiating migration may be less likely to survive the energetic demands of migration. Lowest survival occurred during the first summer of life (63%) shortly after initiation of migration, indicating the importance of fledglings being in good physical condition when they leave the nest area. Timing of migration appeared to relate to food availability and likely, physical condition; most fledglings left the study area while fish abundance was declining. First-hatched birds tended to migrate at a younger age than second-hatched birds. Since the older sibling generally dominated in food conflicts, it could achieve the physical condition necessary for migration more quickly. The younger sibling in two-chick nests also had significantly lower survival (59% vs. 71%) through the first year of life. Prey deliveries decreased at one nest after the older sibling had migrated. Perhaps if young do not leave on their own, food deliveries are decreased by adults, possibly in response to declining prey availability.

ELECTROCUTION MORTALITY OF GOLDEN AND BALD EAGLES IN AN AREA OF HIGH PREY CONCENTRATION

WOODBRIDGE, B. *USDA Forest Service, Klamath National Forest, 37805 Hwy. 97, Macdoel, CA 96058.* M. GARRETT. *PacifiCorp, 920 SW Sixth Ave., Portland, OR 97204*

We monitored prey abundance, eagle abundance, and eagle mortality in an agricultural valley in northern California from 1986 to 1992. The distribution of eagles within the study area was divided spatially and temporally through the use of two resource systems: 1) blacktailed jackrabbits in sagesteppe habitats during winter and 2) Belding ground squirrels in alfalfa fields during spring and early summer. Eagle concentration during February through May ranged from 4 to 18 eagles per square mile and often exceeded 16 eagles per square mile in areas of alfalfa cultivation. Transect surveys under power distribution lines detected from 4 to 22 eagle carcasses per year in areas of eagle concentration. Initial attempts to retrofit powerpoles to raptorproof standards were largely unsuccessful at preventing mortalities, probably due to the extremely high use of powerpoles by eagles foraging in alfalfa fields. Secondary modifications to poles in eagle habitat will be discussed.

POSSIBLE FOOD-RELATED EARLY BREEDING OF TWO-YEAR-OLD NORTHERN GOSHAWKS IN SHRUB-STEPPE HABITATS OF NORTHEASTERN NEVADA

YOUNK, J.V. AND M.J. BECHARD. *RRTAC, Department of Biology, Boise State University, Boise, ID 83725*

Northern goshawks normally breed at three years of age. In 1992, 22 pairs of goshawks were found nesting in shrub-steppe habitats in northeastern Nevada that consisted of approximately 10% aspen (*Populus tremuloides*) forest Members of each pair were trapped, color-banded, and aged in the hand. Of these 22 pairs, 11 consisted of mature males mated with two-year-old females. Productivity of adult/adult and adult/two-year-old pairs averaged 3.0 and 2.54 young per pair, respectively. Despite the fact that two-year-old females were as productive as adult females (t-test $P = 0.25$), their dates of fledging young were later (means of June 28 vs. July 5, $P < 0.01$), and more variable (SDs of 5.1 vs. 2.5, $P = 0.038$). These two-year-old females may have begun breeding early because of an abundance of ground squirrels (*Spermophilus beldingi*) in 1992. Blind observations at eight nests showed that breeding goshawks of all ages preyed almost exclusively on these ground squirrels until July when young were approaching fledging age. At this time, estivation of ground squirrels and the increasing abundance of recently fledged young of various species of birds may have caused the shift from ground squirrels to birds such as northern flickers (*Colaptes auratus*), robins (*Turdus migratorius*), and black-billed magpies (*Pica pica*).

POSTER PRESENTATIONS

AN ALTERNATIVE TRAPPING METHOD FOR BURROWING OWLS

BANUELOS, G. *H.T. Harvey and Associates, P.O. Box 1180, Alviso, CA 95002*

In order to trap a large population of Burrowing Owls within a short period (two weeks), a trapping method incorporating a one-way door surrounded by a wire mesh cage was used at a construction site in Manteca, California in July 1992, and at a site in Santa Clara, California in August 1991. Wire cages (2′ × 2′) were placed over burrow entrances with one-way doors that allowed owls to exit burrows and enter the trap. Traps were set at occupied burrows and monitored at hourly intervals. At a Manteca site on 14 July, six owls were captured at three trap sites during a time span of two hours and fifteen minutes (2015–2231). On 16 July, three owls were captured at two trap

sites (two owls in one trap) during a time span of four hours (1715–2115). At a Mission College construction site in Santa Clara, California, two owls were caught at one trap during a one hour and twenty-three minute time span (2042–2205) on 7 August. The following day, two owls were captured at two trap sites during a two hour and fifteen minute time span (2300–0115). The ease of constructing and setting the trap, the potentially high capture rate, and the lack of trapping injuries allow the one-way door trap to be used as an alternative to Bal-chatri, noose carpets, and padded leg-hold traps.

DIRECTIONS AND PRIORITIES FOR RAPTOR RESEARCH IN THE WESTERN UNITED STATES

BEDNARZ, J.C. *Raptor Research Center, Boise State University, Boise, ID 83725*. S.W. HOFFMAN. *HawkWatch International, P.O. Box 35706, Albuquerque, NM 87176*

We initiated an assessment of the priorities of potential research directions to furnish a framework that would help guide future research on western raptors. We solicited input by means of a survey of opinions sent to a representative sample of established raptor specialists throughout North America. A total of 27 responses was received and summarized. Most respondents to our survey favored emphasizing priority research on the species of most critical conservation need rather than on essential general research questions. Specifically, participants advocated that research efforts be focused on declining species and species of unknown status. On the basis of recommendations received and review of the literature, we classified all western raptors into one of three priority categories. Species that were ranked in the highest priority category include the California Condor, Northern Goshawk, Ferruginous Hawk, Golden Eagle, Northern Pygmy-Owl, Mexican Spotted Owl, Boreal Owl, and Ferruginous Pygmy Owl. Based on the survey results and our own familiarity with the state of raptor research, we classified 15 general research topics into one of three priority categories. The respondents to our survey overwhelmingly identified three topics that should receive greatest research emphasis: 1) develop accurate monitoring techniques, 2) monitor population numbers, and 3) determine habitat affinities and needs. Finally, we ranked the priority of several specific topics related to developing reliable monitoring techniques. Of foremost importance is research designed to determine the validity and sensitivity of various existing and proposed monitoring approaches. We suggest that current and future studies that involve both species and research topics in the highest priority categories will likely represent significant contributions to the understanding and conservation of western raptors.

BEHAVIORAL INTERACTIONS WITHIN A BREEDING PAIR AND OFFSPRING OF MISSISSIPPI KITES (*ICTINIA MISSISSIPPIENSIS*)

BOTELHO, E.S. *P.O. Box 300001/Department 3AF, Department of Biology, New Mexico State University, Las Cruces, NM 88003*. A.L. GENNARO. *Station #33, Department of Biology, Eastern New Mexico University, Portales, NM 88130*. P.C. ARROWOOD. *P.O. Box 300001/Department 3AF, Department of Biology, New Mexico State University, Las Cruces, NM 88003*

A single Mississippi Kite (*Ictinia mississippiensis*) nest with two nestlings was studied from hatching to fledging. Six nestling behaviors are examined in relation to days or weeks from hatching. Parental care was carried out by both parents throughout the nestling period. The male provided more food to both nestlings than did the female. Nestlings consumed similar amounts of food over the duration of the nestling period. Allopreening, setting the nest, and working the nest were observed among the nestlings Intra-nestling aggression occurred with the younger chick exhibiting almost as many aggressive pecks against the older chick as vice versa. These data suggest that the Mississippi Kite's, and perhaps other kites', pattern of parental care and nestling behaviors may be quite different from that of other raptors.

FIRE SUPPRESSION AND MANAGEMENT OF SPOTTED OWL HABITAT IN THE WENATCHEE NATIONAL FOREST

BUCHANAN, J.B. *NCASI, 720 SW 4th, Corvallis, OR 97339 (Present Address: Washington Department of Wildlife, 600 Capitol Way N., Olympia, WA 98504)*. L.L. IRWIN. *NCASI, 720 SW 4th, Corvallis, OR 97339*

Historically, fire was the most significant disturbance factor in the mixed-conifer forests of the east slope of the Cascade Mountains in Washington. Prior to fire suppression, low-intensity ground fires generally occurred at intervals of less than 50 years across much of the landscape in this region. These short fire intervals prevented the establishment of fire avoiders such as grand fir (*Abies grandis*). During the recent period of fire suppression, a much longer fire interval has influenced stand structure and species composition, resulting in forest stand conditions suitable for occupancy by Spotted Owls (*Strix occidentalis*). Concomitantly, suppression of frequent, low intensity fires has enhanced conditions for stand-replacement fire by increasing fuel accumulations and continuity. In the Wenatchee National Forest (WNF), Spotted Owls appear to nest exclusively in forests naturally regenerated following fires of varying intensity and magnitude. About half of the known Spotted Owl nests occur in even-aged stands 65–135 years old. Most of these stands are dominated by Douglas-fir (*Pseudotsuga menziesii*), although grand fir is present at nearly all sites and typically ranks second in terms of tree abundance and basal area. In addition, 23% of the nest sites had been partially harvested, apparently several decades prior to our study. Priority fire protection has been recommended for sensitive forest habits

used by threatened and endangered species. However, given the forest history and stand conditions in the WNF, we see the need for a more proactive landscape management strategy that will eventually incorporate natural fire regimes and various timber harvest procedures. Adaptive management experiments designed to evaluate these procedures are required to reduce the risk of catastrophic wildfire.

EXPERIMENTAL MANIPULATION OF MANAGED STANDS TO PROVIDE HABITAT FOR SPOTTED OWLS AND TO ENHANCE PLANT AND ANIMAL DIVERSITY

CAREY, A.B. AND L. WUNDER. *USDA Forest Service, Forestry Sciences Laboratory, Pacific Northwest Research Station, 3625 93rd Ave. SW, Olympia, WA 98512*

This study represents an effort to examine the feasibility of accelerating the development of spotted owl habitat in managed forests by increasing structural and species diversity. We have adopted two means of approaching this issue: manipulation of the spotted owl prey base and silvicultural alterations. We are attempting to increase population densities of spotted owl prey (primarily northern flying squirrels) by providing additional nest sites for squirrels (artificial cavities and nest boxes). We are also creating wildlife thinnings, designed to maximize structural diversity (both horizontal and vertical) and growth of several strata of understory vegetation. We have gathered a year of baseline data and are currently beginning the experimental manipulations of our study plots.

BIODIVERSITY RESEARCH AT THE BLM'S PACIFIC FOREST AND BASIN RANGELAND SYSTEMS COOPERATIVE RESEARCH AND TECHNOLOGY UNIT

COLLOPY, M.W. *BLM Cooperative Research Unit, 3200 SW Jefferson Way, Corvallis, OR 97331*

The Pacific Basin and Rangeland Systems Cooperative Research and Technology Unit was recently established at Oregon State University, in Corvallis. Its location significantly enhances the opportunity for the BLM to develop stronger linkages with the scientific research and graduate education programs associated with Oregon State University and the PNW Research Station (USFS). Cooperative research programs are being implemented in both rangeland and forested ecosystems. The Vegetation Diversity Project is a research and demonstration program to improve the BLM's ability to restore and maintain native plant diversity on degraded semiarid lands in the Great Basin and the Columbia Plateau. Studies will examine the role of plant competition from exotic annual plants in the establishment of native perennials, the importance of seed source in restoration, the role of grazing animals in maintenance of diverse plant communities, and the potential effects of climate change on native plant diversity and on plant interactions. In western Oregon, biodiversity research at the stand and landscape levels is being developed to provide guidance to the management and conservation of managed and old-growth forest ecosystems on BLM lands. This research will assist in the development of alternative silvicultural systems that can be used to create desired characteristics in forested landscapes. A series of integrated studies are being designed to detect how the floral and faunal components of the landscape change in response to various management activities. This integrated approach will enable the Cooperative Research Unit to develop much needed landscape-level information on the status, stability, and distribution of plant and animal communities, as well as high-profile species (e.g., northern spotted owls, marbled murrelets, northern goshawks, and neotropical migrants), under various management regimes.

POPULATION CENSUS AND PRODUCTIVITY OF NESTING GOLDEN EAGLES, PRAIRIE FALCONS, COOPER'S HAWKS, SWAINSON'S HAWKS, AND FERRUGINOUS HAWKS IN CIMARRON COUNTY, OKLAHOMA

DAY, R.H., D.H. WOLFE, K.V. COLBERT, AND S.K. SHERROD. *G.M. Sutton Avian Research Center, P.O. Box 2007, Bartlesville, OK 74005*

As part of an ongoing study of prairie and prairie-edge nesting birds conducted by the Sutton Avian Research Center, population censuses and nesting productivity of Golden Eagles (*Aquila chrysaetos*), Prairie Falcons (*Falco mexicanus*), Cooper's Hawks (*Accipiter cooperii*), Swainson's Hawks (*Buteo swainsoni*), and Ferruginous Hawks (*Buteo regalis*) were conducted from 15 May 1992 through 18 July 1992 in Cimarron County, Oklahoma. Eight Golden Eagle nests were found, which produced a total of seven fledged young. Three Prairie Falcon nests were found, which produced a total of five fledged young. Four Cooper's Hawk nests were found, which produced a total of 11 fledged young. Thirty-five Swainson's Hawk nests were found, which produced a total of thirty-seven fledged young. Fifteen of the thirty-five Swainson's Hawk nests were destroyed by hail and/or high winds.

SATELLITE TELEMETRY OPTIONS FOR AVIAN RESEARCH

ELLIS, D.H. AND M.R. FULLER. *U.S. Fish and Wildlife Service, Patuxent Wildlife Research Center, Laurel, MD 20708*

Four manufacturers now produce transmitters in the size range suitable for raptors (3–5% of body mass). Dummies of these transmitters will be displayed and harnessing techniques will be demonstrated. Estimates will be given for: cost, reliability, longevity, mass, availability, programmability, power output and other information essential in deciding on manufacturer and model.

HISTORICAL PRESENCE OF THE BURROWING OWL IN MEXICO

ENRIQUEZ ROCHA, P.L. *Ap. Postal 519, 77000 Chetumal, Quintana Roo, Mexico*

The Burrowing Owl (*Speotyto cunicularia*) has been listed in the Blue List since 1972 in the U.S.A. and classified as threatened in Canada. Northern banded Burrowing Owls have been recovered in Mexico and Central America. However, due to the scarce knowledge about the breeding and non-breeding distribution in Mexico, I compiled data on 279 Burrowing Owls from twenty-seven museums. Historical Burrowing Owl collects date since the 1840s through 1980s. Most of the individuals were collected in the decade of the 1900s. Sixty-three percent of collects were in the non-breeding (wintering) season. In Mexico, the Burrowing Owl has a wide distribution. It is located in 28 of 32 Mexican states. Baja Peninsula has provided the most information. The Southeastern region stands out for lack of information. *S. cunicularia* is the third most common owl collected in the country. The high number of individuals during the non-breeding season suggests an increase of Burrowing Owl populations. Possibilities may indicate the arrival of North American migrants at winter. I suggest finding breeding and non-breeding preferred and/or priority areas, banding individuals to define migration routes, and establishing the effects of human activities to determine if this impact affects the species' decline.

OPPORTUNITIES AT THE ALASKA RAPTOR REHABILITATION CENTER

FORD, S., R. MAY, E. BEECHWOOD AND E. CRADDICK-PATT. *Alaska Raptor Rehabilitation Center, P.O. Box 2984, Sitka, AK 99835*

The Alaska Raptor Rehabilitation Center is located in Sitka, Alaska and was founded in 1980. Its three-part mission includes treatment of injured Alaskan birds of prey, education of the public concerning raptor ecology and medicine, and the support of research pertaining to the ecology and medical treatment of raptors. Although the center's beginnings were extremely modest, now it has grown to accommodate thousands of visitors a year and treats more than 50 bald eagles, its primary patients, each year as well as many other birds of prey and non-raptorial species. The staff at ARRC know that, although their efforts to save a few birds will not be significant in the overall population of raptors directly, the knowledge gained and shared from working with the birds will slowly awaken people to their significance and the magnitude of the impact that civilization has upon them. Being more aware of these elements, many of the preventable, man-caused injuries ARRC treats will diminish. ARRC invites others to share in its mission through volunteering, donation, and membership, and a special invitation is extended to raptor organizations and researchers to participate in ongoing research opportunities at ARRC.

USE OF RANDOM AMPLIFICATION OF POLYMORPHIC DNA (RAPD) IN THE ANALYSIS OF METAPOPULATION STRUCTURE IN *STRIX* OWLS

GERHARDT, R., P. STACEY, A. HODGSON, S. GARLAND AND G. HOELTZER. *EEC Biology, University of Nevada, Reno, NV 89512*

Random amplification of polymorphic DNA (RAPD) is a comparatively new technique for detecting diversity in the nuclear genome. Relative to many other molecular genetic techniques, it is both time and cost effective. We are currently using RAPD to examine the degree to which small breeding populations of both Spotted Owls (*Strix occidentalis*) and Great Gray Owls (*S. nebulosa*) are genetically distinct from neighboring populations. We present here several examples of the type of results yielded by the RAPD technique. These results will enable us to construct population models that will in turn lead to a better understanding of the impact of various management strategies on these owl populations. In addition, we are exploring the applicability of the RAPD technique to questions of the phylogeny of the *Strix* complex and other closely related species.

ARTIFICIAL STRUCTURES FOR NESTING FERRUGINOUS HAWKS IN TWO COUNTIES OF WASHINGTON STATE

HICKMAN, G.J. *Washington State Department of Wildlife, Spokane, WA 99218*. L. JURS AND T. THOMPSON. *Bureau of Land Management, N. 8702 Division St., Spokane, WA 99218*

Approximately sixty (60) nesting territories of Ferruginous hawks (*Buteo regalis*) are found in eastern Washington. Washington is on the margin of this species range, and often human activities in these areas have adversely impacted nest productivity. Furthermore, availability of suitable nest location is a problem for this species. In a cooperative effort to manage these populations in Lincoln and Franklin counties, the Bureau of Land Management and the Washington State Department of Wildlife have constructed and placed two types of nesting structures in an effort to help bolster productivity. One nest structure is circular metal, which is bolted to a basalt cliff. This device has been used to replace nests which have fallen from the cliff or on cliffs where nesting shelves are nonexistent. The second structure is used in conjunction with juniper and other tree nest locations. Construction of these nest structures provides nesting pairs with an option other than a ground nest, which may be vulnerable to predation

USE OF GPS AND GIS TO STUDY BALD EAGLES AT AMERICAN FALLS RESERVOIR, IDAHO

HOWARD, R. *U.S. Fish and Wildlife Service, 4696 Overland Rd., Room 576, Boise, ID 83705*

Since 1980, standard bald eagle winter surveys have been conducted in the American Falls area in conjunction with the Idaho bald eagle survey. Data from these surveys were compiled with information from other standard survey routes throughout Idaho from the Raptor Research and Technical Assistance Center, Bureau of Land Management, Boise, Idaho. In 1991, the Bureau of Reclamation initiated a planning process with the U.S. Fish and Wildlife Service to develop a Resource Management Plan for the American Falls Reservoir area. A major objective was to assess the wintering and nesting bald eagle population in the 133 sq. mile study area. Monthly aerial surveys were conducted during the winter of 1992 for bald eagles using a Maule fixed-wing aircraft. The aircraft was equipped with a geo-positioning polycorder (GPS) which acquired electronically obtained locations of bald eagles observed during the survey using three satellites. An onboard computer stored the locations in LatiLong and UTM formats. A geographical information system (GIS) database was developed of the study area using ARC-INFO software. The stored locations of bald eagles were electronically transferred directly to the GIS, and color-coded map overlays were developed using a CalComp printer-plotter. Average number of bald eagles observed during the three surveys in 1992 was 73 (range 63–80). This falls within the range of bald eagles counted in the study area (range 41–114) since surveys were initiated in 1979. Bald eagles first nested successfully in the study area in 1991. In 1992, two pairs of bald eagles established territories and built nests. Both were unsuccessful at fledging young. Bald eagles attempting to nest in this area may be from the expanding population of 33 pairs found in the upper Snake River near Yellowstone National Park. The use of GPS to accurately map bald eagle locations during aerial surveys and the use of GIS to produce map overlays can be powerful tools for resource management agencies.

THE STATUS OF THE BURROWING OWL IN NORTH AMERICA

JAMES, P.C. *Saskatchewan Museum of Natural History, Wascana Park, Regina, SK, Canada S4P 3V7*

The status of the Burrowing Owl (*Speotyto cunicularia*) in North America is reviewed. For each state or province, the breeding population is estimated within an order of magnitude, its trend is given, and factors affecting are presented.

CHARACTERIZATION OF POPULATION AND FAMILY GENETICS OF THE BURROWING OWL BY DNA FINGERPRINTING

JOHNSON, B.S. *2321 Evenstar Lane, Davis, CA 95616*

Genetics attributes of the burrowing owl were revealed by DNA fingerprinting with the minisatellite probe pV47-2. I report here on DNA fingerprint variability, on fingerprint inheritance and rate of mutation, and on population substructuring. Each genetic profile comprised an average of 28.9 highly variable, somatically stable Mendelian markers, and contained single-locus, as well as multilocus, banding patterns, depending on hybridization stringency. Individual fingerprint specificity was minimally 8.4×10^{-17}, with an estimated mutation rate of 0.005. Allelic and genotypic frequencies at the pV47-2 locus indicated genetic substructuring within a pool of several geographically separated burrowing owl populations from western North America, and within a pool of populations from California, as well as inbreeding in an intensively studied California burrowing owl population. These results suggest that nonrandom breeding and population subdivision in this species may be occurring at very fine spatial scales, that levels of inbreeding may be elevated, and that burrowing owl genetic effective population size may be small. If local populations are genetically and demographically isolated from one another, local extinctions may be exacerbated, and recolonization from extant burrowing owl populations will be less likely.

KLEPTOPARASITISM AMONG STELLER'S SEA EAGLES ON THE KAMCHATKA PENINSULA, RUSSIA

LADIGIN, A.V. *Kronotskiy State Biosphere Reserve, Kamchatka, Russia, 684010*

Feeding behavior by wintering Steller's sea eagles (*Haliaeetus pelagicus*) was studied on Kuril Lake on the Kamchatka Peninsula, Russia, from 1987 to 1992. Up to 700 eagles congregate here in winter to feed on sockeye salmon (*Oncorhynchus nerka*) carcasses. Kleptoparasitism (intraspecific food stealing) was studied in relation to food abundance, size of the food carcass, eagle group size, and eagle age ($N = 500$ conflicts). Contrary to expectations, kleptoparasitism was most prevalent during periods of food abundance; it also was more frequent when eagles fed on the largest salmon carcasses. Kleptoparasitism increased exponentially as the size of the feeding group increased. Conflicts in small feeding groups were infrequent (0.5/min), compared to large groups (>5/min). Adult eagles were attacked by other eagles of all ages more than twice as frequently as subadults. Although aggression was common during feeding, communal feeding allowed all members of the group to more efficiently find and consume food. The evolution of kleptoparasitism, its energetics costs and benefits, its adaptive advantages, and the influence of eagle plumage coloration will be discussed.

ANNOUNCEMENT OF THE NATIONAL TRAVELING RAPTOR DISPLAY

MARTELL, M. AND P. REDIG. *The Raptor Center at the University of Minnesota, 1920 Fitch Avenue, St. Paul, MN 55108*

The Science Museum of Minnesota (SMM), in collaboration with The Raptor Center at the University of Minnesota (TRC), announces the creation of a national traveling exhibition on raptors. This $3.5 million exhibit, which is partially funded by the National Science Foundation and the National Endowment for the Humanities, is scheduled to open in St. Paul, MN in June of 1994. Both the exhibit and related programs will be structured around the themes of biodiversity, ecology, and human relationships with nature. Both a 5000 square-foot version and a smaller version (less than 2000 square foot), will be produced and available for venues across the country. Collaboration between museums, zoos, nature centers, and raptor programs will be encouraged and can be modelled on the SMM-TRC collaboration. Activities and components will be designed for use in school programs in collaboration with the St. Paul museum magnet school. We are soliciting the loan or donation of museum quality artifacts relating to raptor biology, conservation, or falconry. Individuals interested in presenting the exhibit at their facility or in their town can begin booking in the fall of 1992.

ARE AERIAL RADIOTELEMETRY LOCATIONS ACCURATE AND REPRESENTATIVE OF PRAIRIE FALCON ACTIVITIES?

MARZLUFF, J.M., M. VEKASY AND C. COODY. *Greenfalk Consultants, 8210 Gantz Ave., Boise, ID 83709*

Widely ranging raptors are difficult to radiotrack from fixed locations on the ground; therefore, we investigated the feasibility of tracking Prairie Falcons (*Falco mexicanus*) from a Cessna 182 airplane outfitted with a belly-mounted, rotatable, H antenna. We tracked beacons and falcons by homing on a signal, passing directly over the signal's source, and recording our location at that time with an on board global positioning system. Aerial tracking provided more accurate estimates of stationary and mobile beacons' locations than did ground-based tracking (95% confidence ellipses: mean air = 112 ha, mean ground = 875 ha). Aerial accuracy was not influenced by mobility of a beacon and was similar for two observers. Aerial tracking was efficient; thirty free-ranging, breeding falcons inhabiting a 110 km stretch of the Snake River Canyon were accurately located in a 3–4 hr flight. However, because these birds (especially females) spent a majority of their time in proximity of their aerie, most aerial fixes were close to the nesting territory. This resulted in significant underestimates of falcon foraging ranges. We conclude that aerial tracking is easy to learn, relatively inexpensive to implement, and very accurate. However, the extensive flight time required to consistently locate birds away from their aeries will preclude its application in typical studies of home range estimation.

HOW DO YOU SUCCESSFULLY CAPTURE AND INSTRUMENT SPECIFIC PRAIRIE FALCONS (*FALCO MEXICANUS*) IN A DENSE NESTING POPULATION?

MCKINLEY, J.O., R.R. TOWNSEND, L.S. SCHUECK AND J.M. MARZLUFF. *Greenfalk Consultants, 8210 Gantz Ave, Boise, ID 83709*

During 1991 and 1992, we captured individual Prairie Falcons from specific nesting areas in the Snake River Birds of Prey Area and fitted them with radiotransmitters. We captured 67 Prairie Falcons using a dho-gaza with an owl lure (only 27% of the birds captured were nontargeted individuals). Captures of target birds were maximized by trapping close to the aerie when an individual was present. Capturing a specific sex was easiest during egg laying and early incubation; sets close to the aerie increased our likelihood of capturing females and those farther away were more likely to catch males. To minimize stress during capture, we put "shock absorbers" on the drags to reduce the force of the net's impact on the bird, placed the trap away from obstacles (rocks, steep slopes, sagebrush), and hid someone near the set to quickly retrieve a captured bird. To minimize stress during tagging, we banded and immediately released gravid females and kept other birds hooded and restrained in an abba. When instrumenting individuals, fit of the harness was emphasized and knots were glued and made inaccessible to falcons. We placed the harness's breakaway points on the anterior end of the transmitter to minimize the chances of entanglement while shedding the transmitter. Each radioed individual was monitored after release to assess individual adjustment to the transmitter and to allow for a quick response in case something went wrong. Our precautions succeeded—instrumented birds did not suffer any significant changes in behavior or productivity relative to controls.

ORNITHOCTONA ERYTHROCEPHALA (DIPTERA: HIPPOBOSCIDAE): AN ECTOPARASITE FROM PEREGRINES IN GREENLAND

MEESE, R.J. *Division of Environmental Studies, University of California, Davis, CA 95616.* W.S. SEEGAR. *CRDEC, U.S. Army, Aberdeen Proving Ground, MD 21010-5423.* T. MAECHTLE AND M. ROBERTSON. *Greenland Peregrine Falcon Survey, 307 Blandford Ave., Worthington, OH 43085*

Ectoparasites infecting raptors have received scant attention. Adult peregrine falcons (*Falco peregrinus tundrius*) banded near Søndre Strømfjord, Greenland during summer 1992 served as hosts to several engorged ectoparasites The parasites were later identified as louse flies (Diptera· Hippoboscidae). The genus *Ornithoctona,* though widespread, has not been previously reported to occur on peregrines in Greenland.

VARIABLE SCALES, VARIABLE CONCLUSIONS: PEREGRINE PREY IN GREENLAND

MEESE, R.J. *Division of Environmental Studies, University of California, Davis, CA 95616.* M.R. FULLER. *U.S. Fish and Wildlife Service, Patuxent Wildlife Research Center, Laurel, MD 20708*

Patterns in nature often depend upon the scales at which they are viewed, and many ecological phenomena are scale-dependent in both time and space. Birds were surveyed in West Greenland around six peregrine eyries and at six sites where no peregrines were known to nest to determine the effect of peregrines on passerine densities. The results of such analyses were found to depend upon the spatial scale at which an analysis was conducted. However, the patterns observed were robust through time. We urge other investigators to be alert for similar scale-dependent phenomena.

RANGING DISTANCES OF GREENLAND PEREGRINES DURING THE BREEDING SEASON

PENNYCUICK, C.J. *Department of Zoology, University of Bristol, Bristol BS8 1UG, U.K.* M.R. FULLER. *U.S. Fish and Wildlife Service, Patuxent Wildlife Research Center, Laurel, MD 20708.* W.S. SEEGAR. *Chemical Research, Development and Engineering Center, Aberdeen, MD 21010*

To estimate the area used by Peregrine Falcons during the breeding season in Westcentral Greenland, we radio-marked six adult males and four adult females. Location estimates of marked falcons were obtained from a Cessna 182 airplane, with one forward and side-pointing Yagi antenna, by homing to the signal. The location of the aircraft, while it passed around the radio signal, was estimated from the Global Positioning Satellite system using a Garmin 100 AVD receiver. Three of the nine nests at which peregrines were marked were unsuccessful. Seventy-four percent of the 336 total location estimates were obtained within 1.0 km of birds' eyries. Beyond 1.0 km, one female was detected at only 1–2 km, one male at 2–3 km, one male and one female at 3–4 km, one male no more than 4–5 km, three males and one female from 5–6 km, and one male between 6 and 7 km from their eyries.

AGE IDENTIFICATION OF NESTLING AND FLEDGLING BURROWING OWLS

PRIEST, J. *Humane Society of Santa Clara Valley, 2570 Lafayette St., Santa Clara, CA 95959*

Two captive hatched Burrowing Owls were photographed each two days during the nestling and fledgling period to document exact age by down and feather progression. Photos will be displayed with other pertinent information.

FALCONIFORMES FROM TUXTEPEC, OAXACA, MEXICO

REUTER CORTES, R. *Corina 117 A-12 Col. del Carmen, Coy. C.P. 04100, Mexico D.F. Mexico*

Considering avian diversity in Mexico, Oaxaca is one of the richest states in this country with both resident and migratory species. In the area of Tuxtepec, Oax. where a huge dam was recently built (about two years ago), a study has been carried out by people from the National University of Mexico (UNAM), who in 1989–90 reported the presence of 15 different raptor species in the area. The observations done in this study, in November 1991 and June 1992, report the presence of eight species previously unrecorded for the area. Considering the species previously reported and the ones found in this study, the total (23 species) represents 43% of the Falconiformes known for Mexico and approximately 8% of the species number known for the world. The results of this study show that this area can be of great importance for raptor biologists because of the number of species, both resident and migratory, that occur in the locality. Finally, it is important to mention that a lot of research on the different species is still needed in order to understand their biology, and ensure their permanence in the natural environment.

BREEDING ECOLOGY OF THE CRESTED CARACARA (*POLYBORUS PLANCUS*) IN THE CAPE REGION, B.C.S., MEXICO

RIVERA-RODRIGUEZ, L.B. AND R. RODRIGUEZ-ESTRELLA. *Centro de Investigaciones Biologicas, Div. Biol. Terr., A.P. 128 La Paz 2 3000 Baja California Sur, Mexico*

The Cape Region of Baja California Sur has a permanent and abundant breeding population of Crested Caracaras (*Polyborus plancus*). Nevertheless, several changes have occurred the last two years in the region, changes that are affecting the nesting places of Crested Caracaras. For this reason, a study on the ecology of caracaras in the Cape Region began in 1987. During 1990, we studied the breeding ecology of the species, and the results of the study are presented here. Censuses along transect show that population densities of Crested Caracara range from 1.12 to 4.82 birds/km^2, being densest at the end of the breeding period. The breeding season was extended from February to August. The Crested Caracara nested mainly on cardon (*Pachycereus* spp., 76%), but it also used yucca (*Yucca valida,* 9.5%), teso (*Olneya tesota,* 4.7%), palmera (*Washingtonia robusta,* 4.7%), and paloverde (*Cercidium microphyllum,* 4.7%) ($\chi^2 = 27.5$; g.l. = 1; $P < 0.001$; $N = 21$). Nest height ranged from 3.5 to 8.5 m ($N = 22$). The mean height of vegetal species used to support nests was 8.68 ± 2.85 m ($N = 21$). The chamizo *Ruellia peninsularis* (69.2%) and alfilerillo *Condalia globosa* (61.5%) were the most used plants to build the nest. Nest re-use in 1990 was of 84.62% ($N = 13$). Eighty-three percent of the nests used during 1990 were successful ($N = 16$). The clutch size was two

or three, but we found a significant difference between the nests containing two fledglings and those with 0, 1 or 3 ($\chi^2 = 109.37$, g.l. = 3, $P < 0.01$). The diet of Crested Caracaras in the breeding season indicates a tendency both to have a broad diet breadth and to be an opportunistic species. Although the productivity of the species in the Cape Region was high (1.93 ± 0.85 young/attempt, $N = 16$), we believe the species will be threatened if human disturbance, deforestation, hunting and habitat loss are not stopped. We are concerned because "Los Cabos" are now suffering from the "tourism effect" and the increasing agricultural activities.

PAIRED USE OF SATELLITE AND VHF TELEMETRY ON REHABILITATED BALD EAGLES

ROSE, E.F., W. ENGLISH AND A. HAMILTON. *Woodland Park Zoo, 5500 Phinney Ave. N., Seattle, WA 98103*

Two rehabilitated Northern Bald Eagles (*Haliaeetus leucocephalus alascanus*) fitted with backpack-mounted satellite tracking transmitters (PTTs) and tail-mounted VHF ground-tracking transmitters were released into the Skagit River Bald Eagle Natural Area (SRBENA) by the Woodland Park Zoo in Seattle. A juvenile female (90 hatch) was released in January 1991 and a sub-adult female (89 hatch) was released in January 1992. The paired use of satellite and VHF telemetry was tested to see if birds that left the vicinity of the release site could be relocated using the latest satellite location data as a starting point to begin a ground search using standard VHF telemetry. The juvenile female was tracked by satellite for six months prior to transmitter failure. The subadult female is currently being tracked by satellite eight months after release. Failure of the tail-mounted VHF transmitters after approximately four months each has prevented continued ground tracking of these birds. It was found that the paired use of satellite and VHF telemetry allowed longer term tracking and monitoring of individual rehabilitated eagles than was possible with VHF telemetry alone.

IDENTIFICATION OF INDIVIDUAL OSPREYS BY USE OF PLUMAGE PATTERNS

RYMON, L.M. *Department of Biological Sciences, East Stroudsburg University, East Stroudsburg, PA 18301*

Individual ospreys often are difficult to distinguish in the field, particularly when unbanded or incubating deep in a nest. By observation of over 350 osprey including all four subspecies, I have developed a method of distinguishing individuals by head and upper body plumage patterns. During the 12-year study, comparisons were made in both the field and museums. The variations in patterns also make it possible to determine the identity of individuals in subsequent years. Long-lens photography and sketches were used to document plumage patterns which have proven unique and consistent. This method has been of great assistance during reintroduction programs in Pennsylvania and is recommended for field use.

CRITERIA FOR DETERMINING AGE AND SEX OF NESTLING OSPREY

SCHAADT, C.H. *Wildlife Technology, Penn State, DuBois, PA 15801*

During the period 1984–87, the development of 63 nestling osprey, 33 males and 30 females, was monitored in 39 broods in North America. Eleven variables were measured on birds of known age and sex every other day until fledging. Using a combination of plumage and weight variables, which are easily measured and highly dimorphic, a method is presented to quantify age and sex-determining criteria suitable for use in field situations.

FACTORS INFLUENCING THE DISTRIBUTION OF PEREGRINE FALCONS (*FALCO PEREGRINUS*) IN THE AUSTRIAN ALPS

SLOTTA-BACHMAYR, M.L. *Department of Zoology, Hellbrunnerstr. 34, 5020 Salzburg, Austria*

From studies of some species of birds of prey, we know that the availability of suitable nest sites and food supply are the main factors influencing their breeding distribution. For the Peregrine Falcon, some authors claim that there is some evidence for this relation but, until now, no quantified data has been available. A two-year survey of Peregrines in Salzburg county (Austria) showed that the distribution of this species is very irregular. The present study aims to shed more light on the situation by elucidating which factors determine the distribution of the peregrine and whether the species has a preference for specific types of habitat or for a particular range of altitudes. Between the two subareas (Calcareous and Central Alps) differences in the distribution of breeding pairs were found. Nesting sites in the Calcareous Alps are spaced regularly, while those sites in the Central Alps are spaced in a more random fashion. However, for both subareas there is a clear negative correlation between both elevation and prey density (individuals and biomass) and the "nearest neighbor distance" between breeding pairs. There was no significant preference for a specific habitat type. It seems that there are different factors influencing breeding distribution of peregrines in different parts of Salzburg county. In the Calcareous Alps, prey abundance is limiting breeding density whereas in the Central Alps, suitable cliffs are in short supply. This study quantifies the importance of different factors for population regulation of Peregrine Falcons and makes it possible to include these parameters in future management programs.

RAPTOR ABUNDANCE IN SOUTHCENTRAL KENYA IN RELATION TO LAND-USE PATTERNS

SORLEY, C.S. *Department of Fisheries and Wildlife, Uni-*

versity of Minnesota, 200 Hodson Hall, 1980 Folwell Ave., St. Paul, MN 55108. D.E. ANDERSON AND P.F. MCINNES. *MN Cooperative Fish and Wildlife Research Unit, Department of Fisheries and Wildlife, University of Minnesota, 200 Hodson Hall, 1980 Folwell Ave., St. Paul, MN 55108*

We conducted nine road surveys for birds of prey from 12 January through 17 March 1990 in Nairobi National Park and in an adjacent area dominated by subsistence agriculture and livestock grazing in southern Kenya. We observed an average of 4.27 raptors/km inside the park and 0.40 raptors/km outside the park ($P < 0.005$). Excluding very abundant species [lesser kestrels (*Falco naumanni*) and vultures; 72.6% of all observations] and species associated with human settlements [black kites (*Milvus migrans*); 8.9% of all observations], raptors were observed more frequently in the park (0.47 raptors/km) than outside the park (0.23 raptors/km) ($P < 0.01$). Although species richness was similar inside (18 species) and outside the park (22 species), eagles, vultures, and lesser kestrels were seen more frequently inside the park and some infrequently observed species were only seen either inside or outside the park. These results reflect the differences in land-use practices inside and outside of the park, and suggest significant changes in raptor community structure (species richness, density, and species identity) related to human land use.

EFFECTS OF RECREATIONAL ACTIVITY ON FEEDING BEHAVIOR OF WINTERING BALD EAGLES

STALMASTER, M.V. AND J. L. KAISER. *Stalmaster and Associates, 209 23rd Avenue, Milton, WA 98354.* S.K. SKAGEN. *National Ecology Research Center, U.S. Fish and Wildlife Service, Fort Collins, CO 80525*

For 5 years we studied how recreational activity affected wintering bald eagles (*Haliaeetus leucocephalus*) on the Skagit River Bald Eagle Natural Area (SRBENA) in Washington. Nearly 300 eagles wintered on SRBENA and fed on chum salmon (*Oncorhynchus keta*) carcasses, and up to 115 recreational events occurred each day (mean = 17 events/day). The number of eagles on the SRBENA was negatively correlated ($P < 0.001$) with the daily number of recreational events. Feeding activity declined exponentially ($P < 0.001$) with increasing recreational activity. Motorboats were particularly disruptive to feeding behavior. After 20 activity events per day, eagles still present were reluctant to feed, and after 40 events, feeding was nil. On weekends, when recreational activity was high, eagles fed 30% less than on weekdays, when activity was low. Eagles fed mostly in morning hours (64%), especially between 0900 and 1100 H (39%), and feeding disruptions were most pronounced during these hours. Number of feeding subadults declined faster than adults ($P < 0.05$) in the presence of recreational activity and subadults were slower ($P < 0.001$) to resume normal feeding after disturbances. Resumption of normal feeding was relatively fast after boat traffic (mean = 36 min), but slow after foot traffic (mean = 228 min). Under current levels of recreational use on the SRBENA, overall feeding activity was reduced by 35%. We recommend restricting recreational use, particularly motorboats and foot traffic, during morning hours to allow eagles to feed without being disturbed.

COMPARATIVE EVALUATIONS OF HEMATOLOGIC PARAMETERS OF RED-TAILED HAWKS AND AMERICAN KESTRELS TRAPPED IN CALIFORNIA

STEIN, R.W., J.T. YAMAMOTO, D.M. FRY, N.D. OTTUM AND B.W. WILSON. *Department of Avian Sciences, University of California, Davis, CA 95616.* J.N. SEIBER, M.M. MCCHESNEY AND E.E. RICHARDSON. *Department of Environmental Toxicology, University of California, Davis, CA 95616.* V.J. JOSEPH. *Bird and Pet Clinic of Roseville, 4010 Foothill Blvd., Suite 106, Roseville, CA 95747*

Winter red-tailed hawks (*Buteo jamaicensis*) and American kestrels (*Falco sparverius*) were studied in the Modesto area to evaluate the risk presented to raptors from organophosphate (OP) dormant spray exposure. Blood was collected from 36 red-tailed hawks and 30 American kestrels during the dormant spray season (November–February) of 1990–91 and 1991–92. Additional samples from captive American kestrels and red-tailed hawks trapped in the Sacramento area are included in the analysis. Complete blood cell counts, hematozoa identification, and quantification of serum enzymes, protein, and electrolytes are reported. Age and sex differences of hematologic parameters will be presented. Correlation of hematologic parameters with OP residues will be examined to emphasize physiologic effects and symptoms of exposure. Supported by the Almond Board of California.

RELOCATION OF BURROWING OWLS DURING COURTSHIP PERIOD

TERRILL, S.B. AND P. DELEVORYAS. *H.T. Harvey and Associates, P.O. Box 1180, Alviso, CA 95002*

In February 1990, five pairs of Burrowing Owls (*Speotyto cunicularia*) were translocated from Mission College, Santa Clara, California, to two adjacent sites in south San Jose, Santa Clara County, a distance of 19 linear miles. Owls were trapped, banded, and color-banded, held in hacking aviaries, and released into artificial burrows at relocation sites. Two pairs nested and produced nestlings by 15 May. One of these nests was successful and the second was destroyed by predator(s). Two female owls with failed nesting attempts returned to the Mission College site. In April 1992, two color-banded owls were observed at the south San Jose release site. In August 1992, one owl was recaptured at the original capture site. A second color-banded owl was found injured in August 1992, near the

original site. This owl later died due to complications resulting from probable impact with a vehicle.

A SUMMARY OF REPRODUCTIVE SUCCESS AND MORTALITY IN A DISTURBED FERRUGINOUS HAWK (*BUTEO REGALIS*) POPULATION IN NORTHCENTRAL MONTANA, 1990–92

VAN HORN, R.C. *Department of Biology, Montana State University, Bozeman, MT 59717*

The Kevin Rim is a sandstone escarpment in northcentral Montana. Ferruginous hawks (*Buteo regalis*) are common nesters along the rim, which is surrounded for several miles by the Kevin-Sunburst oilfield. The Kevin Rim area is considered a Special Management Area under the Bureau of Land Management's (BLM) Key Raptor Area program. Reproductive success and mortality were examined during two studies funded by the BLM. Dr. A.R. Harmata and M. Restani studied the impacts of petroleum development on breeding raptors of the Kevin Rim in 1990. This study was followed in 1991–92 by R.C. Van Horn, who examined the responses of raptors to these disturbances. Nest sites were observed from May to August in 1990, 1991 and 1992. In areas with little human disturbance, the number of fledglings produced per occupied nest varied from 2.20 in 1991 ($N = 6$) to 0.08 ($N = 11$) in 1990. In areas disturbed by petroleum development activities, the number of young per occupied nest varied from 2.60 in 1990 ($N = 12$) to 1.0 in 1992 ($N = 9$). No cases of ferruginous hawk mortality, either as fledgling or adult, could be directly attributed to oilfield activities. Two nests in 1992 had losses apparently due to starvation, but neither was in an area developed for petroleum extraction. Three cliff nests were destroyed during strong thunderstorms in 1992, and multiple nests were raided each year by mammalian and avian predators. Golden eagles (*Aquila chrysaetos*), prairie falcons (*Falco mexicanus*), great horned owls (*Bubo virginianus*), coyotes (*Canis latrans*) and red fox (*Vulpes vulpes*) were all possible sources of mortality.

REPRODUCTIVE SUCCESS OF AMERICAN KESTRELS NESTING ALONG AN INTERSTATE HIGHWAY IN CENTRAL IOWA

VARLAND, D.E. *Department of Animal Ecology, Science II, Iowa State University, Ames, IA 50011*. T.M. LOUGHIN. *Department of Statistics, Snedecor Hall, Iowa State University, Ames, IA 50011*

We studied the reproductive success of American Kestrels nesting in nest boxes attached to backs of highway signs along Interstate 35 in central Iowa, 1988–92. Nest box occupancy averaged 45 percent. All of the nest boxes faced either north or south, and there was no significant difference in nest box occupancy by nest box orientation. European Starlings built nests in nearly every nest box not occupied by kestrels. Kestrels evicted starlings from nest boxes, but starlings probably caused some kestrels to abandon their nests as well. Apparent nesting success, the percentage of nests fledging at least one young, averaged 69 percent. There was no significant difference in apparent nesting success by nest box orientation. Using the Mayfield method, we detected significantly lower probabilities of survival during the incubation stage in comparison with the brood rearing stage. Clutch size averaged 4.8 over the five years of the study, while mean hatching success was 62.5 percent. Mean brood size was 3.1, and the mean number of birds in a brood to fledge was 2.9. Fledging success, the percent of young hatched that fledged, averaged 91 percent. The reproductive success of kestrels in our study was similar to that of kestrels nesting in nest boxes attached to trees, utility poles, and buildings in other states. The highway sign provides a strong support, a high perch, and predators cannot easily climb to the nest. Across Iowa's agricultural landscape, nest boxes on interstate signs have given kestrels nesting opportunities that would not exist otherwise.

BREEDING DISTRIBUTION, POPULATION TRENDS, AND MANAGEMENT OF FIVE DIURNAL RAPTOR SPECIES IN WASHINGTON STATE

WATSON, J.W. AND K.R. MCALLISTER. *Washington Department of Wildlife, 600 Capitol Way N., Olympia, WA 98501-1091*

Statewide nesting surveys of bald eagles (*Haliaeetus leucocephalus*), peregrine falcons (*Falco peregrinus*), osprey (*Pandion haliaetus*), golden eagles (*Aquila chrysaetos*), and ferruginous hawks (*Buteo regalis*) were conducted over the past 8 to 17 years in Washington. Occupied peregrine falcon and bald eagle territories increased from 1 and 114 in 1975, to 17 and 444 in 1991, respectively. Population increases were pronounced on the Olympic Peninsula and Puget Sound. Productivity levels for both species remained near 1.0 yng./occ. terr. in 1991, although depressed productivity for bald eagles continued on the Lower Columbia River and Hood Canal. Osprey territories, distributed statewide except in southeast Washington, increased from 226 in 1984 to 412 in 1989, and productivity was high (1.49 yng./occ. terr.). The golden eagle population, consisting of 187 territories located mainly in northcentral Washington, experienced slight decreases in occupancy (49 percent to 41 percent) and productivity (33 percent to 26 percent) from 1985 to 1990. Preliminary analysis of 103 historic ferruginous hawk territories in eastern Washington indicated decreased occupancy and productivity from 1987 to 1992. Statewide management activities emphasized bald eagles and peregrine falcons; two biologists managed bald eagle habitats on a full-time basis, and the peregrine eyrie-attendant and captive-bred release programs continued from the 1980s.

REPRODUCTIVE PERFORMANCE OF BURROWING OWLS (*ATHENE CUNICULARIA*): EFFECTS OF SUPPLEMENTARY FOOD

WELLICOME, T.I. *Department of Biology, University of Saskatchewan, Saskatoon, SK, Canada S7N 0W0*

I provided 14 of 28 Burrowing Owl pairs with extra food during the laying and incubation periods in 1992 to test the hypothesis that food availability limits reproduction. Supplementally-fed owls initiated laying 2 to 3 days earlier and laid approximately one more egg than did controls. Fed birds also tended to lay larger eggs than unfed birds. Hatchability did not differ between the two groups, but since food-supplemented pairs had larger clutches, they hatched more young. I conclude that food supply restricts egg, clutch, and brood size in breeding Burrowing Owls. These results could help explain the poor reproductive performance of owls nesting in areas where human activity may reduce habitat quality in terms of prey availability.

KESTREL HABITAT USE AND PESTICIDE EXPOSURE DURING WINTER IN AGRICULTURAL AREAS OF THE CENTRAL VALLEY OF CALIFORNIA

YAMAMOTO, J.T., D.M. FRY, B.W. WILSON, R.W. STEIN AND N.D. OTTUM. *Department of Avian Sciences, University of California, Davis, CA 95616.* J.N. SEIBER AND M.M. MCCHESNEY. *Department of Environmental Toxicology, University of California, Davis, CA 95616*

Habitat use and home range information on wintering American kestrels (*Falco sparverius*) in California was collected for the purposes of pesticide exposure assessment and comparison with other raptor species under study. During the 1992 dormant spray season (January–February), thirty American kestrels were trapped in a 50 square mile area of heavy agricultural use in the Central Valley. All kestrels were foot-rinsed and blood-sampled for pesticide residues and plasma cholinesterase; eighteen birds were fitted with radiotransmitters prior to release. Tagged birds were monitored on a daily basis throughout the spray season and on a weekly basis until birds left the area or transmitter batteries ceased functioning. In addition to habitat use, data were gathered for roosting behavior, response of the birds to their transmitters (mounted in two different styles), transmitter and harness wear, and mortality. Five radio-tagged birds died during the study; four of these were probable predations, possibly by Cooper's hawks, while the fifth carcass was not retrievable. Three methods of home range calculations were compared using the GIS program CAMRIS: minimum convex polygon, density surface, and fixed buffer zones around observation points. Based on home range size and patchiness, and degree of usage of different habitat types suggested by each method, density surface was chosen as the most accurate and realistic type of calculation. Habitat use data suggested that open pasture or fallow field areas are of primary importance but that other types of agricultural habitat (e.g., orchards, vineyards, dairy, and poultry operations) are also utilized. Preliminary residue and biochemical analyses suggest low level exposure of kestrels to pesticides as a result of dormant spraying. Laboratory toxicological and behavioral studies on captive kestrels are underway to improve understanding of pesticide hazards to these and other wild raptors. Supported by the Almond Board of California.

FILMS AND VIDEOS

FIELD GUIDE TO THE RAPTORS OF THE WESTERN PALEARCTIC

CLARK, W.S. *4554 Shetland Green Rd., Alexandria, VA 22312.* J. SCHMITT. *11609 Alburtis Ave., Norwalk, CA 90650*

We are preparing a field guide to the raptors of Europe, North Africa, and the Middle East (Western Palearctic) for publication by Oxford University Press. The guide will consist of 48 color plates, an extensive text for each of the 49 species that occur there, and many color photographs. We will show slides of perched and flying raptors and the first eight color plates. The text will be similar in format to that in the North American raptor guide, coauthored by William Clark, but it will include a section on molt.

A PHOTOGRAPHIC GUIDE TO NORTH AMERICAN DIURNAL RAPTORS

CLARK, W.S. *4554 Shetland Green Rd., Alexandria, VA 22312.* B.K. WHEELER. *P.O. Box 943, Longmont, CO 80501*

We are preparing a photo guide that will include 360 color photos showing all plumages of North American diurnal raptors, both perched and flying. It is intended as a companion to our raptor field guide, published in the Peterson series, and will be published by Academic Press. Each species account will consist of a short text and extensive photo captions for every photo. We will show a sample of photos to demonstrate the quality (closeness, sharpness, lighting) of the photos to be used. The complete set of photos of the Bald Eagle will be shown. These will show the field marks to correctly age all Bald Eagles, both in flight and perched.

SKYDIVING WITH AN IMMATURE MALE PEREGRINE

FRANKLIN, K. AND S. FRANKLIN. *2959 San Juan Valley Road, Friday Harbor, WA 98250.* T. DONALD. *425 East End, SK, Canada*

We attempted to determine the terminal diving speed of a male peregrine by training the peregrine to stoop after a skydiver in free fall trailing a lure.

INTIMATE OBSERVATIONS OF CAPTIVE BREEDING OF WILD, DAMAGED BURROWING OWLS OF GREAT PLAINS STOCK FOR RELEASE OF YOUNG

MCKEEVER, K. *The Owl Rehabilitation Research Foundation, 21st St., RR 1, Vineland Station, Ontario, Canada L0R 2E0*

Color video with remotely controlled pan, tilt and zoom focuses on one family (of five families in 3600 sq. foot breeding complex) of Great Plains origin Burrowing Owls, as five fledglings emerge from underground tunnels 2½ meters from nest chamber. Scenes include parental feeding, development of the young owls from poor physical coordination to beginning hunting prowess, sibling competition, juvenile response to parental warning of overhead threat, sunning, preening, grooming and instinctive, though ineffectual, sand scuffing on burrow mound. Juvenile behavior near the home burrow demonstrates the extreme vulnerability to predation from land or air of these early fledglings, when clumsiness and inattention are most apparent.

THE ADVANTAGES PROVIDED BY AERIAL CORRIDORS BETWEEN COMPOUNDS IN ALLOWING RESIDENT OWLS TO FORM EFFECTIVE BONDS THROUGH CHOICE

MCKEEVER, K. *The Owl Rehabilitation Research Foundation, 21st St., RR 1, Vineland Station, Ontario, Canada L0R 2E0*

This is a remotely controlled video of successful breeding of wild, permanently damaged Northern Hawk Owls through the ability to self-select potential mates. The female of this pair had occupied a 600 sq. foot divided compound for five years, sharing the total space with first one, then another, arbitrarily introduced wild males without any evident bonding behavior. In the winter of 1992, a 12-foot-long aerial flight tunnel was suspended across to another compound containing two other males and a female—all damaged wild Hawk Owls. Immediately, the five-year resident female flew across the corridor, began negotiations with both males, apparently selected one (who followed her back up the corridor to her own long-held territory), drove out the incumbent, and commenced egg-laying—all in the space of four (4) days! The successful issue of three young is shown in nestling, fledgling and early flighted stages.

LOSING GROUND: A CALIFORNIA BURROWING OWL STORY

STENDER, S.A. *Scott A. Stender Video Productions, 306 Starling Road, Mill Valley, CA 94941*

The program is a look at the habitat loss problems facing California burrowing owl populations. Interviews with biologists and land managers are interspersed with natural history footage of the owls.