singing adult in conifer stands east of the sample area in Sheep Creek. Suitable breeding and winter habitats are found throughout most of the study area.

Reproductive Biology

Reproductive information for the pygmy owl is taken from similar habitat areas outside of southeastern Idaho, because we have not found any information specific to Idaho. Colorado, Montana and Arizona studies report egg-laying to occur from early April to mid-May (Holt and Norton 1986, Johnsgard 1988). The study of one nest in NW Montana found egg laying to occur between April 3-15, incubation started April 15 and hatching occurred May 15 (Holt and Norton 1986). Incubation is estimated at 28-30 days. The northern pygmy is one of the few owls that has synchronized incubation and thus hatching occurs over an interval of only 1-2 days. Asynchronized hatching has also been documented (Holt and Notron 1986). Clutch sizes range from 3-6 eggs. Within 25 days the young owlets are fully feathered and fledge at 23-30 days. Nests have been found in dead and live Douglas-fir, ponderosa pine, aspen, grand fir and Western red cedar. Nest cavities used by pygmy owls have been excavated by sapsuckers and northern flickers (Bull et al. 1987). The European pygmy uses cavities excavated by northern three-toed woodpeckers (Mikkola 1983).

Ecology and Habitat Relationships

The northern pygmy resides in a variety of habitat types ranging from oak savanna to mixed montane coniferous forests. Nests may be found near openings such as meadows, partially timbered sites or wetlands (Reynolds et al. 1989). Such locations are thought to be associated with foraging habitat. They are typically not found in continuous forests territories but near clearings, meadows, open water or other such openings (Verner and Boss 1980). This owl is associated with low elevation habitat but does range into higher elevation mountain areas (Reynolds et al. 1989). Male northern pygmies defend large territories year round and may be assisted in this defense by its mate, thus earning the description of "unsociable" owls. As with the flammulated owl, territories are thought to course natural topographic features such as ridges. There is almost nothing known about the territory and dispersal of this owl species. After following a singing male pygmy owl in northern Mexico and southern Arizona, Marshal (1957) described the their territory as "immense" (Reynolds et al. 1989). The northern pygmy owl feeds on small mammals such as shrews, mice, and voles and small nuthatches, flycatchers and finch-size birds. Pygmy owls have also been documented to kill large prey such as red squirrels, young chicken and quail, although they were unable to lift them into the air, and had to feed upon them in place (Holt and Norton 1986). Ouside of the nesting season, hunting takes place during the crepuscular hours of the day and is accomplished by surprise and pursuit on the wing. Because of the large territory of this species, they occur at relatively low densities throughout their range.

Detection Methods

Often in the winter this small owl can be easily observed in urban areas and at bird feeders where they are drawn to potential prey. During the nesting season, however, the pygmy is similar to other small cavity nesting owls in its secretive behaviors. The use of conspecific broadcast calls are used to detect presence of this species during its breeding season (April though early June). We have heard territorial vocalization of the northern pygmy along the river corridor in early June. The European pygmy has been heard vocalizing it's territorial call throughout the year but more so during March to May (Mikkola 1983). Mikkola (1983) describes the European pygmy owl as highly vocal and as strongly attracted to imitated calls. Protocol for using taped calls follows that presented for the flammulated owl. Observed mobbing by small birds can be an attractant to finding pygmies.

Discussion

Raptors have long been noted as sensitive indicators of environmental change, and are often the first species to show the effects of habitat alteration, particularly in insular habitats (Wilcox 1987). There are several detailed studies of individual raptor species in the Greater Yellowstone Ecosystem, e. g. Franklin 1987, and assemblages of 2 or 3 interacting species, e. g. Restani 1989. However, we know of only one long-term study of the entire assemblage of raptors, the notable research conducted by John and Frank Craighead and associates in Jackson, Wyoming (Craighead and Mindell 1981.). Our interest is to develop a baseline record of the raptor community in the Snake River study area and to initiate long-term monitoring. We are hopeful that this information will be used by planners in on-going efforts to conserve the area's unique qualities and natural resources. We anticipate that this growing data base will also have value for the conservation of raptorial birds beyond our geographic area of interest. The statistical methods developed here should be applicable to many species and other levels of biological diversity.

Species of concern

Several of the raptor species noted here have special designations because of perceived vulnerability to species decline. The bald eagle and peregrine falcon are listed as threatened and endangered species by the federal U. S. Fish and Wildlife Service. The northern goshawk and ferruginous hawk are listed as category 2 species, species for which listing as endangered or threatened species may be appropriate, but for which conclusive data on species vulnerability is lacking. Species listed as sensitive or rare by state and/or federal agencies for the region include the Swainson's hawk, flammulated owl, northern pygmy-owl, burrowing owl, great gray owl, and boreal owl. Little is known about the population status of the small forest owls, particularly the flammulated, northern pygmy, and boreal owls. The flammulated owl and Swainson's hawk are neotropical migrants; species which annually migrate south to winter habitats in Mexico/Guatemala and South America, respectively. There is serious concern with the status of many neotropical land migrants because of notable population declines (Terborgh 1989).

Comparative Study

Impacts to raptor communities occur at varying spatial scales from individual breeding territories to continents and beyond for migratory species. Recent tracking of Swainson's hawks, for example, has discovered large scale losses of hawks due to pesticide use in wintering grounds in Argentina (Woodbridge pers. comm.).

Effects of habitat modification

Many will acknowledge that habitat modification is a two sided-coin: both negative and positive effects can result. The Snake River study area today is vastly different from its condition before settlement. For example, shrub-steppe communities, sage and mountain brush, have been altered by grazing and cultivation (see Young and Sparks 1985). Aspen woodlands have greatly diminished due to cattle grazing and clearing. Riparian communities of great significance to birds of prey have changed because of altered stream flow and fire control (Lee et al. 1987). The current housing boom in the Greater Yellowstone Region may be leading to yet another major change in local habitats.

Habitat changes affect raptor populations in three primary ways: 1) positive or negative influences on direct mortality, 2) loss or gain of potential nesting habitat, and 3) altered prey availability. Human induced direct mortality arises chiefly from toxic chemicals, shooting, collisions, electrocution, and disturbance at critical times in nesting. These factors are relatively easy to control, with the possible exception of toxic chemicals, because problems are often very specific and local.

Impacts to nesting habitat may be more

general. For example, changes in ground cover due to cultivation, grazing or other disturbances can make sites unsuitable for nesting by ground nesting raptors, the harrier and short-eared owl. Human housing development can also influence the abundance of potential nest predators such as raccoons and red foxes. Numbers of both species have increased dramatically in recent years. Cavity nesters like kestrels and small forest owls depend upon the presence of dead or partially dead trees of sufficient size and cavity builders like flickers and woodpeckers. Stick nesters and cliff dwellers all have specific nesting habitat requirements. Owls generally need nest builders, like corvids or red-tailed hawks, because they do not build their own nests.

Prey availability strongly influences raptor productivity and local population size (Garton et al. 1987). Reproductive effort and success often fluctuate in concert with prey populations. Year to year population density may be strongly influenced by prey availability. Raptorial birds are highly mobile; large shifts in seasonal raptor populations such as wintering rough-legged hawks are known to follow prey population changes. Mass raptor population movements have been noted following prey population crashes.

Effects of Land Uses

The multitude of human land uses effect raptor populations both positively and negatively, and raptor habitat needs should be considered in light of potential impacts. We discuss several land uses briefly as follows: grazing, agriculture generally, recreation, timber harvest, toxic chemicals, linear rights-of-way, and urbanization.

A pervasive grazing influence is the effect upon prey distribution and abundance (Kochert 1987). Some prey species favor low levels of cover, and may be more available to foraging raptors if cover is removed. Dense ground squirrel populations are found in heavily grazed areas. On the other hand, many small mammals and birds require vegetative cover. As mentioned earlier, grazing can alter ground cover needed by ground nesting raptors. Heavy grazing can reduce regeneration of suckering trees like aspen and cottonwoods, and thus reduce the long-term availability of nesting trees. Grazing practices that include site specific control of stock numbers, timing, and use can mitigate impacts to raptorial birds.

Agricultural practices that affect prey abundance and raptor foraging opportunity include tillage, planting and cultivation, irrigation, application of chemicals, and harvesting (Young 1987). Many native raptor habitats were replaced by croplands, roads and farmsteads soon after settlement. Primary crops include grains, potatoes, and hay. Cultivated crops are usually taller and denser than adjacent native vegetation, and may prevent raptor foraging or harbor lower prey densities. However, alfalfa hay may support higher densities of prey than native vegetation (Woodbridge 1985). Hayfields are very important raptor foraging habitat. A high proportion of Swainson's hawk foraging occurs in this habitat.

Recreational activities can alter raptor nesting distribution, disturb birds during nesting activities, or force changes in foraging behavior. Some species are tolerant of nearby human activity, e.g. osprey will nest very near to areas used by people. Other species such as bald eagles may be very sensitive to recreational activity that occurs near nesting areas. A key factor in raptor response to human activities is the degree of predictability in the human behaviors. For example, many raptors nest on farmlands where they often see farmers at work, but react strongly to less predictable recreationists who enter nesting areas. Recreational impacts to nesting and foraging raptors can be mitigated by spatial and temporal control of activities.

Timber harvest has altered stands of old growth and mature timber in upper portions of the study area, which are important habitats for forest species such as accipiter hawks and some owl species. These habitat changes have benefited other raptor species with tolerance for more open habitats. Thus, conservation of the full compliment of native forest-dwelling raptors requires better understanding of habitat relationships and species interactions, inventory of raptor populations, and careful monitoring of the effects of management activities.

DDT and other organochlorine pesticides have been widely implicated in past, and some continuing losses of raptor populations (Risebrough and Monk 1987). Most of these chemicals are no longer in use in the United States. Other pesticides and herbicides currently in use may cause occasional raptor deaths or reduce prey availability.

New power lines and many new access roads are being built in the study area. Linear rights-of-way associated with roadways and powerlines are often the location of raptor mortality associated with collisions or electrocutions. Vegetation alteration during the siting of roads or powerlines can impact raptor habitat. Mitigation measures include careful consideration of sensitive habitats and use of designs that least endanger raptors.

Development of Swan Valley and the Henry's Fork corridor for homesites and other structures has dramatically increased in recent years. As natural and agricultural open space is converted to other uses, raptor nesting and foraging habitats may be lost. Programs that maintain open space in areas of key importance to raptors are needed. For some of the more tolerant raptor species like osprey and kestrels, artificial nesting structures can in part mitigate habitat losses.

Future Study Efforts

Our 1994 effort at presence/absence sampling has led to a much improved sampling regime for 1995. In the future years of this project, we will refine our objectives and methods as discussed earlier in this report to attain a useful monitoring program.

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