ECOLOGY OF NESTING BALD EAGLES ON THE KENAI NATIONAL WILDLIFE REFUGE, ALASKA

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Abstract: Bald eagles (Haliaeetus leucocephalus) were censused in a boreal forest region on and near the 757,700 ha (1,970,000 acre) Kenai National Wildlife Refuge for the first time in 1979. Although only four active nests were observed in 10 randomly selected 10.4 km^2 (4 mi^2) quadrats, we observed a total of 22 active nests by checking locations where eagle nests had been reported in the past. Twenty-three active nests were observed in 1980. An average of 1.0 and 1.4 eaglets per nesting pair were recorded in 1979 and 1980, respectively. The majority of bald eagle nests were in cottonwood (Populus trichocarpa) or aspen (Populus tremuloides) trees. Eagles preferred nest sites near clear streams where ice breakup occurred early in the spring and where spawning rainbow trout (Salmo gairdneri) and longnose suckers (Catostomus catostomus) utilized streams or lakes. A high concentration of nests was located in the Moose River drainage, but few nests were located in the Swanson River and Chickaloon River drainages. Nest loss, abandonment, and utilization are discussed as well as eagle productivity and food habits.

Most of the information on bald eagles (Haliaeetus leucocephalus) in Alaska has been gathered in remote coastal areas such as Kodiak Island (Hensel and Troyer 1964), Southeast Alaska (Robards and King 1966), and the Aleutian Island Chain (Murie 1940). Few studies have been conducted on more inland populations of bald eagles near areas of rapid human development, leaving a gap in our knowledge of this nation-

ally significant bird. Recent surveys conducted on the Kenai National Wildlife Refuge in Southcentral Alaska have indicated both the eagles' adaptiveness and their vulnerability to human disturbance. Bald eagle nest tree selection, productivity, and food habits were examined, as well as the effect of increasing human activity on the Kenai Peninsula.

STUDY SITES

The 757,700 ha (1,970,000 acre) Kenai National Wildlife Refuge is located in Southcentral Alaska and encompasses much of the lowland boreal forest on the Kenai Peninsula. The peninsula has been repeatedly burned since the early 1900s, and the resulting vegetation types form a mosaic pattern of unevenly aged stands of mature and regrowth timber (Spencer and Hakala 1964). The refuge contains more than 1,200 freshwater lakes larger than 2 ha (5 acres) and has more than 2,100 km (1,302 mi) of streams. Four species of salmon (Onchorhynchus spp.) spawn on the refuge, and other species such as rainbow trout (Salmo gairdneri), Dolly Varden (Salvelinus malma), and longnose suckers (Catostomus catostomus) are common in many of the lakes and streams. Typically the summers are cool, with light to moderate rain, while the winters are cold with complete snow cover from November through April. Lakes and rivers on the refuge freeze over in early November and are open by May.

METHODS

We first censused bald eagles on the refuge in 1979 by using a modification of the quadrat sampling method suggested by Grier (1977). An intense aerial survey of 10 randomly selected 10.4 km^2 (4 mi^2) quadrats produced only four active nests. Based on these results a population of 40 active breeding pairs was estimated for the 1,040 km^2 (412 mi^2) of assumed prime bald eagle nesting habitat on the refuge north of the Kenai River.

Because of the observed distribution of nesting sites, the few nests located, and the amount of time and cost of the survey, that technique was abandoned. Instead, locations where nests had been reported in the past were intensively surveyed. While only 4 nests were located using the quadrat method, 32 nests were found by surveying suspected locations. The refuge staff had observed and recorded most of the nests during extensive aerial surveys for other wildlife on the refuge during the past 25 years. This information made it easier for us to locate bald eagle nests than could have normally been accomplished.

We now make aerial surveys of bald eagle nests by flying to known nests and circling at low speed and altitude (100 m) (328 ft) until necessary data are recorded. We survey each nest twice, once in late May to determine nest activity and once in early August to record eaglet production (Troyer and Hensel 1965). All areas with suspected, reported, or potential nesting sites are surveyed intensively to locate new nests. Six nests not located in 1979 were discovered in 1980 during other types of aerial surveys and from reports from the general public.

In the spring of 1980, eight nests were examined from the ground. Tree height was estimated, d.b.h. was measured, and the nest tree and several adjacent trees were aged with an increment borer. The distance from water and height were estimated for all nest trees during aerial surveys.

RESULTS AND DISCUSSION

Nest Selection

The types of trees selected by bald eagles as nesting sites on the Kenai National Wildlife Refuge were typical of nesting trees selected by bald eagles throughout North America (Troyer and Hensel 1965, Corr 1974, Lehman 1978). Although the preferred species of nesting tree varies with location, the general attributes of a nest tree do not vary (Lehman 1978). Typically, nest trees are close to water, have a clear view to water, are usually the oldest and largest living members of the dominate overstory, and often provide some type of sparse cover above the nest (Hensel and Troyer 1964, Robards and King 1966, Lehman 1978). This general description of nest trees accurately identifies the type of tree that was used by bald eagles on the refuge.

Nest trees found on the refuge were typically cottonwoods (Populus trichocarpa) (77 percent), although aspen (Populus tremuloides) (19 percent) was also commonly used. One eagle pair (3 percent) nested in a white spruce (Picea glauca), but certain characteristics of this nest suggested it was probably originally constructed by an osprey (Pandion haliaetus) and later used by eagles.

The average distance from nest trees to water was less than 0.2 km (0.1 mi) and more nests were close to streams (60 percent) than to lakes (40 percent). Trees selected for nesting by bald eagles averaged about 13 m (42 ft) tall. Nests were built 8-10 m (26-33 ft) above ground, with sparse branches above them, as commonly reported in other areas (Hensel and Troyer 1964, Lehman 1978). Nests on the Kenai Peninsula appeared to be constructed from cottonwood and aspen sticks, with grass linings. This is consistent with information Hensel and Troyer (1964) reported on Kodiak Island. The average age of 23 trees in stands

at eight measured nest sites was approximately 133 years, slightly more than the approximate 100-year average age for trees in the mature forest in the same region (J. Lewandoski, personal communication*).

Fires on the Kenai Peninsula (Spencer and Hakala 1964) resulted in large areas of regrowth vegetation that have undoubtedly influenced nest tree selection by the resident bald eagle population. Approximately 160,000 ha (395,200 acres), 35 percent of the refuge's boreal forest, has burned in the past 40 years, and potential bald eagle nesting trees were destroyed by fires. The absence of eagle nests along most of the Swanson River and portions of the Moose River system is most likely attributable to loss of old trees by fire. Eagle nests found in the burn areas are in mature stands that escaped extensive fire damage.

The distribution of eagle nests on the refuge showed a pattern that suggests nesting bald eagles prefer areas near streams that are clear, slow moving, and relatively shallow, and that are used by spring spawning fish and have fall salmon runs. The Moose River drainage contained the highest concentration of nests (25 percent) of any single river system on the refuge. One factor that sets the Moose River system apart from other river systems on the refuge is the concentration of lakes nearby. These lakes are clear, and most have abundant fish populations. Few nests were located near silty lakes, probably because any factor that reduces fish visibility also reduces fishing success (Grubb 1977). Lakes near the Moose River are often surrounded by strips of mature trees and small knolls. The protection they offer probably adds to the lakes' attractiveness to eagles. The trees and knolls reduce the effect of wind on the water, which increases fishing success (Grubb 1977). The eagles can perch on the numerous tall trees and hunt without expending energy flying. It is possible that these types of lakes may provide fish for eagles when no spawning fish are in the streams. This hypothesis is supported by the fact that 60 percent of all known eagle nests were within 1 km (0.6 mi) of a lake and about 90 percent of all known nests on the Kenai were located in areas with numerous clear, fish-producing lakes. Lehman (1978) reported that 77 percent of all nest sites in California were associated with reservoirs, while 18 percent were located on natural lakes and only 12 percent on rivers or creeks. It was unclear whether eagles chose to nest by reservoirs or whether they had previously selected trees along creeks and remained after the reservoirs were built. However, Lehman's data indicate that eagles nested successfully, utilizing lake habitat almost exclusively.

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Productivity

Two years of data on the productivity of bald eagles on the refuge suggest that eagle production on the refuge was about the same as that in other areas in Alaska and greater than that reported from other areas in North America (Sprunt et al. 1973). In 1979 the average active nest produced one eaglet, while in 1980 each active nest produced 1.4 eaglets. The average eaglet production per active nest was between 0.6 and 1.4 for Kodiak Island (Hensel and Troyer 1964), and 1.4 to 1.6 eaglets per active nest in Southeast Alaska (Robards and King 1966, Corr 1974). These data indicate that eaglet production per active nest on the Kenai may be the same or slightly less than that found in other Alaskan populations. Nesting success in other areas of North America was often less than one eaglet per active nest (Sprunt et al. 1973), while nests on the Kenai have been producing an average of more than one eaglet per active nest.

Other indices of eagle nesting success on the Kenai are similar to those found on Kodiak Island (Hensel and Troyer 1964) and in Southeast Alaska (Corr 1974). Seventy-eight percent of known eagle nests on and near the refuge were active in 1980, while 77 percent were active in 1979. In 1979, 72 percent of the active nests produced eaglets, with 66 percent, 26 percent, and 6 percent of the successful nests fledging one, two, and three eaglets, respectively. In 1980, 78 percent of the active nests produced eaglets with 27 percent, 66 percent, and 5 percent of the nests having one, two, and three eaglets, respectively. Apparently, 1980 was a better year for eagle production on the refuge than was 1979, since a larger number of eaglets was produced and a greater number of nests had two eaglets. Higher production among various raptor populations is usually associated with increased summer food. The higher reproduction rate in 1980 is assumed, therefore, to be due to higher food availability in 1980. Food availability seems to affect the number of eaglets surviving to fledge in each nest rather than the number of adult pairs that nest or the percentage of active nests that are successful.

One hypothesis to explain differences in yearly eagle food availability, as suggested in 1979 and 1980, is linked to winter severity. Breakup in the spring of 1980 was earlier than in 1979, and both lake and stream fish populations may have been vulnerable to eagle predation earlier in the spring. Postupalsky (1967) commented that he believed winter severity had an impact on the reproduction success of eagles. The contrast between 1979 and 1980 eagle productivity data on the Kenai Peninsula could be interpreted as supporting that theory.

In order to examine the impact of human activity on bald eagle nest use and productivity, we arbitrarily separated bald eagle nests on the Kenai into two categories: those that probably experienced some human disturbance and those that probably had little human disturbance.

Of 13 nests that probably experienced disturbance, only 3 (23 percent) produced eaglets in either 1979 or 1980, while 16 (88 percent) of 18 nests that probably experienced little disturbance produced eaglets in either 1979 or 1980. One (8 percent) potentially disturbed nest produced eaglets in both 1979 and 1980, while 9 (50 percent) nests in undisturbed sites produced eaglets in both 1979 and 1980.

This information suggests that bald eagles on the Kenai Peninsula are susceptible to human disturbance and that eagles do not reproduce as successfully in areas of high human activity as they do in more remote sites. Hensel and Troyer (1964) reported that nest abandonment was a major factor in influencing nesting success on Kodiak Island; Robards and King (1966) suggested that human harassment is a factor influencing nest location in Southeast Alaska. Corr (1978) also commented on bald eagle nest abandonment and suggested that disturbance during egg laying and incubation may have been an important reason for nest abandonment.

Most of the human activity classified as disturbance in this paper was occasional and for recreation such as boating, canoeing, and camping rather than for industry or other development. Most of the human activity on the refuge occurs from the end of May to late September and coincides with bald eagle incubation and rearing.

Food Habits

Specific information about bald eagle food habits was not collected on the Kenai. It is generally assumed, however, that fish, particularly salmon, comprise a major portion of the eagles' summer diet, because most of the nests are along salmon streams. Grubb and Hensel (1978) suggested that bald eagles are opportunistic feeders, and several observations from the Kenai support that suggestion. Bald eagles have been known to take snowshoe hares (*Lepus americanus*), gulls (*Larus* spp.), and commonly are observed feeding on moose (*Alces alces*) carrion in the winter. Carrion may be an important winter food source for eagles overwintering on the refuge, and eagles are often reported caught by trappers using exposed baits. Limited information obtained from refuge trapping permits from 1972 through 1976 indicated an average of 6.5 eagles were captured each year, with 80 percent being released unharmed. The actual capture rate is probably much higher than reported because many trappers hesitate to report capturing an eagle. Fish are largely unavailable during the winter, and so small game hunting and scavenging probably play an important part in eagle food habits then.

CONCLUSIONS

Among bald eagle nests surveyed on the Kenai National Wildlife Refuge, nest locations and nest tree selections were typical of the locations and types of trees selected by bald eagles in other areas. The nest tree was generally an older living member of the dominant overstory that is near water. Eagles tended to select trees that were near slow-moving, clear streams that are used by spawning salmon in the fall and spawning trout in the spring, and trees that were near clear, fish-producing lakes.

Eagle productivity on the refuge appeared to be the same or slightly less than that of eagles in other areas in Alaska, while greater than that reported in the continental United States. Eaglet production appeared to vary greatly from year to year. The variation was probably food related. Human disturbance appeared to negatively influence the nesting use and reproduction success of eagles.

Bald eagles on the refuge appeared to depend on fish, particularly salmon, as an important part of their summer diet. Eagles were observed to hunt and scavenge both in the summer and winter. The number of eagles caught by trappers indicates that carrion may be an important food source during the winter. The food habits of bald eagles on the refuge could best be described as opportunistic.

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