Nesting Bald Eagles (*Haliaeetus leucocephalus*) in Urban Areas of Southeast Alaska: Assessing Highway Construction and Disturbance Impacts

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The impact of human-caused disturbance on the nesting success (productivity) of bald eagles in Southeast Alaska is discussed. The literature on disturbance of raptors generally and bald eagles specifically was reviewed. Raptor biology and behavior as they may be related to disturbance and habituation of eagles are discussed. Examples of nondisturbing highway construction completed within the standard buffer zones and time frames to protect eagles as recommended by the United States Fish and Wildlife Service for Southeast Alaska are presented. Energy (time) budget research to determine levels of (and possibly define) disturbance of bald eagles is briefly explored. A case-by-case approach to prevent disturbance of nesting bald eagles during highway construction, as required under the federal Bald Eagle Protection Act, is proposed. The approach allows incorporation of realistic, enforceable stipulations in project environmental and construction bid documents to protect nesting bald eagles, yet maximizes the flexibility necessary to schedule highway projects to minimize design and construction costs.

In Southeast Alaska (Figure 1), bald eagles (*Haliaeetus leucocephalus*) that have chosen nest sites in or near urban areas are often acclimated to high levels of human activity. The Alaska Department of Transportation and Public Facilities (ADOT&PF) has found that for these urbanized eagles, current U.S. Fish and Wildlife Service (FWS) guidelines on blasting and general highway construction to prevent disturbance of nesting bald eagles under the Bald Eagle Protection Act can be too restrictive.

The FWS basic stipulations to protect nesting bald eagles state that to permit eagles to initiate nesting activities there should be no heavy construction work within 100 m of a nest from March 1 to May 15, and this period should continue to August 31 if the nest is occupied (*1*). If the nest is not occupied by May 15, construction activities within 100 m can proceed. For blasting, the timing restrictions remain the same, but the buffer zone is 800 m.

Some recent ADOT&PF projects have involved blasting and heavy equipment work near eagle nests within the FWS buffer zones and time frame. The pairs of eagles using these nests successfully raised young during the affected nesting seasons. In addition to this field information, ADOT&PF undertook this study to evaluate the existing literature on disturbance of nesting eagles and methods of monitoring disturbance. On the basis of the findings of the study, the department recommends that the FHWA develop a memorandum of agreement (MOA) with the FWS to (a) on a case-by-case basis, mitigate or monitor potential impacts from construction on eagle nest trees to prevent disturbance, and (b) undertake research to better define disturbance.

Increases in location and design costs caused by mitigation or monitoring on a case-by-case basis will be more than offset by the minimization of both construction delays and elevated costs caused by the presence of active eagle nests adjacent to highway construction projects.

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BACKGROUND AND HISTORY OF DISTURBANCE STUDIES

The federal Bald Eagle Protection Act of 1940 prohibits the taking of bald eagles (including nests or eggs) at any time or in any manner without a permit. As defined in the Act, "taking" includes "molest or disturb"; however, nowhere in the Act (or implementing regulations) are these two terms defined. To date, case law offers the only definition of what may constitute "molest or disturb."

The eastern region of the U.S. Forest Service implemented a policy of establishing buffer zones around individual bald eagle nest trees in 1963 (*2*). Whether the FWS concept of buffer zones evolved from this policy or was established independently is unclear.

Early Studies

Early investigations of potential impacts of human activities on nesting bald eagles have been documented in the literature (*3*,*4*). Quantification of impacts in these studies has been general, focusing on the human activities involved, then attempting to measure nest abandonment or lowered productivity as an indication of disturbance. Nests were usually grouped into disturbed and undisturbed categories.

One of the first studies to evaluate human disturbance as a potential cause of nesting failure among bald eagles was carried out in the Chippewa National Forest in Minnesota (*2*). Results indicated specific types of human activities did not significantly disturb nesting eagles. A major component

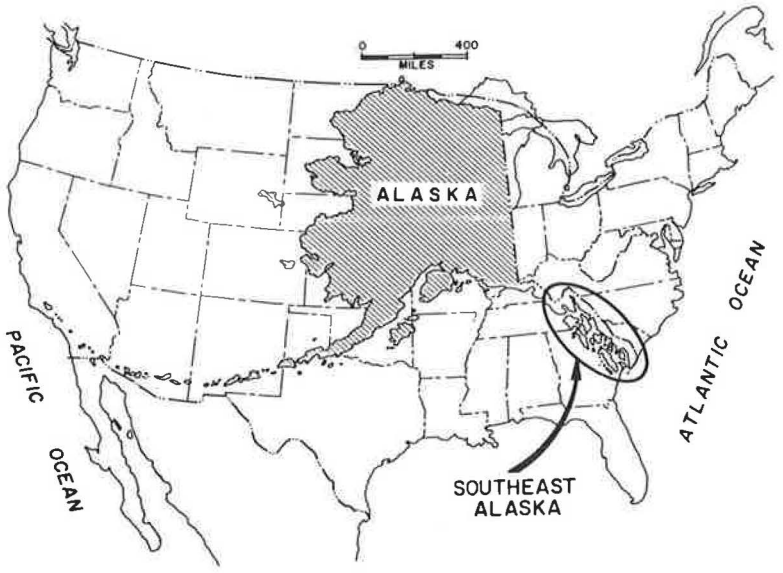

FIGURE 1 Alaska and the Lower 48.

of the disturbances was human recreational activities that took place from mid-June throughout the rest of the summer. These activities occurred after nests were established and the young hatched, the two most critical time periods from a disturbance standpoint. Nest occupancy and fledging of young were used as measures of nesting success.

Two other researchers (*5*) on the Chippewa National Forest classified four different levels of disturbance within 1 mi of nests. Analysis of the data showed a negative relationship between both apparent nesting activity and measured production as compared to degree of disturbance. The ratio of activity to productivity was better with lesser disturbance.

A study on the Kenai National Wildlife Refuge in Alaska (*6*) separated eagle nests into disturbed and undisturbed categories. Human disturbance was not quantified, and apparently no statistical analyses were made of the productivity data, but the study indicated human disturbance can decrease productivity.

Another study in the Chippewa National Forest (*7*) found no evidence that under management policies at that time, natural or induced human activities had any major impact on bald eagle reproductive success. The authors concluded that, "birds at unsuccessful nests, as a group, were not exposed to higher levels of human activities than birds at successful nests." The investigators went so far as to suggest:

> [E]xperiments in which a substantial number of eagles are disrupted to the point of nest failure by a variety of human activities will have to be carried out in a number of different areas in order to address this question (of the affects of human disturbance on nesting eagles) adequately. The relatively stable population of eagles in Alaska and Canada could be used in such studies.

The use of the word "disrupt," i.e., to break apart, rupture, to throw into disorder, or to cause to break down, implies that levels of disturbance that do not cause nest abandonment are acceptable. This approach is extreme and unnecessary. The investigator's straightline approach toward a nest, with pausing at 20-m intervals in plain view, until the attending adults flush, is unnatural human behavior and is directly threatening to nesting birds. The technique may have been designed for statistical analysis rather than duplicating normal human-induced disturbance factors. The principal investigator of the FWS Eagle Management Studies Program in Southeast Alaska (Jacobson, unpublished data) agrees that any direct threats by man can significantly impact breeding behavior and success.

More recent work in western Oregon (*8*) characterized 201 bald eagle nest sites in three different forest types over four nesting seasons. Mean productivity was "lower at sites altered by logging or other human disturbance," particularly clear cuts, main logging roads, and nonrecreational human activities. In given nesting territories, most newer, more recently used nests were farther from human activities than associated older nests in these same territories.

The researchers measured many variables to characterize individual nest trees, the forest stand surrounding each nest tree, and human activity. Many of the human activity categories were actually measurements of habitat alteration over time rather than direct impacts of day-to-day human activities on nesting birds. Clearcut logging and associated roadways plus nonlogging roads and highways, public facilities, and private homes were some of the major human activities measured.

Other studies (*9–11*) have also demonstrated lowered productivity and site desertion associated with human disturbance at bald eagle nest sites.

Activity Budget Approach

The current approach to quantifying impacts of disturbance to raptors is typified by the use of the activity or energy budget on peregrines in the Sagavanirktok River drainage in Alaska (*12*). The technique consists of determining the energy budgets of undisturbed nesting birds and then statistically com-

paring them with the energy budgets of those same birds (or other nesting pairs) under disturbed conditions. The energy budget is the amount or percent of time (or energy) expended by an animal in performing various behavioral activities as determined through field monitoring. No significant difference in the two sets of data indicates no impacts to breeding success from the disturbance under consideration.

In this study, behavioral and environmental data were recorded both on activity and disturbance forms for each half-hour of observation at each nest site. Observations focused on the attending adult at the nest or in the adjacent cliff area. During experimental disturbances, intensive observations were made on the focal bird. Each recorded disturbance was described by several characteristics: (a) behavior of the birds before disturbance, (b) type of disturbance (other species, helicopter, light truck), (c) degree of reaction of the birds (none, mild, moderate, severe), (d) duration of disturbance (time within restricted zone), (e) duration of reaction of the birds, (f) direction (in relation to falcons), (g) distance (closest linear distance to falcons for all disturbances, and altitude for avian predators and aircraft), (h) noise level (none, low, medium, high), and (i) visual stimulus (none, unlikely, probably, positive).

Experimental disturbances included construction and maintenance equipment, airplanes, river boats, snow machines, and people on foot. The type and timing of experimental disturbances were varied to simulate both normal and unusual disturbance activities.

The author tested the "hypothesis that time spent in each activity category did not differ among the two disturbed and the undisturbed activity budgets. . . ." He then used a battery of nonparametric analyses of variance to determine levels of significance. He concluded that the disturbances studied "did not cause significant changes in the time spent in important behaviors (e.g., incubation), and did not cause measurable impacts on occupancy or productivity."

Although no significant differences in activity budgets with regard to specific human activities indicates no disturbance, significant differences may begin to define disturbance from a biological standpoint, that is, by causing reduction in current and future productivity. For example, operation of heavy equipment adjacent to a nest in the early morning hours may significantly reduce parental feeding behavior of newly hatched young to the point of lowering productivity.

The basic activity budget approach is also applicable to bald eagles (*13*). This pioneering study on quantifying the nesting activity (time) budgets of bald eagles in Southeast Alaska concluded, "Detailed accounts of nesting time budgets are needed to develop criteria for bald eagle management in areas where the potential for human disturbance is of concern." Remote, time-lapse movie cameras were used to "document the amount of time adults spent at incubating, brooding, and feeding at the nest, with specific emphasis on: the division of these activities between the male and female, temporal changes in time budgets, and the effects of several environmental parameters on nesting time budgets."

Time-lapse photography provided instantaneous samples, single-frame exposures every 90 sec. The films were developed and then analyzed with a time-lapse analyzing projector. Activity data were punched directly into a computer for analysis. Results indicated significant differences both in individual and pair activity budgets with regard to human disturbance, incubation, brooding, prey deliveries, feedings, and effects of weather on nesting activities. With respect to disturbance, reactions were variable, "but . . . most eagles were extremely sensitive to intrusion during incubation and for the first one or two weeks after hatching."

Video equipment has also been used to monitor nesting bald eagles in California and Arizona (*14*). These continuous real time observations lend themselves to a variety of analyses unlike time-lapse photography, which records data at preset intervals.

Habitat Disturbance

Observations and data collected during most of the disturbance studies attempted to measure only the direct impacts of human activities on the nesting eagles themselves. The more important long-term problem of the loss of bald eagle nesting habitat caused by human activity (disturbance) must always be kept in mind (*1*,*7*,*8*,*15*). Existing nest trees will eventually be lost from one cause or another, such as decay, blowdown, or human activities, and, therefore, over the long term, alternative sites must be available to maintain viable eagle populations.

In a study of the relationships of bald eagle nesting to forestry practices near Petersburg, Alaska, from 1967 through 1969 (*15*), nest sites located in the fringe of timber left along the beach as a result of logging were found to be highly susceptible to wind throw. In one winter, 1968–1969, 20 percent of the known nests were lost to storm damage. Buffer zones of 660 ft and reduction of beach strip logging to ensure potential nest sites were recommended.

In an attempt to minimize impacts on eagle nests and nesting on federal lands in Southeast Alaska, the U.S. Forest Service (FS) and the FWS entered into a memorandum of understanding (MOU) in 1968. It requires the FS to "establish and maintain a minimum five-chain radius habitat management buffer zone around each bald eagle nest tree and exclude all land use activity within the zone." It also provides a mechanism for possible variances to these buffer zones. However, the FS and the FWS jointly agree that to "maintain the bald eagle nesting population at natural levels of abundance, a sufficient number of trees, suitable for supporting eagle nests and properly distributed along the shoreline, must be present in perpetuity." Neither "natural levels" nor "sufficient numbers" are defined.

In 1979 and 1980, bald eagle nests in Southeast Alaska were surveyed before and after logging to assess the adequacy of the 100-m buffer zone to protect nests and nesting habitat (*1*). Few of the clearcuts in the study were adjacent to the 100-m buffer zones. However, had clearcuts been adjacent to all buffer zones, "loss (due to wind throw) would have averaged 17 percent of the buffer zone after just a five-year period." If the clearcuts had "surrounded the 100-meter buffer zone, potential would exist for much greater losses to blowdown." The author concluded, "the loss of nesting habitat from blowdowns adjacent clearcut areas will probably cause the most serious long-term problems for eagles under the existing management policy." Similar problems have been documented in the coterminus states (*8*).

The potential loss of future nesting habitat becomes heightened in urban areas where land ownership shifts from unreserved public lands (those left in their natural state) to public use and private lands. The Bald Eagle Protection Act can be implemented to protect nesting eagles and existing nest trees but cannot exclude construction of highways, homes, businesses, and other urban amenities in areas that may some day provide future eagle tree nest sites. Thus, the availability of potential nest trees may depend on reserving parcels of unreserved public lands and fortuitous retention of suitable sites on private lands.

Legal Definition of Disturbance

Even though evidence clearly demonstrates eagles can be disturbed to the point of deserting their nests and young, legal action to halt such activities seems to require proof of negligence or show of intent to do harm. The Bald Eagle Protection Act itself states, "Whoever . . . shall knowingly, or with wanton disregard for the consequences of his act take . . ." A case in point (*16*) involved an eagle nest in the Juneau area on private property that was being developed. The owner was observed clearing and burning brush near the nest site in March. He was informed of the presence of the nest, given a copy of the Bald Eagle Protection Act, and advised not to disturb the birds from March through July. He indicated he would not disturb the area. The eagles selected the site and nested. In late April, the owner, disregarding his earlier statement, began clearing and burning again. Drifting smoke disturbed the adult eagles. The owner was warned again. The adults abandoned the nest in late June. Subsequent field investigation revealed a dead eaglet at the base of the nest tree. The owner and an employee were each fined $200 for what Schempf called an "open and shut case of willful disturbance that ultimately caused the death of the eaglet."

Although existing case law may define disturbance from a legal standpoint, there is a difference between the point of successful criminal prosecution and a more conservative point of acceptable management impacts associated with disturbance (Schempf, unpublished data). From both legal and biological standpoints, there is a need for a functional, biological definition of disturbance. An emerging approach for defining disturbance is maintaining long-term productivity. Assuming adequate food resources, the number of available nest sites and the number of young raised per nest site each year are the key factors of the long-term productivity equation. Of course, productivity data must be balanced against mortality and survival rates.

Questions that must be addressed in fine tuning this definition are as follows:

- Should the definition include an assessment of current and potential levels of bald eagle productivity?
- Should it include measurement of lowered productivity during the time of disturbance?
- How would productivity be measured?
- Would the definition require abandonment of nest, eggs, or young?
- Would successful nesting in successive years counterbalance specific levels of disturbance from human activities, particularly during years of high eagle populations?

Development of a functional definition of disturbance is also in the best interest of state and federal highway agencies. It should lead to more cost-effective and expeditious development of public works projects.

RAPTOR BIOLOGY AND BEHAVIOR, EFFECTS ON POTENTIAL NESTING DISTURBANCE

For most raptors, the main habitat requirements for nest selection and successful rearing of young are (a) adequate food supplies before and throughout the breeding season, (b) a satisfactory nest site with associated perching areas, and (c) visibility of adjacent territory or feeding grounds (*4,17–20*). The more completely these three conditions are met, the less raptors are disturbed by human activities.

Work with peregrine falcons (*Falco peregrinus anatum*) in the Yukon Territory (*18*) indicates that "physiological condition of breeding females may be the key factor in regulating annual breeding success." Breeding success was considered to be strongly and inversely tied to the energy requirements expended during spring migration by breeding females and could affect the psychological as well as physiological conditioning of the birds. Does this type of preconditioning also affect the breeding success of bald eagles? Evaluating the physiological condition of nesting eagles may be a base ingredient in any monitoring program and should include quantitative and qualitative measures of available food sources within individual nesting territories.

An interesting situation with respect to preconditioning in nesting bald eagles seems to occur annually in the Chilkat Valley near Haines, Alaska (Jacobson, unpublished data). Observations during late spring nesting surveys conducted by the FWS in the middle to upper Chilkat Valley show average, though often variable, densities of active nests. However, their observations during production surveys flown later in the summer indicate very low nesting success. The middle Chilkat Valley, with its abundant winter food source of spawning salmon, is an important over-wintering area for bald eagles, particularly young birds. A certain percentage of young and maturing birds may orient to the area, making their first nesting attempts there. During the spring and early summer, the large spawning runs of salmon are not present, however. The low nest success rates may be from inexperience, or the combined impacts of high nesting density and inadequate food supply. These nesting pairs may be severely stressed, making them susceptible to even low levels of human disturbance. In this situation, any loss of productivity caused by human disturbance of a marginal breeding population may be insignificant. Also, early termination of what would normally be an unsuccessful nest may free up food resources for another marginal pair to raise their young to fledging.

Human activity may also increase the local food supply and thus concentrate eagles (*21*). Bald eagles frequently used a garbage dump on Amchitka Island, Alaska (*22*). A high percentage of use was by subadult eagles; however, adults did use the dump as a supplemental food source. During the winter and early spring months, the dump may have been an important supplemental food source for young birds and potential nesting pairs.

An experimental winter feeding program for eagles was carried out in Maine from 1981 through 1985 (*23*). During

this period, 98,000 kg of carrion were dispensed at feeding stations in four major eagle wintering areas. First- and second-year birds became heavily dependent on the artificial food source, with older birds less dependent. Analysis of banded birds showed productivity of local populations near feeding sites was enhanced.

The relative health of any population under study must be considered along with preconditioning when attempting to determine the effects of human activities on nesting bald eagles. The estimated bald eagle population of Southeast Alaska was approximately 7,000 adults for both 1967 and 1977 (*24*). In the FWS's Seymour Canal Study Area in Southeast Alaska, productivity exhibited a broad scale decline in 1979, 1980, and 1981, dropping by almost 50 percent for unknown reasons (*1*). The most recent aerial census of bald eagles in Southeast Alaska indicated a total adult population of close to 12,000 birds (Jacobson, unpublished data).

The bald eagle population may be peaking in Southeast Alaska (Jacobson, unpublished data). The rate of population increase is slowing and reproductive rates are dropping off.

With large population fluctuations over an extensive area in Southeast Alaska, there remains a provocative question that should be addressed in any definition of disturbance from a biological standpoint. What is the real biological impact of 1 year of reduced or missing production from one to a few nests either on a local population or the larger regional population? Long-term cumulative impacts of individual projects must also be considered.

Another important variable that must be considered is the individuality of the birds. For peregrine falcons (*25*), variations "in response to a disturbance exists between individuals, . . . in one individual over time, . . . and in one individual's reaction to different types of disturbance." Also, "a complex array of factors may influence a peregrine's response to disturbance, and perhaps more important, the reaction of the falcon in any particular instance is highly unpredictable." Factors that may affect a given bird's response to disturbance are "nature of the disturbance, type and severity, frequency and duration, distance from nest site, height of nest above river, presence of intervening topographical features, time relative to reproductive phenology" and "sex, age and breeding status of the individual(s)."

This same difficulty of predicting the effects of a given type of disturbance applies to individual bald eagles because of their variable responses to human activity (*19*).

The variability of reactions of individual bald eagles to the climbing and placing of cameras in eagle nest trees or adjacent trees was documented in a study of bald eagle nesting activities on Admiralty Island, Alaska (*13*). One female returned to the nest while the camera was still being mounted in a tree less than 30 m from the nest. At another nest, the female returned within a few minutes of the researcher's descent from the camera tree. At a third site, the male was the first to return, but not until nearly 2½ hr following camera installation.

The individuality of raptors also influences the degree to which particular birds or pairs of birds can become habituated to human activities (*7,26*). Habituation is the nonreaction of an animal to nonthreatening, usually repetitive events, although there is often a behavior threshold beyond which the involved disturbance is unacceptable. At that point, avoidance behavior sets in and nest abandonment may occur. This threshold, for raptors in general (*12*), is "influenced by season, age, sex, previous breeding experience, health of birds, weather and/or prey availability." In the Admiralty Island study (*13*), some eagles abandoned nests because of installation of nest monitoring cameras. However, in the 2nd year of the study, the researcher made regular visits to the study nests before installation of the cameras and found it greatly reduced nest abandonment.

Analysis of data gathered on the Chippewa National Forest (*7*) suggests "eagles avoid human settlements when building new nests." Settlements consisted of clusters of houses occupied throughout the year. The availability of nest trees in the area was not the limiting factor (Mathisen, unpublished data). However, on the basis of recent observations, some newer territories (1986–1988) have been established closer to the housing areas. This proximity is probably a result of habituation and the population's approaching saturation density. Current nesting data indicate a slowing of the population growth rate coupled with a reduction in productivity.

The fact that bald eagles nest and successfully raise young in urban areas demonstrates that the required nesting habitat is present and any needed physiological preconditioning dependent on availability of foods has been met. Man-caused disturbance factors are usually greater in urban than wilderness or rural areas, so it follows that these breeding pairs of eagles are tolerant of, or have become habituated to, some degree of human disturbance. Several current researchers (Ambrose, Cain, Lincer, Mathisen, and Ritchie, unpublished data) agree.

From 1981 through 1987, 215 nestling bald eagles have been captured by the FWS in Southeast Alaska for translocation to the contiguous 48 states (*27*). Most of these birds, 180, came from the Chatham Strait study area, which mainly includes the eastern coastline of both the lower Chilkat Peninsula and Chichagof Island. These 180 eaglets constitute a 59 percent removal of the 303 young available on the entire study area over the 7-year period. A control area is located near the removal area. Study data show "an increasing trend in production of (total young) for the experimental area and a decreasing trend for the control area." The high productivity rate could be caused by the removal of the nestlings, which "may have actually created a positive reproductive response in the experimental area." In addition, the number of young raised per occupied nest was identical for the experimental and control areas. Therefore, the author concludes, "no detrimental effect on productivity has been detected from removal of young during the 7-year study period."

Recent work by the FWS Eagle Management Program indicates nest densities along the Juneau road system, particularly the Auke Bay area, are higher than in many nonroaded portions of Southeast Alaska. Also, productivity appears to be comparable to, or in some cases exceed, other surveyed areas.

The FWS has collected several years of nesting success data both for the Juneau urban area and the remote Seymour Canal study area on Admiralty Island. These data should be analyzed to determine the degree to which overall impacts of urbanization have affected long-term eagle nesting success and productivity.

The argument can be made that the Mendenhall River estuary, biologically rich Auke Bay marine waters, and associated

uplands are prime eagle nesting habitat and that eagle nesting densities and productivity were substantially higher before urbanization. Although this may be so, unfortunately, no historical productivity data are available to substantiate this hypothesis. On the other hand, the data indicate that as long as nest sites are available, the eagles will occupy them and successfully produce young at rates similar to nests in nonurbanized areas. This would tend to indicate the limiting factor is the number of available nest sites (or territoriality) rather than food supplies or disturbance by human activities in the area. The head of FWS Southeast Alaska Eagle Management Studies feels there is no one limiting factor (Jacobson, unpublished data). He feels food supplies may be the key. If food is plentiful and trees are available for nesting, then the eagles will use the trees to nest.

The bald eagle population may be peaking in Southeast Alaska (Cain, unpublished data; Jacobson, unpublished data). The rate of population increase is slowing and reproductive rates are dropping off.

URBAN EAGLES IN SOUTHEAST ALASKA—THE NEED FOR CASE-BY-CASE ASSESSMENT

As demonstrated in the four cases to be discussed, the bald eagle's tolerance of, or acclimation to, human disturbance in urban areas, at least in Southeast Alaska, can be high (Figure 2).

Stabler Point

This nest is located along biologically rich Auke Bay, near Juneau, Alaska. Before highway construction in the area, the nest tree was approximately 50 m from the edge of a 20-m rock cliff. Following highway construction, the nest was less than 15 m from the edge of the cliff. Historically, the nest has been regularly productive. Eagles successfully raised two young in the nest during the 1981 and 1982 nesting seasons when removal of the rock face through the use of explosives and general highway construction activities occurred.

Recommendations in the ADOT&PF construction contract required blasting within 800 m and general construction activities within 100 m be suspended during the March 1 to April 30 nest selection period. If the eagles selected the nest, the restrictions would continue through August 31. If they did not select the nest by April 30, construction could resume.

In 1981, the contractor did not finish drilling and blasting by March 1 and asked for a 3-week extension. The FWS required blasting and construction to be monitored to prevent substantial disturbance of the nesting eagles. Nine rock blasts were monitored from March 3 through March 13, 1981. During these shots, eagles attending the nest flew nine times (64 percent) and did not fly five times (36 percent). Other reactions such as raising wings and staring in the direction of the blasts indicated some level of disturbance.

Construction noise levels measured at the base of the nest tree ranged from 40 to 50 dBA. Light planes flying nearby registered 55 to 65 dBA. Background noise levels ranged from 40 to 50 dBA. Aircraft overflights were in the mid-50- to 70-dBA range with peaks at 75 and 80 dBA.

At least seven shots occurred the next year from March 2 through March 17. Reactions of the nesting eagles were not monitored, nor were any noise measurements taken.

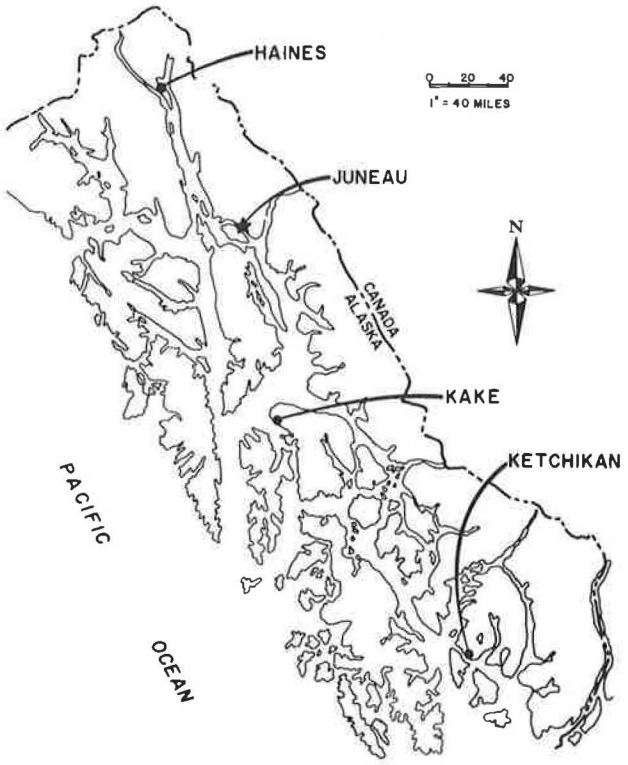

FIGURE 2 Southeast Alaska.

North Tongass

This project consisted of reconstructing the North Tongass Highway from the Ketchikan city limits to the Ward Cove bridge. One large area of rock blasting occurred in the Ward Cove cannery area. Two eagle nests are located near the rock removal area, one at about 230 m distance and the other at about 500 m. Over the past several years, one or the other nest has been occupied; however, during the 1988 blasting period, both nests were occupied (Jacobson, unpublished data). At least one young was fledged at each site.

In March of 1988, ambient noise levels, mainly caused by aircraft traffic, were measured twice at the nest nearest the blast area. Noise levels from 18 aircraft were measured during 1 hr on the 1st day and from eight aircraft during 1 hr on the 2nd day. Noise levels generated by these aircraft generally were in the mid-50- to mid-60-dBA range. Two helicopter flyovers registered 65 to 67 and 75 to 76 dBA. The loudest noise levels were produced by two Dehavilland Beaver aircraft, 78 and 94 dBA. General highway traffic noise averaged in the 40-to-50-dBA range with highs in the 50-to-60-dBA range. Two rock blasts were monitored at a point 60 m closer to the blast from the nest site. One registered 54 dBA; the other less than 50 dBA.

At the nest farther from the blast area, ambient noise levels were monitored for only one 1-hr period and no blasts were monitored. Again, aircraft were the main generators of noise, with 10 overflights. Half of the aircraft registered in the 50-to-60-dBA range. Two helicopters measured 63 to 66 dBA,

two Beavers registered 60 to 67 dBA, and one unknown aircraft registered 70 to 72 dBA. General highway traffic noise ranged from 40 to 50 dBA. This site was noticeably quieter.

Both nests are well within the 800-m buffer zone for blasting recommended by the FWS. Blasting and removal of the first lift of rock occurred before eagle nest selection. Succeeding blasts were below the edge of the cliff, which was oriented away from the eagle nests. The blasts were small, generated velocities of less than 2 ft/sec at 30 m distance, and occurred on a regular basis, usually at 10:00 a.m. daily.

Fred Meyers

This nest is located to the north behind Fred Meyers. It is 15 to 20 m from the Old Glacier Highway in Juneau and has been used regularly for a number of years.

In 1988, firewood logging occurred throughout the nest selection period. Some trees within 10 m were felled. General noise levels at the base of the nest tree were monitored in mid-June during a 1-hr period from 3:00 to 4:00 p.m. General highway noise from the Egan Expressway (approximately 400 m distant) ranged from the mid-50s to the low-60s dBA. Peak vehicle noises and light planes at the Juneau International Airport averaged 68 dBA. Nineteen sight-seeing helicopter overflights averaged 78 dBA. The helicopter flights most likely started in mid-May with the beginning of the tour boat season. This disturbance would have followed nest selection and probably hatching. Also in mid-June, a bulldozer was used to grade the vacant lot across the Glacier Highway at about 75 to 100 m from the nest. FWS personnel on a helicopter survey, July 27, 1988, found two young in the nest. On August 31, 1988, one fledged young was seen perched near the nest.

Kake

This nest is located adjacent to Keku Road about 1.5 km south of Kake and just north of the Alaska Marine Ferry Terminal. No noise or other disturbance data are available for this nest, which has been regularly active over the last several years. The nest tree is located approximately 30 m from the centerline of Keku Road, 30 m from the communities' diesel-fueled power generating and transformer station, 40 m from an active fuel tank farm, 10 m from fuel supply lines, 60 m from a service station, 70 m from a heavy equipment maintenance station, 75 m from a new port facility, 45 m from an operating cannery, and 170 to 330 m from an intermittently used rock quarry. All of these facilities are in plain view of the eagle nest. Also, heavy equipment from road graders to logging trucks frequently traverse the road.

The conclusions of the following study probably apply to all raptors, including the bald eagle and the mandates of the Bald Eagle Act. The work deals with a study of the protection of peregrine falcons from disturbance under the Endangered Species Act of 1973 (*25*) on the basis of a review of the literature and the results of a questionnaire the FWS sent out to biologists who have worked closely with the peregrine and other raptors in Alaska.

Citing several cases documenting the variability of reactions among individual peregrines to human disturbance, the researcher concludes, "it is extremely difficult to draw upon observations of individual birds or pairs to make inferences about the sensitivity or behavior of an entire population or species." This same variability of peregrines to a particular response "poses something of a dilemma to (any) attempt to develop protection measures."

The author acknowledges that the current recommended restrictions on human activities near peregrine aeries "are not inviolable." They are intended to aid responsible agencies as to whether proposed activities may affect the peregrine. When a proposed action might violate any of the restrictions, the initiator of the action "must enter into consultation with (the FWS) to examine in detail the proposed activity and its effect on" the peregrine. This type of "biological assessment" is required under Section 7 of the Endangered Species Act.

Two pertinent responses quoted from the review of the questionnaire are as follows:

1. "All respondents affirmed that the distance at which restrictions should apply should depend on the nature of the activity, time during the breeding season, and local topography. The desirability of a case-by-case review was expressed."
2. "All respondents agreed that human activities should be restricted near nest sites. Approximately 50 percent of (the) biologists who answered the question qualified their answers, stating that the nature of the intrusion, distance from eyrie, and presence of intervening topography should be considered, and that human activity need not be restricted in all cases."

Researchers in Minnesota (*7*) concluded, "Not only are individual eagles likely to differ in their response to disturbance, but the same eagles may respond differently at different times. . . ." Because this tolerance to human disturbance can vary among populations, they strongly recommended that "buffer zones be based on data from each managed population and, to the extent possible, from observations of specific pairs of eagles." This recommendation supports the concept for creating management plans for individual pairs of nesting eagles (*28*). Several other researchers agreed that guidelines need to be developed on a case-by-case basis (Ambrose, Grubb, Schempf, and Ritchie, unpublished data).

The general application of the FWS guidelines (800 m for blasting and 100 m for general construction during nest selection and nesting) in urban areas certainly may not always be appropriate. Case-by-case analysis in FHWA project development procedures should expedite needed public works projects and save money, yet adequately maintain nesting viability of bald eagles in urban areas. However, case-by-case analyses will have to be based on field research, particularly activity (time) budget studies tailored to specific bald eagle nesting situations.

RECOMMENDED APPROACH

The following procedure for assessment of potential disturbance of nesting bald eagles on a case-by-case basis and incorporation of needed stipulations in design and construction projects is recommended:

1. In consultation with the FWS, assess known eagle nests during the reconnaissance/location phase that lasts 1 to 2 years.

Measure ambient conditions, particularly human disturbance in relation to the nesting sequence. Evaluate potential disturbance of nesting eagles by proposed construction techniques, including effects on wind firmness of nesting trees. Consider use of habituation to acclimate the birds to minimize impacts of construction. Include required or recommended procedures in the project environmental document.

2. Incorporate required or recommended procedures into the design phase of the project. Initiate habituation, if necessary, at this time. Identify potential construction disturbances that may significantly alter nesting behavior, thereby halting construction.

3. Clearly list, in the project bid documents, any limitations on construction procedures or timing (as determined in Items 1 and 2). Clearly state conditions under which field monitoring may be required. List any known conditions under which work will or can be modified, curtailed, or rescheduled.

4. During construction, perform field monitoring (using a trained observer) to ensure contractor compliance with stipulations as spelled out in contract bid documents. Where necessary, monitor eagles to track those situations that might require project alteration or shutdown.

5. Summarize field data and notes in a project construction monitoring report. The report should assess the project construction guidelines to minimize disturbance as stipulated in the bid documents and how they were implemented during construction. This report should include recommended changes or improvements for future projects. A copy should be sent to the FWS for their review and comment.

6. Monitor nest use and productivity in succeeding years to confirm the level of construction impacts. Without banding, nest site tenacity is an unknown. However, assuming nest sites are the limiting factor in urban areas, continued use of the site following construction may indicate no appreciable impacts from construction activities.

CONCLUSIONS

Protecting nesting bald eagles near highway construction projects is not always a simple matter of merely applying the buffer zones and timing constraints as recommended by the FWS. The 100-m buffer zone for general construction, 800-m buffer zone for blasting, and the timing restriction of March through August for active nests are often too restrictive. This is particularly true for eagles nesting in urban areas. In Southeast Alaska, the March through August closure is three-fourths of the average construction season. Unnecessary restrictions on construction timing or techniques can significantly increase project costs.

An array of variables including food supplies, satisfactory nest sites, and innate and learned behavior of individual birds can greatly affect nest site tenacity of any given pair of bald eagles. The greater the nest site tenacity, the less potential disturbance caused by construction activities. In order to address this variability, each nesting pair must be addressed on a case-by-case basis. As demonstrated in the case studies presented, construction can often proceed within the FWS-recommended buffer zones and timing restriction.

A systematic methodology to assess eagles on a case-by-case basis should be developed in consultation with the FWS. This approach to maintaining long-term productivity of eagle nests adjacent to urban construction projects should show good faith intent to abide by the mandates of the Bald Eagle Protection Act. Addressing the potential construction impacts on nesting bald eagles and prescribing mitigation measures in the project National Environmental Policy Act document, plus implementing the agreed-to stipulations to prevent disturbance during construction should also avoid legal action.

Incorporation of realistic, enforceable stipulations in project environmental and construction bid documents in a timely manner is necessary. It would allow the maximum flexibility necessary to schedule highway projects to minimize design and construction costs.

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