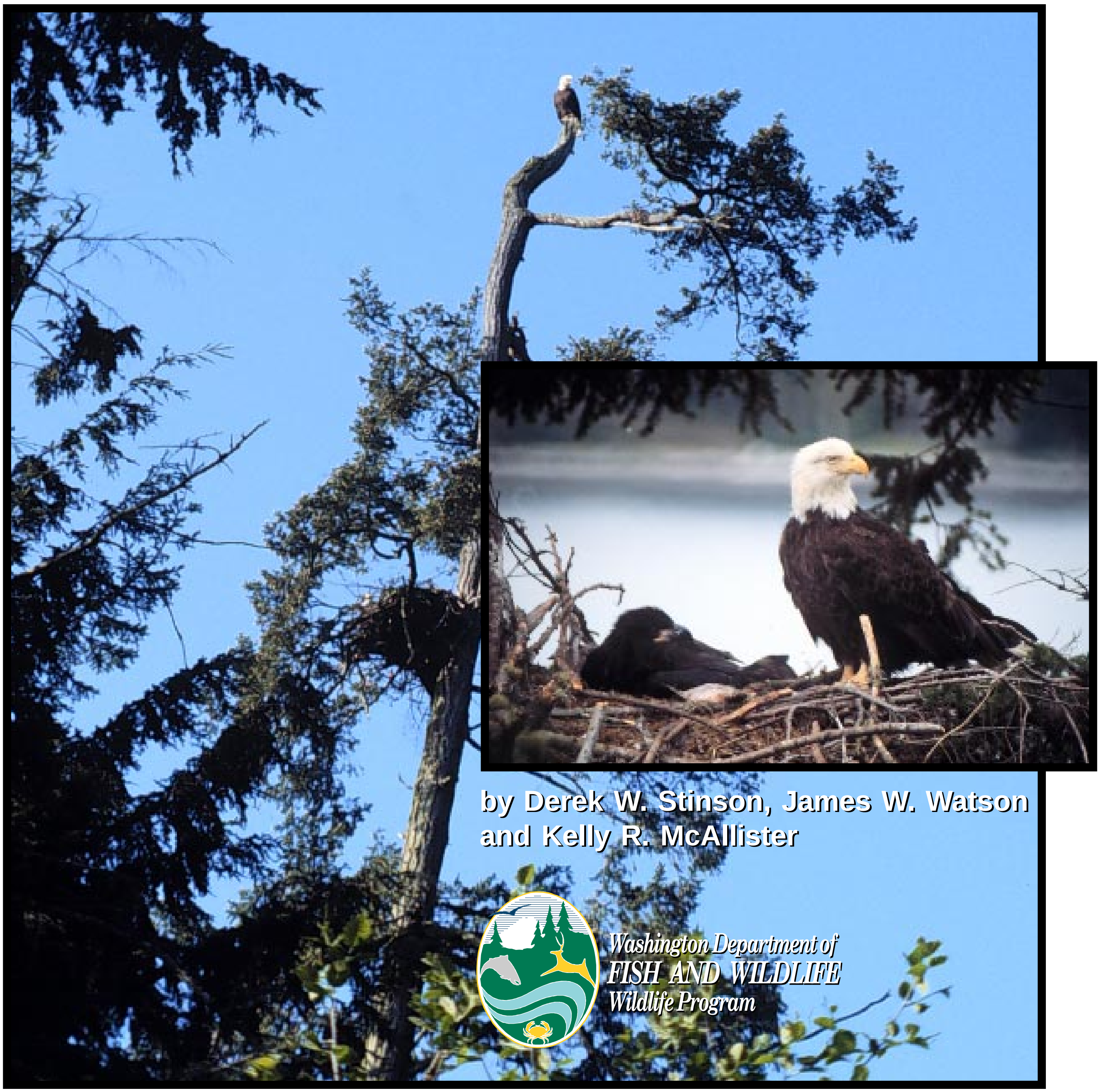
STATE OF WASHINGTON October 2001

Washington State Status Report for the Bald Eagle



by Derek W. Stinson, James W. Watson and Kelly R. McAllister

Washington Department of
FISH AND WILDLIFE
Wildlife Program

WDFW 759

The Washington Department of Fish and Wildlife maintains a list of endangered, threatened and sensitive species (Washington Administrative Codes 232-12-014 and 232-12-011, Appendix I). In 1990, the Washington Fish and Wildlife Commission adopted listing procedures developed by a group of citizens, interest groups, and state and federal agencies (Washington Administrative Code 232-12-297, Appendix I). The procedures include how species listing will be initiated, criteria for listing and delisting, public review and recovery and management of listed species.

The first step in the process is to develop a preliminary species status report. The report includes a review of information relevant to the species' status in Washington and addresses factors affecting its status including, but not limited to: historic, current, and future species population trends, natural history including ecological relationships, historic and current habitat trends, population demographics and their relationship to long term sustainability, and historic and current species management activities.

The procedures then provide for a 90-day public review opportunity for interested parties to submit new scientific data relevant to the draft status report and classification recommendation. During the 90-day review period, the Department held three public meetings to take comments and answer questions. The Department has now completed the final status report, listing recommendation and State Environmental Policy Act findings for presentation to the Washington Fish and Wildlife Commission. The documents and recommendation are available for a 30-day public review period.

This is the Final Status Report for the Bald Eagle. **Submit written comments on this report and the reclassification proposal by 22 November 2001 to: Harriet Allen, Wildlife Program, Washington Department of Fish and Wildlife, 600 Capitol Way N, Olympia, WA 98501-1091.**

The Department intends to present the results of this status review to the Fish and Wildlife Commission for action at the December 7-8 meeting. However, in the event that the bald eagle has not been de-listed by the U.S. Fish and Wildlife Service under the federal Endangered Species Act, the presentation for action by the Commission will be postponed until federal de-listing has occurred.

This report should be cited as:

Stinson, D. W., J. W. Watson, and K. R. McAllister. 2001. Washington state status report for the bald eagle. Washington Dept. Fish and Wildlife, Olympia. 92 pp.

Cover photos by Jim Watson, cover design and title page illustration by Darrell Pruett.

Washington State Status Report

for the Bald Eagle

Prepared by

Derek W. Stinson, James W. Watson, and Kelly R. McAllister

Washington Department of Fish and Wildlife
Wildlife Program
600 Capitol Way N
Olympia, WA 98501-1091

October 2001

TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

ACKNOWLEDGMENTS

Tom Owens conducted the analyses that produced much of the tabular data, and manipulated spatial data to create several of the map figures. Beth Waterbury analyzed and summarized over 1000 bald eagle management plans to provide the synthesis contained herein. Gary Wiles interviewed personnel in 32 counties and obtained information for a summary about county ordinances. Peggy Ushakoff created map figures 1 and 4. Grainger Hunt made suggestions for estimating the equilibrium population. Mark Stalmaster, Grainger Hunt, Terry Grubb, Steve Negri, and Beth Waterbury provided excellent comments on a draft. WDFW personnel that provided constructive comments on the draft included: Harriet Allen, Steve Zender, Greg Schirato, Elizabeth Rodrick and Jim Ames.

In addition, numerous people provided reports, regional count data, information on eagle fatalities, or other material assistance included Mary Mahaffy, Mel Walters, Monte Garrett, Karen Bedrossian, Tom Chisdock, Paul Fielder, Millard Deusan, Maureen Murphy, Catherine March, Mark Goldsmith, John Talmadge, Darrell Pruett, Peter Dunwiddie, Steve Miller, Scott Pearson, Don Kraege, Jennifer Brookshier, John Grettenberger, and Pete Castle. Numerous people from county planning departments provided information and copies of ordinances. Thanks to those individuals who commented during the public comment period.

Acronyms Used in the Report

DDT:	dichlorodiphenyltricloroethane, an organochlorine pesticide.
ESA:	U.S. Endangered Species Act of 1973
FFR:	Forest & Fish rules (new Forest Practice regulations)
PCBs:	polyclorinated biphenyls
RCW:	Revised Code of Washington
WAC:	Washington Administrative Code
WDF:	Washington Dept. of Fisheries (see also, WDFW)
WDFW:	Washington Dept. of Fish and Wildlife-the Departments of Wildlife and Fisheries merged in 1994 to form WDFW.
WDG:	Washington Dept. of Game- name of the state wildlife department from 1933-1986, when it became the Dept. of Wildlife
WDNR:	Washington Dept. of Natural Resources
WDOE:	Washington Dept.of Ecology
WDW:	Washington Dept.of Wildlife-name of the state's wildlife department from 1988-1994 (see also WDG and WDFW).
WSPR	Washington State Parks and Recreation
USFWS:	U.S. Fish and Wildlife Service, Dept. of Interior

EXECUTIVE SUMMARY

The early summer population of bald eagles when white settlers first arrived in Washington may have been around 6,500. Persecution, the cutting of forests, commercial exploitation of salmon runs, and finally the use of DDT reduced the state's population to only 105 known breeding pairs by 1980. Loss of wetlands, contamination of estuaries, and declines in water quality also probably have reduced the carrying capacity for eagles. The erection of >1,000 dams and the introduction of warm water fishes, however, has likely added nesting and wintering sites and produced changes in local distribution and abundance of eagles. The population has recovered dramatically with the ban on DDT use after 1972 and increased protection for eagles and eagle habitat. In the past 20 years, the population of nesting bald eagles grew about 10% per year as eagles reoccupied habitat. Based on a model, the population is predicted to reach carrying capacity at about 733 nesting pairs. In 1998, there were 664 occupied nests, and there are some indications that the population has reached carrying capacity in parts of western Washington. The population may still be increasing in northeastern Washington and along some western Washington rivers. Though the nesting habitat may be saturated around Puget Sound and other marine coasts, the total late spring/early summer population may continue to grow with an increase in the pool of non-breeding adults until all available food resources are exploited. If there is no decline in the number of nest sites, productivity, or survival, the population may stabilize around 4,400.

Comprehensive, statewide surveys of wintering eagles in Washington from 1982-89 counted 1,000-3,000 eagles in the state. The increasing trends in those surveys and in resident breeding birds predict a population of 3,200 winter visitors and a total winter population of about 4,500 bald eagles in Washington in the year 2000; this assumes that winter carrying capacity limits have not been reached. Statewide winter counts have not been conducted in recent years, and the carrying capacity is unknown. The number of resident breeders, and trends in localized winter counts suggest that Washington hosts perhaps 3,500 – 4,000 bald eagles each winter. Up to 80% of the eagles seen in mid-winter in Washington consists of migrants, largely from the Canadian provinces and Alaska. Wintering eagles will most benefit from protection of salmon runs and communal roosts, and managing human disturbance at eagle concentration areas.

Almost no late seral forest remains in the lowlands around Puget Sound, and eagles nest in small patches of residual large trees and second growth. The large trees along shorelines used by eagles are a diminishing resource, as more and more shoreline is dedicated to residential development. Only 1% of the Puget Sound Douglas-fir Zone is found on lands dedicated to the conservation of biodiversity. Conservation of bald eagle nesting habitat is difficult because 80% of the land within ½ mile of shores is privately owned, and contains desirable view property. Two thirds of the aggregate land within eagle territories and two thirds of eagle nests are on private lands. The state bald eagle protection rule (WAC 232-12-292) requires a management plan for development, forest practices, or potentially disturbing activities on state and private lands near eagle nests and roosts. Over 1,200 management plans have been signed by Washington landowners since 1986. There are indications that some eagles in Washington, and other states, have become fairly tolerant of human activity near nests. Most eagles, particularly those in rural areas, remain rather sensitive to disturbance during nesting.

The U.S. Fish and Wildlife Service is expected to remove the bald eagle from the federal list of threatened and endangered species in 2001. Bald eagles will still be protected by the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act. The Bald and Golden Eagle Protection Act also prohibits disturbance or molesting of eagles. Despite state and federal protection, a large percentage of fatalities of adult bald eagles have human related causes, including shooting, poisoning, vehicle collisions, and electrocution, and a black market trade in eagle feathers and parts still exists.

Although the breeding population of bald eagles in Washington has increased dramatically in the past 20 years, two thirds of nests are on private lands. Only about 10% of eagle nests are on lands where their habitat values could be considered secure in the absence of habitat protection rules. Land near shores is highly desirable for residential development and the human population of Washington is expected to increase by 2 million to 7.7 million in the next 20 years, and double to 11 million by 2050. Forest near shores is rapidly being cleared, and the needs of eagles and desires of humans are increasingly in conflict. Without protections of nesting and roosting habitat, the bald eagle could again decline dramatically and require re-listing as threatened or endangered in the state. For these reasons we recommend that the bald eagle be down-listed to sensitive, but not de-listed, in the State of Washington, and that the bald eagle protection rule be amended to apply to a Sensitive species.

TAXONOMY

Bald eagles are members of the order Falconiformes which includes most diurnal birds of prey. They are part of the family Accipitridae, a family of eagles, hawks, kites, Old World vultures, and harriers. The bald eagle is the North American representative of the genus *Haliaeetus*, which contains eight species of sea and fish eagles (Stalmaster 1987). The bald eagle is closely related to the white-tailed eagle (*H. albicilla*) of temperate Eurasia, southwest Greenland and Scandinavia, with which it is said to form a "superspecies" (A.O.U. 1998). Two subspecies or races of the bald eagle are sometimes recognized: a southern race, *Haliaeetus leucocephalus leucocephalus*, and a northern race, *Haliaeetus leucocephalus alascanus* (Johnsgard 1990). The races were separated rather arbitrarily along a north-south size gradient, with the northern birds, including those in Washington state, being larger.

DESCRIPTION

Bald eagles are among the largest birds in North America. Wing spans range from 6.5 to 7.5 ft and body length from 2.5 to 3 ft. Individuals can weigh from 6 to 15 lbs.

Like the other seven species of sea eagles, bald eagles have unfeathered lower legs and large, powerful talons. Females are larger than males. The plumage of adult bald eagles is characterized by a snowy white head and tail with deep brown body and wing feathers. Adults have yellow eyes, beak, and cere (fleshy area at the base of the beak). Juveniles and subadults lack the white head and tail and display widely various patterns of dark brown, light brown, whitish gray, and white on the body and wing feathers. Early in life the eyes are dark brown, transforming with age. The beak and cere also start off very dark, almost black. Eagles in juvenile plumage appear larger than adults because of longer feathers, particularly in the wings and tail. These and other details of plumage and color allow the separation of five distinct plumages that correspond to bald eagle age classes (Stalmaster 1987, Wheeler and Clark 1995).

DISTRIBUTION

North America

As a group, the sea eagles occupy ranges on every large land mass except South America. Bald eagles are the only species of sea eagle regularly found in North America (Stalmaster 1987). Bald eagles breed in much of this range though numbers are highest along marine shorelines of Canada, Alaska, the northern conterminous states, plus Florida and South Carolina. They are less numerous in the southwestern United States and Mexico. Wintering eagles and migrating birds are found broadly over the continent and many southern areas are more important as wintering areas than as breeding areas.

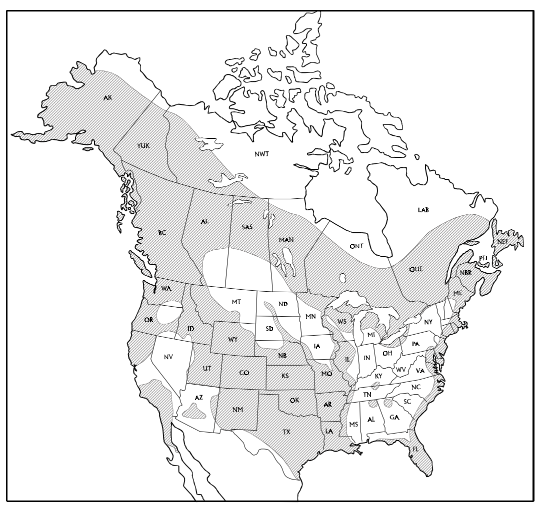


Figure 1. The range of the bald eagle (based on Johnsgard 1990).

Washington

Bald eagles can be found in all the forested parts of Washington throughout the year, but they are substantially more abundant in the cooler, maritime region west of the Cascade Mountains than in the more arid eastern half of the state (Fig. 2). Bald eagle nests are most numerous near marine shorelines, but nests are also found on many of the lakes, reservoirs, and rivers of Washington. In eastern Washington, nesting bald eagles are uncommon but scattered pairs occupy the northern tier of counties that border British Columbia and several areas along the east slope of the Cascades Mountains. The only large area of the state which is largely devoid of nesting bald eagles is the dry shrub-steppe habitat of the Columbia Basin away from large rivers where large trees are absent.

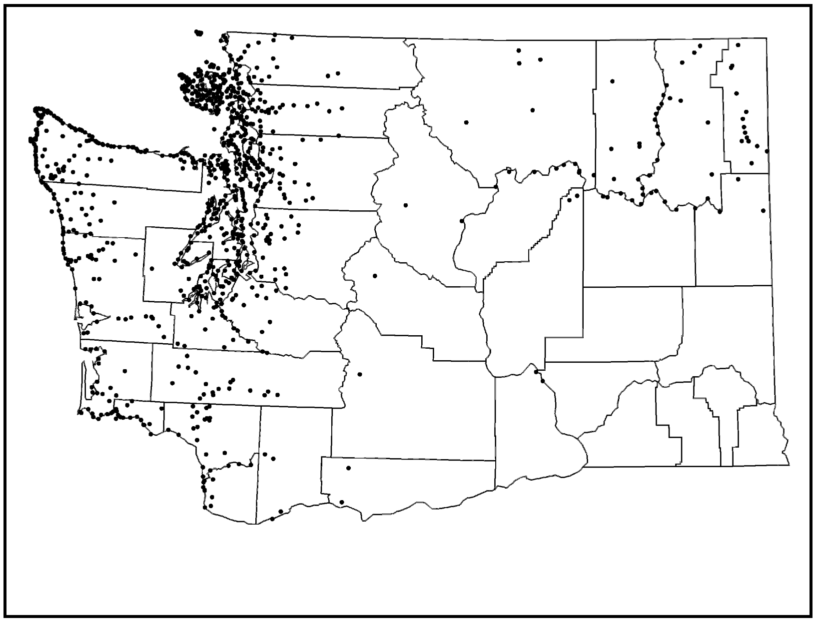


Figure 2. Distribution of nesting bald eagles in Washington, 1998.

The winter distribution of bald eagles in Washington is similar to the breeding distribution, but more concentrated at salmon spawning streams and waterfowl wintering areas (Fig. 3). Some areas where birds are rarely or never seen during the breeding season, support wintering birds. In eastern Washington, the reservoirs and major tributaries of the Columbia River become significant bald eagle habitats during winter. Additional effort to document roosts, particularly in western Washington would probably add many more locations to the existing database.

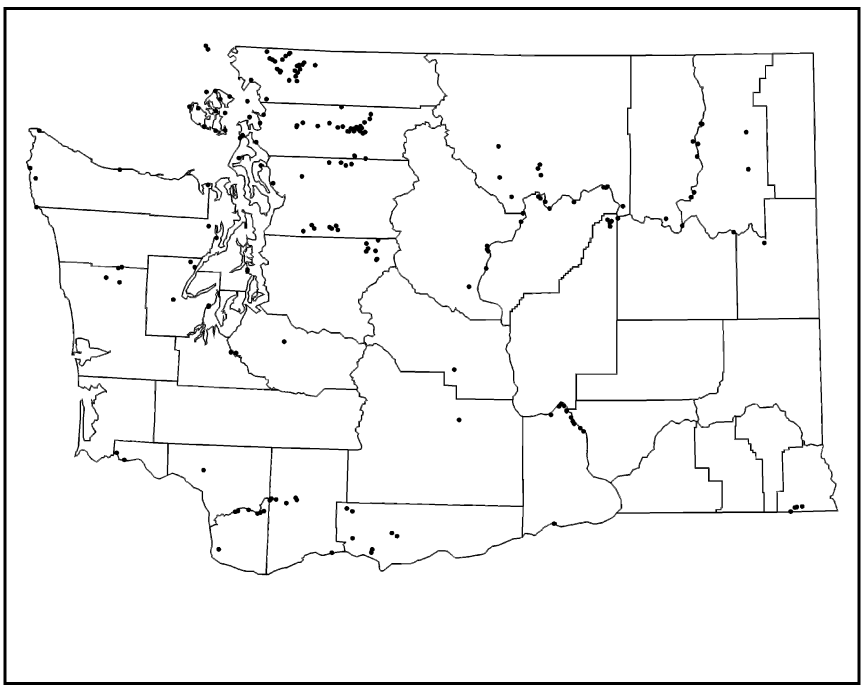


Figure 3. Known winter roosts and feeding concentrations of bald eagles in Washington.

NATURAL HISTORY

Reproduction

In bald eagle populations at carrying capacity, where competition for nest sites exists, eagles typically begin breeding at age 6, but sometimes defer breeding until age 7 or 8 (Bowman et al. 1995, Buehler 2000). The average age of first breeding was estimated to be 6 at Besnard Lake, Saskatchewan (Gerrard et al. 1992), and 6.2 years for 6 eagles in the Yellowstone ecosystem (Harmata et al. 1999). Raptors breed at a younger age than usual in years when food is particularly abundant, or when a population decline has left many territories vacant (Newton 1979). Where there is less competition for food, and limited potential mates, bald eagles may attempt to breed at age 3 or 4 (Gerrard et al. 1992, Buehler 2000).

Territoriality. Bald eagles defend their territories from other adult eagles that attempt to intrude. The adult pair attempts to maintain exclusive occupancy of the territory through passive perching atop dominant trees, threat vocalizations, circling displays, and territorial chases. Subadult eagles are usually tolerated to a greater degree than intruding adults. Eagles occasionally fight using their talons to grasp the opponent while in flight. Such fights are responsible for many of the injured birds that require rehabilitation and fights sometimes have fatal outcomes.

Mating behavior. Adult bald eagles go through a series of courtship behaviors that establish a relationship known as a "pair bond," that often lasts until one eagle dies (Jenkins and Jackman 1993). When one eagle of the pair dies or does not return to the territory, it will be replaced by a new adult. The courtship of bald eagles can involve vocal displays, various chase displays, and copulation. Chase displays have been given names such as the "roller coaster flight" or "cartwheel display" (Stalmaster 1987). In Washington, territorial eagles engage in courtship behavior in January and February, although some pairs begin to repair nests as early as December (Watson and Pierce 1998a).

Nesting and brood rearing. Bald eagles build large nests constructed of sticks with nest cups lined with soft materials like grasses, shredded bark, and downy feathers. A nest territory may contain only one nest, but can have as many as many as 8 additional alternate nests (WDFW data). Alternate nests (n = 74) were an average of 1050 ft from 54 occupied nests in western Washington (Grubb 1976). Bald eagles, particularly males, exhibit strong fidelity to their nest territory (Jenkins and Jackman 1993). Eagles usually return to a territory near a reliable food source year after year.

The clutch is most often 2 eggs (79%), occasionally 1 (17%) or 3 (4%) (Stalmaster 1987). Clutches of 4 are extremely rare. The dull white eggs measure only about 3 x 2 in, rather small for a bird the size of an eagle. Incubation lasts for about 35 days. Both members of a mated pair participate in the incubation of eggs and care of young, but the female does the bulk of incubation. Eggs are turned about every hour and are sometimes covered with soft nesting material when left unattended for a short time. Adults brood their young, particularly when the eaglets are less than a month old. Brooding keeps the young warm (or cool, in southern climates), dry, and protected from predators. In western Washington most eagles begin to incubate their eggs by the third week in March, and young hatch by late April (Watson and Pierce 1998a).

Prey are brought to the young in the nest. The male delivers most of the prey during the first month while the female is usually busy with brooding the young. During this first month, the adults tear meat from a prey item and dangle it above the chick until it is taken. In nests with more than one eaglet, the largest chick often receives the most food. The adults respond to the most noticeable eaglet, both in terms of its size and the noise it makes in fussing for food. This can create increasing disparity in size between nestmates.

During the first month after hatching, nestmates often fight vigorously. They will peck and grab at one another, sometimes seizing the other's wing and dragging it about the nest. The earliest to hatch is larger and will sometimes bully smaller nestmates into submission so the larger chick is able to eat more of the food brought to the nest without competition from its siblings. While this type of fighting is common, actual death of a nestmate from this behavior may be rare. Most young eagles fledge at 11 to 13 weeks of age, usually during early to mid-July in Washington (Watson and Pierce 1998a).

Movements and Dispersal

Migration. Washington's breeding adults are on their territories until early fall when they migrate north to coastal British Columbia and southeast Alaska for several weeks to take advantage of food supplies associated with early salmon runs (Servheen and English 1979, Watson and Pierce 1998a). They return to territories in Washington by January to commence nesting again. Fledglings also disperse northward, but they may remain there for several months before returning to Washington (Watson and Pierce 1998a). Juvenile eagles from California also migrate north and pass through western Washington while en route to Canada (Hunt 1992a, Sorenson 1995).

Eagles generally leave northern breeding grounds during fall and seek out milder climates where prey are concentrated during the winter months. Fall migration may be a response to dwindling food supplies on breeding areas, or the lack of feeding opportunities when lakes and rivers freeze over in the interior. The relatively mild winter climate and abundant fall salmon runs in Washington attract eagles from as far away as the northern Canadian provinces, Alaska, and Montana (Swenson et al. 1986, McClelland et al. 1994, 1996, Watson and Pierce 2001, Harmata et al. 1999). Fall migration for eagles that were monitored by satellite telemetry began anytime from 13 July to 19 January, but the average initiation date was 17 November (Watson and Pierce 2001). Fall migration lasted an average of 38 days for 17 eagles (25 seasons). Migrants move south in the fall along both coastal and interior routes (Figure 4). All eagles in the Northwest Territories migrate because prey are unavailable after lakes and rivers freeze. Some of these birds cross the Continental Divide to the Skagit and other coastal rivers of Washington and British Columbia, while others by-pass Washington to winter in California (Watson and Pierce 2001). In contrast, many eagles in southeast and coastal Alaska, particularly breeders, do not migrate very far from their breeding areas.

Wintering eagles begin to arrive in Washington in October; most adults arrive in November and December, and many juveniles arrive in January (Buehler 2000, Watson and Pierce 2001). Satellite telemetry was used to track 23 eagles captured on the Skagit River. Based on the subsequent breeding locations, 30% of these eagles originated from British Columbia, 30% from Alaska, 22% from Northwest Territories, and 9% from the Yukon (the remaining 2 birds seemed to be local birds) (Watson and Pierce 2001). Individual eagles may occupy a small winter range on one river for several weeks during winter,

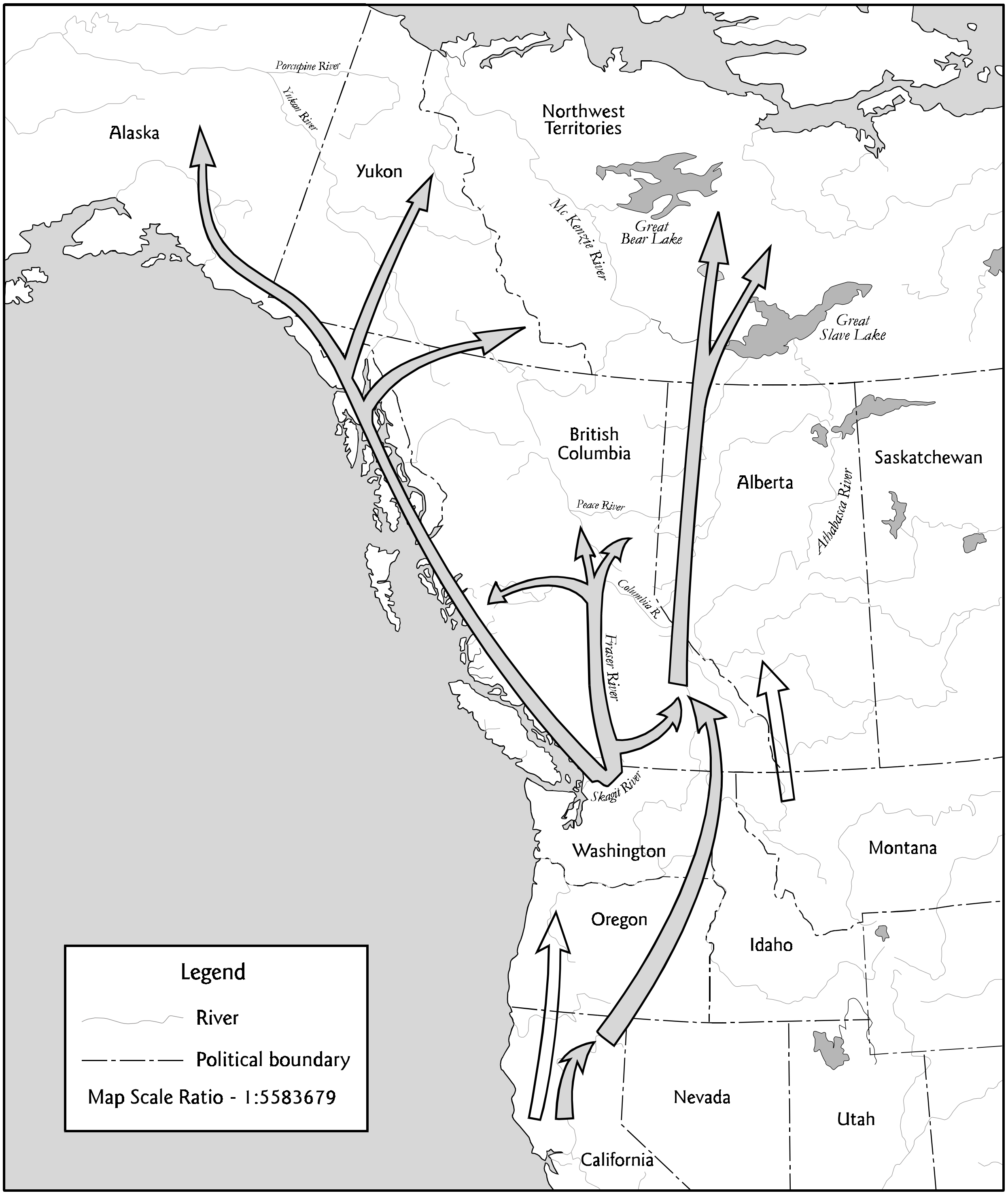


Figure 4. Bald eagle migration corridors in the Pacific Northwest (shaded arrows based on Watson and Pierce 2001; clear arrows based on Grubb et al. 1994, McClelland et al. 1994, and Sorenson 1995; excludes much data on movements from Montana in McClelland et al. 1994).

and then move to other major rivers throughout Washington or southern British Columbia before migrating back to their origins (Watson and Pierce 2001)

For birds captured on the Skagit River, the average spring departure date was 9 March (n = 44), but migration generally occurred from 30 January to 20 April (Watson and Pierce 2001). During spring migration, 23 eagles (46 seasons), reached their destination in about 21 days. The straight-line distance traveled between their winter range and breeding territory averaged 700 miles and ranged from 142 to 1,747 mi. Bald eagle movements generally seem to be driven by food supplies, but the relative role of present vs. past food supplies is not understood. Historic patterns of seasonal food availability may produce genetic programming that is reflected in the general direction of dispersal and migration in a population. For example, Harmata et al. (1999) reported that some juveniles produced in the Yellowstone ecosystem migrated to the California coast, and they speculated that these birds may be looking for spawning salmon runs including some that are now extinct.

Dispersal and Fidelity. Bald eagles seem to exhibit relatively high year to year fidelity to nest territories and wintering areas (Harmata and Stahlecker 1993, Buehler 2000). All the eagles captured on the Skagit River by Watson and Pierce (2001), and monitored during the breeding season (n=14), returned to the same geographic location occupied for breeding the previous year, and 65% returned to the Skagit each winter. Harmata et al. (1999) observed that movements of juveniles out of the Greater Yellowstone Ecosystem was not caused by lack of prey or environmental conditions because the area hosted some wintering juveniles that were produced in Canada.

For migratory breeding populations, including those in Washington or western Canada and Alaska, juveniles and subadults may return to their natal region during subsequent breeding seasons (Wood and Collopy 1995, Watson and Pierce 1998a, 2001, Driscoll et al. 1999, Harmata 1999). Mabie et al. (1994) state that eagles fledged in Texas exhibit strong fidelity to natal nesting areas for breeding, though one nested in Arizona and they suspected that some entered breeding populations throughout the southern breeding range. Driscoll et al. (1999) were able to read band numbers on 14 breeders in Arizona, and all had been banded as nestlings in Arizona. Greater Yellowstone Ecosystem eagles exhibited a strong homing to natal sites and visited there each year after fledging (Harmata et al. 1999). The mean distance from natal nest to first breeding site for 7 eagles banded as nestlings in the Yellowstone Ecosystem was 39 mi (range 11-127 mi). Eagles may exhibit the female-biased dispersal typical of most birds; that is, males typically establish a breeding territory closer to their natal site than do females (Greenwood 1980, Harmata et al. 1999). Once bald eagles have established a nesting territory, they often return to the same territory year after year (Gerrard et al. 1992, Jenkins and Jackman 1993).

Diet and Foraging

"... A fish dies and is washed up on shore. It looks bad and smells worse, is good for nothing, despised by all. I come and eat it and turn that fish...into a soaring wonder, a majestic greatness that stirs the heart of creatures everywhere, including men."
-from *Interview with a Bald Eagle*, Fretwell (1981)

Few birds eat as wide a variety of food as do bald eagles. Fish are usually the most common prey taken by breeding bald eagles throughout North America, but bald eagles also capture a variety of birds (Stalmaster 1987). Diet studies usually use direct observations of foraging eagles, or collect prey items from under perch and nest trees. Comparisons with direct observations indicated that birds, medium-sized mammals, and large bony fishes were over-represented and small mammals and small fish were under-represented in collections at nests (Knight et al. 1990, Mersmann et al. 1992). Fish can be over-represented by direct observations (Knight et al. 1990). Direct observations at two nests in the San Juan Islands in 1962-63 indicated that European hare (*Oryctolagus cuniculus*) that may have been killed by vehicles and farm machinery were the most common food item (Retfalvi 1970). Recent direct observations of nesting eagles in Puget Sound found they captured 78% fish, 19% birds, and 3% mammals (Watson and Pierce 1998a). Invertebrates were not observed to be captured, but were found in prey remains (molluscs 6% and crustaceans 1%). Of 1,198 items collected in 68 nesting territories in the San Juans, Olympic Penninsula, and Puget Sound, 53% were birds, 34% fish, 9% mammals, and 4% invertebrates (Knight et al. 1990). In a more recent study, a collection of 380 prey items under 67 nest trees in the Puget Sound and San Juans was 67% birds, 19% fish, 6.8% mollusks and crustaceans, and 6% mammal (Watson and Pierce 1998a). Birds, including gulls (especially glaucous-winged, *Larus glaucescens*), ducks (at least15 species, especially scoters [*Melanitta* spp.], mallards [*Anas platyrhychos*], and mergansers [*Mergus* spp.]), western grebe (*Aechmophorus occidentalis*), common murre (*Uria aalge*), great blue heron (*Ardea herodias*), and pelagic cormorant (*Phalacrocorax pelagicus*) were among the most common prey remains in the two studies (Knight et al. 1990, Watson and Pierce 1998a). Fish that occurred several times in western Washington studies included flounder (family Pleuronectidae), plainfin midshipman (*Porichthys notatus*), dogfish shark (*Squalus acanthias*), sculpin (family Cottidae), rockfish (*Sebastes* spp.), ling-cod (*Ophiodon elongatus*), walleye pollock (*Theragra chalcogramma*), Pacific hake (*Merluccius productus*), Pacific cod (*Gadus macrocephalus*), cabezon (*Scorpaenichthys marmoratus*), red Irish lord (*Hemilepidotus hemilepidotus*), salmon (unidentified salmonids) and channel catfish (*Ictalurus punctatus*)(Knight et al. 1990, Watson and Pierce 1998a 1998b). Eagles in Puget Sound suburbs are known to prey on northwestern crow (*Corvus caurinus*) nestlings and fledglings (Robinette and Crockett 1999). Prey items delivered to a nest in Discovery Park, Seattle, included fish (87%), birds (6%), including western grebe, gulls, pigeons (*Columba livia*), crows, and a common loon (*Gavia immer*), and crabs (2%) (Sweeney et al. 1992).

Watson and Pierce (1998a) reported that generally, eagles at coastal nests preyed more on birds, and eagles nesting near lakes and rivers fed more on fish. In the Columbia River estuary in the early 1980's, eagles captured 90% fish, 7% birds, and 3% mammals (Watson et al. 1991). Waterfowl were the most common avian prey in nests, while suckers (*Catostomus* spp.), American shad (*Alosa sapidissima*), and carp (*Cyprinus carpio*) were the most common fish.

A study of nesting birds at Lake Roosevelt (Columbia River) in eastern Washington reported that prey delivered to nests were 83% fish, 13% birds, and 2% mammal (Science Applications International 1996). In the same study, prey remains below nests were 71% fish, 27% birds, and 6% mammals. Suckers were the most frequently recorded prey item in remains, and largescale suckers (*C. macrocheilus*) were the most abundant fish in the lake. Hatchery reared rainbow trout (*Salmo gairdneri*) and kokanee (*Onchorynchus nerka*) accounted for a total of 23% of prey observed during deliveries to nests. Other commonly eaten fish included walleye (*Stizostedion vitreum*) and carp, but black crappie (*Pomoxis nigromaculatus*), small-mouthed bass (*Micropteris dolomieui*), yellow perch (*Perca flavescens*), and whitefish (*Coregonus* or *Prosopium* spp.) were also recorded. Birds that occurred as prey included coots (*Fulica americana*), ducks, pigeons, and northern flickers (*Colaptes auratus*) (Science Applications International 1996). Wood (1979) reported dead and injured fish were the most frequent food of wintering eagles at Grand Coulee Dam. Fielder (1982) reported that coots, mallards, and chukars (*Alectoris chukar*) were the most frequent prey of wintering eagles on the mid-Columbia River, and fish comprised only 8% of prey taken. Fitzner and Hanson (1979) reported that wintering eagles on the free-flowing Hanford Reach of the Columbia River fed on waterfowl and coots (53% of biomass) and fish

(48%). The most important prey species were chinook salmon (*Onchorynchus tshawytscha*), mallards, coots, and American widgeons (*Anas americana*). The relative proportions of fish and waterfowl changed during the season, because chinook carcasses were only available from November to mid-December, and waterfowl became the chief prey by late winter (Fitzner et al. 1980).

Bald eagles are capable predators and regularly kill prey using a variety of hunting behaviors. In Washington, bald eagles often raid gull and seabird roosts or nesting colonies to prey on adults, nestlings, or eggs (Kaiser 1989, Thompson 1989), and occasionally prey on nestlings at great blue heron colonies (Norman et al. 1989). Subadult eagles have been observed walking through a seabird colony, stopping to pierce an egg with a talon, and carefully lapping out the contents (Thompson 1989). Diving ducks are taken by circling above and diving upon the duck, causing it to dive repeatedly until it is so out-of-breath that it is easily taken. Mammals, including rabbits, raccoons (*Procyon lotor*), muskrats (*Ondatra zibethicus*), opossums (*Didelphis virginiana*), deer carrion (*Odocoileus hemionus*), and the carrion or the after-birth of cattle, sheep, and seals are also eaten by bald eagles (Knight et al. 1990, Seeley and Bell 1994; D. Norman, pers. comm.; Watson, pers. obs.). Thus, bald eagles are also effective scavengers, willing, at times, to feed on well-decayed flesh or garbage. In winter, spawned salmon on river banks and bars become the most important food for much of the wintering population. They will often steal prey from osprey and gulls (kleptoparasitize), and have even been observed stealing marine invertebrates from sea otters (Watt et al. 1995), and fish from river otters (Taylor 1992). Bald eagles have also been observed hunting cooperatively while preying on jackrabbits (*Lepus* spp.)(Edwards 1969) and cattle egrets (*Bubulcus ibis*) (Folk 1992).

Behavior

Winter feeding. Bald eagles use their keen eyesight to search for food. In winter, when prey are concentrated, they look for other eagles in the act of feeding. Large congregations of eagles often occur where food is abundant. These gatherings are not at all friendly, resembling a group of thieves concentrating on stealing or beating out a neighbor to the food. The opportunity for an individual to eat depends on its aggressiveness, which may be influenced by hunger, size, and age. A variety of behaviors are used to communicate dominance and submission (Stalmaster 1987).

Soaring. Under suitable conditions, bald eagles will soar for long periods, sometimes climbing to great heights. During winter, soaring is usually seen in the afternoon after eagles have fed. Once one eagle has started this behavior, others will often join in until a large flock is spiraling upward together. These "kettles" may consist of 25 to 50 eagles.

Communal roosting. During the winter, bald eagles often spend the night roosting in groups of from two to more than 500 birds. Communal bald eagle night roosts occur at 131 known sites in Washington and some of these roosts are used traditionally, year after year. Roosts occur in areas that are sheltered from the wind, and are otherwise favorable for conserving energy (Stalmaster 1987). Aside from the energetic benefit of the roost site, the advantages of roosting communally is uncertain. Roosts may act as meeting places where pair bonds are formed or renewed, or as information centers where eagles learn of food sources by observing and following other eagles (Ward and Zahavi 1973, Stalmaster 1987). Eagles often advertise the trip to the roost by stopping at prominent staging areas where they are easily seen, and advertise a roost's location by soaring over it at dusk (Stalmaster 1987). Once perched in the roost stand, eagles engage in a variety of social interactions, often antagonistic. New arrivals to the roost often displace prior arrivals from their perches, starting a chain reaction of perch changes within the roost.

Eagles usually select the highest perch that will support their weight, and eagles perched at different heights may reflect the position birds hold in their social hierarchy (Stalmaster and Newman 1979).

Interspecific relationships. As predators and kleptoparasites, bald eagles interact with many other animals. Stealing of fish from ospreys is a well known foraging tactic, but eagles also occasionally steal prey from gulls, loons, mergansers, other raptors, and sea otters (Stalmaster 1987). Ospreys are not always the victim, and they frequently harass eagles (G. Schirato, pers. comm.). Harassment by crows, especially in suburban habitats, apparently can lead to nest failure and territory abandonment (Thompson 1998). Eagle predatory behavior can be disruptive to the nesting success of other birds such as herons, red-tailed hawks (*Buteo jamaicensis*), gulls, and common murres. Bald eagles sometimes create disturbances at great blue heron colonies, giving crows and ravens the opportunity to prey on eggs and chicks while adults are off the nests (Moul 1990). There are unusual cases of bald eagles taking red-tailed hawk nestlings out of the hawk nest and delivering the young hawks to the eagle's nest (Stefanek et al. 1992, Watson et al. 1993, Watson and Cunningham 1996). In at least two instances in Washington, the adult eagles, which likely had originally intended the young hawks to be food for the eaglets in the nest, ended up feeding and rearing the young hawks. In Washington, bald eagles have displaced red-tailed hawks and ospreys and occupied their nests (Watson pers. obs.). Ospreys have been found using nests that eagles had been using a few weeks earlier (G. Schirato, pers.comm). Ospreys are unlikely to expel the larger eagles, but may use a nest when one of the eagles dies. Ospreys and Canada geese (*Branta canadensis*) have also been observed using nests originally built by bald eagles in Oregon and the Chesapeake Bay area (Therres and Chandler 1993, F. Isaacs, pers. comm.).

Longevity, Survival, and Mortality

The longevity record for bald eagles in the wild is $\geq$28 years (Schempf 1997). Captive birds have lived to an age of at least 47, and they are believed to be capable of reproducing for 20-30 years (Stalmaster 1987). Based on survival data, Harmata et al. (1999) estimated a maximum life span of 15.4 years for bald eagles produced in the Greater Yellowstone Ecosystem, although most of the known fatalities were human-related. Given an adult survival rate of 0.88/year, Bowman et al. (1995) estimated that once eagles reach maturity (5 years), the average life-span is 19 years for Prince William Sound, Alaska.

There are many known causes of bald eagle mortality. Eggs and hatchlings may be killed by black bears (*Ursus americanus*), raccoons, wolverines (*Gulo gulo*), gulls, red-tailed hawks, ravens (*Corvus corax*), crows, or magpies (*Pica pica*) (McKelvey and Smith 1979, Nash et al. 1980, Doyle 1995, Perkins et al. 1996). Nestlings are sometimes killed by their nestmates. Similar to other young birds, juvenile eagles are particularly vulnerable to accidents, predation, or starvation during their first year (Stalmaster 1987). Full grown bald eagles have few natural enemies, and the most frequently reported causes of adult bald eagle mortality are human-related (Stalmaster 1987, Franson et al. 1995, Harmata et al. 1999). Adult eagles occasionally die in aggressive encounters with other bald eagles, golden eagles (*Aquila chrysaetos*), or peregrine falcons (*Falco peregrinus*)(Jenkins and Jackman 1993, Driscoll et al. 1999). Bowman et al. (1995) reported that at least 4 of 8 dead adults in Alaska probably died in fights between eagles in a dense population. Two or more eagles in Washington were hit by trains in 2000 (K. Baxter, corresp. on file; D. Stinson, conversation with railroad employee), and collision mortality of eagles feeding on deer killed by trains or vehicles may be more common than data suggest. In ongoing satellite-telemetry studies in Washington, breeding eagles died from gunshot (1), intraspecific aggression (3), and lead poisoning (1); wintering eagles died from electrocution (1), vehicle collision (1), and unknown causes (6) (Watson and Pierce 2001, Watson unpubl. data).

Although the bald eagle has perhaps been the most high profile endangered species in the U.S., there is no comprehensive, systematic effort to record the sources of mortality for carcasses found. Recovery Plan task 2.221 is to "determine the main causes of eagle mortality"(USFWS 1986). Many carcasses are sent directly to the U.S. Fish and Wildlife Service's Eagle Repository in Denver, CO, which distributes feathers and parts to eligible Native Americans for ceremonial purposes. The repository does not record the State of origin of carcasses received (D. Wiist, pers. comm.). If criminal activity is suspected (e.g., gunshot, pesticide mis-use), carcasses may be sent to the USFWS forensics lab in Ashland, Oregon. Eagle carcasses with unknown cause of death are often sent to the National Wildlife Health Lab, in Madison, WI. A report based on 1,429 carcasses received between 1963 and 1984 indicated that gunshot (23%), trauma (21.1%), poisoning (11.1%), and electrocution (9.1%) were the most prevalent causes of death (National Wildlife Health Laboratory 1985). Flight into wires or vehicular impact were major causes of traumatic death. Of the 68 bald eagle carcasses sent to the National Lab from Washington, the most frequent causes of death were trauma (n = 16), gunshot (n = 10), and electrocution (n = 7). This is a small biased subsample of fatalities, however, because most dead eagles are probably not found before they are eaten by scavengers, and eagles killed by human-related causes (roads, powerlines) may be more likely to be discovered. In recent years most eagle carcasses found are probably sent directly to the repository in Denver. Causes of death for 49 bald eagles recovered in the Greater Yellowstone Ecosystem between 1979-97 were: unknown (31%), electrocution or collision with power lines (20%), known or suspected poisoning (16%), and shooting (14%)(Harmata et al. 1999).

While many causes of bald eagle mortality have been identified, there are few data on actual survival rates in populations. Survival rates of bald eagles are the least-studied components of population regulation but perhaps the most important (Grier 1980). Studies in the past 25 years have generally found high rates of juvenile survival compared to expected rates as low as 25% (Stalmaster 1987). Adult survival in some of the same populations, many of which are stable or increasing, has been moderate to high (Table 1). Grier's (1980) model suggests that a population with moderate nest success and

Table 1. Annual finite survival rates (%) of bald eagles by age class throughout North America.

Age Class (year)			Annual population growth rate	Year	Location	Source
1	2-4	5+				
71	95	88	increasing 2%	1989-92	SE Alaska	Bowman et al. 1995
50	50	93		1979-82	SE Alaska	Hodges et al. 1987
63	84-100	-		1987-90	Florida	Wood and Collopy 1995
80-92	85-92	92-93	stable	1968-92	Saskatchewan	Gerrard et al. 1992
70-80	80-95	-		1976-85	Maine	McCollough 1986
100	75-100	83-92	increasing 13%	1986-90	Maryland	Buehler et al. 1991a
		84	increasing	1987-93	Arizona	Driscoll et al. 1999
87	60-85	67-100	stable-increasing	1979-97	Yellowstone	Harmata et al. 1999
100	93	76	increasing 10%[a]	1993-99	Washington	Watson, unpubl. data
		68-95	stable-increasing[b]	1996-99	Washington	Watson and Pierce 2001

[a]Nesting population study of 2 telemetered juvenile, 3 subadult, and 21 adult eagles (8 telemetered).
[b]Wintering population study of 22 telemetered adults; minimum estimate, assumes all stationary signals indicated fatalities.

productivity, such as is found in Washington, must have high survival of juveniles (70%) and adults (90%) for the population to grow. In Washington, survival data are few, but recent marking studies of 68 eagles found somewhat lower adult survival (73% survival of 45 adults on breeding and wintering grounds) than in other regions (Watson unpubl. data; Table 1). Limited data from telemetry studies of eagles wintering on the Skagit River found less than 70% annual survival of near-adult (e.g. 3-4 year old) and adult eagles. Despite this, the Washington breeding population has increased, suggesting the survival estimates from these studies underestimates survival for the entire Washington population. Another explanation, supported by two recent studies, suggests that higher juvenile survival and adult immigration from adjacent regional populations may account for increasing populations despite higher than expected adult mortality (Driscoll et al. 1999, Harmata et al. 1999). Harmata et al. (1999) found that 3-4 year old eagles experienced the lowest survival in the Greater Yellowstone Ecosystem. They suggested that efforts to reduce mortality from poisoning and power lines in these age classes may be the most effective strategy for enhancing that population.

HABITAT REQUIREMENTS

Home Range

The seasonal home range that contains the foraging and nesting habitat of a pair averages about 2.6 mi^2 in the Puget Sound region (Watson and Pierce 1998a) and about 8.5 mi^2 in the Columbia River Estuary (Garrett et al. 1993). Core-use areas, or the area that encompasses the nest, foraging perches and greatest use, averaged 0.73 mi^2 and length of shoreline averaged 2.36 mi within 55 Puget Sound territories (Watson and Pierce 1998a). Home ranges for 18 of those nests on relatively straight featureless shorelines typically contained about 0.93 mi (1.5 km) of shoreline on each side of the nest. The density of nesting eagles depends on many factors that affect habitat quality, such as prey populations, human disturbance, and perhaps the availability of nest and perch trees. In areas of high quality habitat, occupied nests of adjacent nesting pairs may be spaced every few miles. Clallam and San Juan counties, Washington average about 4 - 5.6 mi of shoreline per active nest. Hodges (1982) reported active nests were an average of 1.25-2.5 mi apart along the Seymour Canal of southeast Alaska.

Winter ranges are considerably larger and more variable. Winter ranges for 15 eagles (24 winters) captured on the Skagit River averaged 17,450 mi^2 , and ranged from 89- 113,365 mi^2 (Watson and Pierce 2001). Some birds migrated quickly to a distinct area and remained within a relatively small range, while others moved regularly to new locations throughout the winter.

Nesting Habitat

Breeding bald eagles need large trees near open water that is not subject to intense human activity. In Washington, nearly all bald eagle nests (99%) are within 1 mile of a lake, river, or marine shoreline (mean = 635 ft, range 1- 6,185) and 97% are within 3,000 ft (Figure. 5). The distance to open water varies somewhat with shore type. Nests tend to be closer to marine shores and rivers than to lake shores [mean 457 ft (marine) or 633 (river) vs. 997 ft (lakes), $p<.05$; Duncan's Multiple Range Test]. This difference may be because many lake shores are heavily developed and shoreline nesting habitat has been lost.

Assuming the presence of an adequate food supply, the single most critical habitat factor associated with eagle nest locations and success is the presence of large super-dominant trees (Watson and Pierce 1998a). Alteration of upland nesting habitat from natural events (e.g., fire, windstorms, etc.) or human-caused alterations (e.g., timber harvest, development) that results in more or less permanent loss of nest trees or potential nesting habitat, or prevents trees from attaining the size capable of supporting a nest, have the potential to reduce the number of nesting territories in Washington. Studies throughout the eagle's range have shown the positive relationship between nest presence and large superdominant trees and negative relationship with clearcutting (Livingston et al. 1990, Anthony et al. 1982, Hodges and Robards 1982, Anthony and Isaacs 1989, Blood and Anweiler 1994, Gende et al. 1998, Watson and Pierce 1998a). The forest stands surrounding the nest trees in Washington are highly variable, ranging from pristine old-growth forests along coasts and islands, to patches of forest along rural-residential shorelines, to small patches of trees in residential areas. Bald eagles are not old-growth obligates, but need large trees capable of supporting their weight and their massive nests. They typically select the largest trees in a stand for nesting (Table 2; Anthony et al. 1982). Because average life expectancy of nests is 5 to 20 years (Stalmaster 1987), bald eagles need trees of similar stature located nearby to serve as replacement nest trees if a nesting territory is to persist at the site. In general, habitat alteration that removes large trees, and prevents their replacement would prevent eagles from nesting. In western Washington, nest

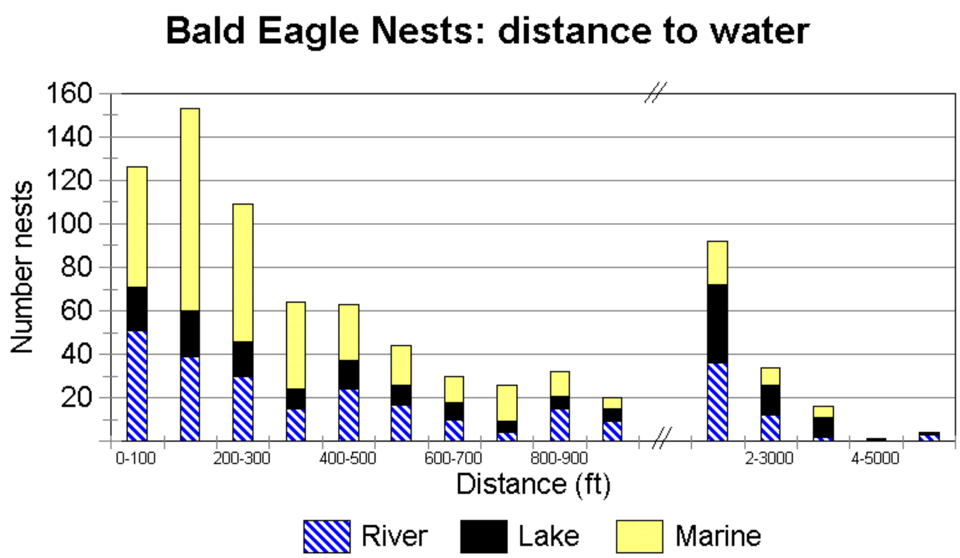


Figure 5. Distance to open water for 817 bald eagle nests grouped by nearest shore type (note change in scale at x axis break).

Table 2. Characteristics of 218 bald eagle nest trees and surrounding forest stands in two forest types in Washington (Anthony et al. 1982).

	Nest tree		Nest Stand		
Forest type	Mean dbh (range)(in)	Mean height (range) (ft)	Mean dbh (in)	Mean height (ft)	Mean tree density[a]
Douglas-fir	50 (24-90)	116 (82-197)	21	74	64 stems/ac
Spruce/hemlock	75 (41-109)	145 (82-197)	27	86	67 stems/ac

[a]Density of trees >10.5 in dbh.

trees are most often old-growth Douglas-fir (*Pseudotsuga menziesii*) and Sitka spruce (*Picea sitchensis*) near the coast (Grubb 1976), with a higher component of mature grand fir (*Abies grandis*) and black cottonwood (*Populus balsamifera*) around Puget Sound (Watson and Pierce 1998a). Ponderosa pines (*Pinus ponderosa*) and black cottonwoods are often used for nesting in eastern Washington (S. Zender, WDFW).

Perch Trees

Perches from which nesting bald eagles forage are distributed throughout their nest territories along shorelines and prominent points which provide a commanding view of the foraging area. Nesting eagles exhibit consistent daily foraging patterns and use of the same perches (Stalmaster 1987, Gerrard and Bortolotti 1988). Wintering birds monitored with radio-telemetry on the Skagit River frequented the same perches year after year (Watson and Pierce 2001). Foraging perches should be stout enough to support the weight of a perching eagle, and offer some degree of isolation from human activity, such as boating and clamming (McGarigal et al. 1991, Watson et al. 1995). Perch trees provide eagles with some security; eagles perched in trees are more tolerant of disturbance than when they are perched on the ground (Stalmaster and Kaiser 1998). Wintering eagles along the Nooksack River in Washington had a strong preference for dead trees for perching (Stalmaster and Newman 1979). Eagles also preferred bigleaf maples (*Acer macrophyllum*), black cottonwoods, and Sitka spruce, which were typically much taller than red alder (*Alnus rubra*) which were much more abundant. Eagles may show a preference for deciduous trees in winter because the absence of foliage improves visibility and provides a relatively unobstructed flight path through the crowns (Stalmaster and Newman 1979). Major perch trees of eagles wintering along the mid-Columbia were the tallest, largest in diameter with the most open crowns, and overlooked primary foraging areas (Eisner 1991). Often the same trees were used both as foraging perches and as night roosts. The distribution of perch trees and human disturbance had a greater influence on the distribution of wintering eagles on the mid-Columbia than did food abundance (Eisner 1991). An examination of perch tree use and human development around Chesapeake Bay found eagles used perches in shoreline segments that had more large trees with stout, horizontal limbs, had a larger percentage of forest cover, and had trees that were closer to the water than unused shoreline (Chandler et al. 1995).

Foraging Habitat

Nesting bald eagles are opportunistic foragers but feed most consistently on fish and waterfowl which are usually associated with large, open expanses of water (Stalmaster 1987). Bald eagles most often forage close to shoreline perch trees (<1,640 ft or 500 m), and areas of shallow water may be preferred because the limited depth brings fish closer to the surface (Buehler 2000). The wide food-niche breadth of breeding bald eagles allows them to nest successfully in a variety of habitats. Coastal and estuarine areas provide both fish and birds, but also a variety of marine invertebrates to scavenge at low tide (Watson et al. 1991, Watson and Pierce 1998b). Adequate prey resources are most important during the brood-rearing period when young grow rapidly to fledging size. Insufficient prey may result in the starvation of one or all of the nestlings (Wood and Collopy 1995).

Washington’s breeding bald eagles migrate northward each year after nesting to feed on late summer and fall runs of salmon along coastal British Columbia and southeast Alaska (Watson and Pierce 1998a). Adults spend up to 6 weeks away from breeding territories, while subadult eagles may spend several months away from Washington. This post-breeding period of intense feeding and foraging success on winter areas may be vital for breeding adults to be sufficiently healthy to reproduce successfully the following spring (Hansen and Hodges 1985).

Food is also the key habitat component that attracts eagles to wintering areas (Hunt et al. 1992c, McClelland et al. 1994). Hundreds of adult eagles that winter in Washington rely on chum salmon as an annual food source. In northwest Washington, the abundance and distribution of wintering eagles on major rivers is correlated to abundance and distribution of chum salmon carcasses (Hunt et al. 1992c). When chum salmon carcasses are depleted at one location in mid-winter, eagles may disperse to other major rivers to feed on salmon carcasses, or feed on waterfowl or carrion from dairy farms in the lowlands of Puget Sound (Hunt et al. 1992c, Watson and Pierce 2001). Chum salmon abundance on Washington rivers, which is directly affected by salmon escapement, flooding events, and water flow controlled by dam releases (Hunt et al. 1992c), is important to population dynamics of other breeding eagle populations, principally in Canada and Alaska (Watson and Pierce 2001).

Roosting Habitat

Communal night roosts are an important component of bald eagle wintering habitat. Many eagles roost singly and change roost sites frequently (Biosystems Analysis 1980). Eagles may also roost in pairs or gather in large congregations of as many as 500 individuals at locations that are used year-after-year. Roosts vary widely in land area, with 26 roosts described by Watson and Pierce (1998a) ranging from 3.7-79 ac, and 5 roosts in the Klamath Basin ranging from 19.76-627 ac (Keister and Anthony1983). Eagles roost in stands of timber that are adjacent to or relatively near foraging areas; all 26 studied by Watson and Pierce (1998a) were within 0.68 mi (1,100 m) of foraging areas. Bald eagle use of a roost in a given basin is foremost a function of prey abundance and distribution, and is secondarily related to the unique features of the roost (Watson and Pierce 1998a). Studies have shown that communal night roosts provide a microclimate more favorable than available elsewhere in the vicinity (Keister et al. 1985, Stalmaster 1981, Knight et al. 1983, Stellini 1987). Higher air temperatures, lower direct precipitation and/or lower windspeeds within roost stands can result in a net energy savings of up to 10% (Hansen et al. 1980, Keister et al. 1985, Knight et al. 1983, Stellini 1987). Fifteen of 26 roosts studied by Watson and Pierce (1998a) were located on a slope: of these, 11 (67%) had a northern orientation. The northerly aspect of these roosts provided protection from frequent southwesterly winds. Thus, reduction of tree buffers around roosts, or loss of roost trees or stands to timber harvest or fire may increase the metabolic needs of wintering eagles and have the potential to affect health and survival (Stalmaster 1983, Stalmaster and Gessaman 1984).

Eagles selected roost sites on the basis of tree structure and exposure; the largest, tallest, and more decadent stands of trees were often used for roosting. Several studies of communal night roosting of bald eagles in Washington characterized roosts by the presence of large, old trees (Hansen 1977, Hansen et al. 1980, Keister 1981, Knight et. al 1983, Stellini 1987, Watson and Pierce 1998a) (Table 3). Eagles tended to roost in the older trees with broken crowns. Though these roosts may not always meet strict definitions for old-growth, at least a remnant old-growth component is usually present and the older trees are the trees used most frequently by roosting eagles (Anthony et al. 1982, Watson and Pierce 1998a, Hansen et al. 1980). Trees in 26 northwest Washington roost stands were larger in diameter and taller than random trees. The mean diameter and height of the 4 dominant tree species in roosts were: western redcedar (*Thuja plicata*), 32 in and 128 ft; black cottonwood, 32 in and 167 ft; western hemlock (*Tsuga heterophylla*), 30 in and 167 ft; and Douglas-fir, 39 in and 164 ft (Watson and Pierce 1998a).

Table 3. Characteristics of roost trees and roost stands in three forest types in Washington (Anthony et al. 1982).

	Roost Tree		Roost Stand			
Forest Type Roost	Mean Roost Tree Ht. (ft)	Mean Roost Tree DBH (in)	Mean Tree Ht. (ft)	Range in Tree Ht. (ft)	Mean Tree DBH (in)	Range in Tree DBH (in)
Douglas-fir						
Brewster	-	-	79	50-116	24	11-48
Van Zandt	190	33	-	-	-	-
Slide Mtn.	174	32	-	-	-	-
Mixed conifer						
Azwell	-	-	89	50-132	23	12-34
Black cottonwood						
Barnaby	-	-	93	66-132	21	12-52
Eagle Island	-	-	91	66-149	23	12-64

POPULATION STATUS

Decline, Protection and Recovery in North America

The bald eagle was historically very widespread in North America, and bred in nearly all of the coterminous states in addition to Canada and Alaska. According to one rough estimate, there may have been one quarter to one half-million bald eagles in North America at the arrival of white settlers (Gerrard and Bortolotti 1988). This estimate may not be unreasonable given that there were still around 70,000 - 80,000 in1980, with most of these in Alaska and British Columbia (Gerrard 1983, Buehler 2000). Bald eagle populations exhibited a slow but widespread decline due to habitat loss, decline of wintering foods (e.g. bison carrion, anadromous fishes), and persecution from the time of white settlement. Nesting sites were lost to shore development, and eagles (both bald and golden) seem to have been shot at every opportunity. Audubon noted that bald eagles were formerly abundant, but much diminished on the lower Ohio and Mississippi Rivers by the 1840s (Gerrard and Bortolotti 1988). The Chesapeake Bay population declined from >3,000 nesting pairs at European settlement, to about 600 in 1936 (Buehler 2000). Many nests in some localities were being plundered by egg collectors. The bald eagle was listed as vermin, as were most predators, by states and Canadian provinces for a century (Beebe 1974). Van Name (1921) expressed concern for the continued existence of the species and stated the need for federal protection to prevent its extinction. Alaska paid a bounty on 128,273 bald eagles between 1917 and 1952 until federal protection was extended to Alaska (Laycock 1973). Eagles were believed to prey on lambs, and were shot by many sheep ranchers. An estimated 20,000 were killed to protect lambs, but careful studies have shown that it is extremely rare for bald eagles to prey on lambs, kids, or goats (Gerrard and Bartolotti 1988). Beginning in the 1930s eagles were shot from light aircraft (Dale 1936), and though bald eagles enjoyed official protection with the Bald Eagle Protection Act of 1940, shooting continued because golden eagles were not protected, and few ranchers knew how to distinguish subadult bald from golden eagles (Spofford 1969). Shooting continued into the 1970s despite legal protection, and one pilot in west Texas estimated that he was responsible for the deaths of 12,000 eagles (mostly goldens) (Beans 1996). Many eagles were trapped or poisoned by widespread attempts to control livestock predators by ranchers and federal animal damage control agents, often with carrion baits laced with compound 1080, strychnine, cyanide, and thallium sulfate. For example, in 1970 alone federal agents distributed 850,000 poison baits throughout the western states. Bald eagles were also killed to supply artifacts both to American Indians for ceremonial uses, and for a black market of collectors. For example, 22 people in Washington were indicted in 1981 when the parts of 57 bald eagles were sold to undercover agents of the U.S. Fish and Wildlife Service (Stalmaster 1987:154).

All these factors contributed to a widespread decline, but the decline accelerated dramatically after the early 1940s with the introduction and widespread use of organochlorine pesticides, especially DDT. DDT was widely used in mosquito control programs and later as a general pesticide. In 1945, 33 million pounds was used in the U.S., and by 1951 the amount had increased to 106 million pounds (Laycock 1973). Charles Broley, who banded over 1,200 eagles in Florida in the 1940s and 50s, banded 150 nestlings in 1946. In 1955 he reported an 84% nest failure rate, and in 1957 could only find 1 nestling to band. Though not trained as a scientist, Broley concluded that 80% of Florida eagles were sterile, and he blamed the problem on widespread use of DDT (Broley 1958). Broley (1958) remarked, "Our American bald eagle...is a very sick bird." This report and others like it sparked the National Audubon Society's Continental Bald Eagle Project, which was the first concerted attempt to determine the species status and to investigate breeding failures (Murphy 1980). The National Audubon Society documented 417 nesting pairs in surveys that covered key parts of the country in1963 (USFWS 1999), and there were estimated to be <700 pairs in the lower 48 states (Laycock 1973). In 1965 Sprunt stated, "since 1946 the marked decline of breeding bald eagle populations has exceeded 50% in some regions, reached 90-100% in others, and has been accompanied by nesting failures of 55-96%" (Sprunt 1969). The Chesapeake Bay which hosted perhaps 2,500 pairs in 1890, was reduced to 28 pairs in 1962 (23 of which failed to reproduce that year; Gerrard and Bortolotti 1988). Eagles were extirpated in at least 7 states, and 90% of the breeding pairs occurred in just 10 states (Grier et al. 1983).

Ratcliffe (1967) first noted the correlation between DDT (and its metabolite DDE) and eggshell thinning in raptors. It was later determined that DDE accumulates in the fatty tissues of eagles and impairs calcium release needed for eggshell formation. Nisbet (1989) suggested that eggshell thinning may be a parallel symptom of DDE poisoning, but not the primary, or only mechanism of reproductive failure. The rapidity of declines suggest that both reproductive impairment and excess adult mortality caused by DDT, dieldrin, and other poisons, contributed to local population declines (Nisbet 1989). DDT was banned from use in the United States after 1972, although the Environmental Protection Agency allowed it to be used by the U. S. Forest Service to combat an outbreak of Douglas-fir tussock moth (*Orgyia pseudotsugata*) in southeastern Washington and northeastern Oregon in 1974 (Herman and Bulger 1979).

In 1978, when the Washington bald eagle population was included in federal listing under the Endangered Species Act, several threats were identified, including reproductive failure caused by organochlorine pesticides (including DDT), widespread loss of suitable nesting habitat from logging, housing developments, and recreation, and persecution (USFWS 1978: Federal Register 43(31):6230-6233). Shooting was cited as an important mortality factor accounting for 40-50% of birds picked up by field personnel.

The DDT ban, along with habitat protections, reduced persecution (aided by high profile federal prosecutions), and reintroduction projects in some eastern states allowed the recovery of bald eagle populations. Gerrard (1983) analyzed Christmas Bird Count data for 1955-1980 and arrived at an estimate of the total continent-wide population of 70,500 as of 1980. The number of occupied territories in the lower 48 states increased 726% from 791 in 1974 to about 5,748 in 1998 (USFWS 1999). The bald eagle population doubled every 7-8 years during the preceeding 25 years. Six states (WA, OR, MN, WI, MI, FL) now have populations exceeding 300 pairs. Most populations have reached regional recovery goals, but are still well below pre-European settlement levels (Buehler 2000). In 1999, the USFWS proposed to de-list the bald eagle from protection under the federal Endangered Species Act (USFWS 1999).

Washington: Past

The earliest recorded observations of bald eagles in Washington indicate that the species was common and locally very abundant in the early 19th century, particularly on the Columbia River in late summer and fall (Suckley and Cooper 1860, Buechner 1953). J.G. Cooper got the impression in 1853 that it was "one of the most abundant of the falcon tribe in Washington Territory." In the 1890s, bald eagles were described as common or abundant at many locations including Grays Harbor, and especially near the mouth of the Columbia (Belding 1890, Bendire 1892, Lawrence 1892).

After the turn of the century, eagles were said to be a "not uncommon" resident of Puget Sound, Bellingham Bay, and larger inland lakes (Rathbun 1902, Edson 1908), but Bowles (1906) considered it a rare breeder in the Tacoma area where it was formerly abundant. Beginning in the late 1800s bald eagles (and many other predators) were frequently shot. Lord (1913) warned that people of Washington and Oregon should, "not kill at sight every Eagle that can be reached with a gun or rifle." Dawson and Bowles (1909) believed that bald eagles had already experienced a broad and severe decline in numbers in the state by 1909; they lamented (p.520):

> Fifty years ago they existed on Puget Sound and along the banks of the Columbia in almost incredible numbers... Twenty years ago this eagle was still a common sight ...Now all has changed. One may go out in the open for a week at a time without ever seeing an Eagle; and the only place I know where one may count with any certainty upon seeing two eagles in a day, is along the still unfrequented western coast.

Palmer (1927) noted eagles were still very common along rivers and coasts of the Olympic Penninsula, and Hoffman (1927) called it a "not common" resident in western Washington, and less common in eastern Washington. Kitchin (1934) states the species was a "formerly common breeder in western Washington, now much less so." Eagles still bred in Mt. Rainier National Park, but in fewer numbers than previously (Taylor and Shaw 1927, Kitchen 1939), and Kitchen (1949) indicated that bald eagles were probably more numerous on the Olympic Peninsula than in any other part of the state. Miller et al. (1935) reported that eagles were a common resident of the San Juans. Jewett et al. (1953) called the species a "common permanent resident." However, they noted that the taxidermy firm, Withers Brothers, indicated the "bald eagle was common near Spokane years ago, when more were brought in to be mounted than golden eagles" (Jewett et al. 1953:177).

Estimate of historical population. There are no historical estimates or density figures for bald eagles in Washington. Hunt (1998) describes an approach to estimating what the population size would be at carrying capacity based on survival rates and the number of breeding territories as limited by habitat. The densities reported from less developed areas can be used to derive a reasonable guesstimate of the number of nesting territories, or "serviceable breeding locations" (SBLs) that existed historically. Blood and Anweiler (1994) reported a range of 0.129-0.467 active nests/mi on marine shores of British Columbia, and Hodges (1982) reported a density of 0.499/mi for Seymour Canal, southeast Alaska. Washington may never have supported the density of eagles reported for Alaska, but if we assume that all the marine shores supported the density of nests we see today along the marine shoreline of Clallam

County (0.252 active nests/mi), then the 2,880 mi of Washington marine coasts would have supported 725 active nests. For fresh water shores, Blood and Anweiler (1994) reported a density of 0.19 active nests/mi on the lower Fraser/Harrison rivers, British Columbia and a range of 0.032- 0.064 active nests/mi for several lakes. There are about 4,560 mi of river and lake shore in western Washington, today. However, this includes reservoirs that did not exist, and some lakes that may be too small, or are at high elevation. If we assume that 25% was unsuitable, and a density of 0.06 nests/mi for the remaining 3,420 mi yields 205 nests. Thus the total for western Washington would be 930 SBLs.

In eastern Washington today there are about 1,080 mi of forested and 5,519 mi of unforested shorelines along major rivers and large lakes. If we reduce the 1,080 mi by 25% for reservoirs that did not exist historically, or that have added shoreline, that leaves 810 mi. The amount of treed shore that was inundated by dam construction, and is now unforested is unknown. Fielder (1976) indicated that at least 5% of an area along the mid-Columbia that was to be inundated by the Grand Coulee third powerhouse extension had ponderosa pines present. If we assume that only 1% of the 5,519 presently unforested shorelines was treed with pines or cottonwoods, that would add an additional 55 mi for a total of 865 mi. Blood and Anweiler (1994) reported a recent density of 0.145 active nests/mi on the Columbia River in British Columbia. Using 0.10 nests/mi as a historical average for the 865 miles yields 86 nests (this compares to about 70 today) for eastern Washington.

This provides a total estimate of about 1,016 historical SBLs for Washington. Annual survival rates have been reported from Alaska of 0.88 for adults, 0.95 for subadults, and 0.71 for juveniles (Bowman et al. 1995). Using these survival rates, a life span of 20 years, and an annual productivity of 0.86 young per pair, Moffat’s equilibrium model, as described by Hunt (1998), would yield an equilibrium population of 3,859 adults and 2,643 subadults and juveniles, for a total of 6,503. Populations of eagle species that are relatively stable typically have a large number of nonbreeding adults and subadults (Newton 1979). Hansen and Hodges (1985) reported that known breeders composed less than half of the adult bald eagle populations during 3 or 4 years of their study in Alaska, and nonbreeders, or “floaters” comprised 27-40% of the population at Bresard Lake in Saskatchewan (Gerrard et al. 1992). In this case the historical population would have included about 1,827 floaters.

Thus, if our assumptions have not been either too conservative, or too optimistic, the historical early summer population in Washington before the impact of white settlement may have been around 6,500 bald eagles.

The indiscriminate use of DDT between the 1940s and 1970s is widely named as the main cause for decline in Washington and the other 48 states (Stalmaster 1987); DDT’s effect on reproduction clearly prevented Washington’s bald eagle population from replacing adults that were killed and a steady decline followed. However, the impact of direct persecution should not be underestimated. Beebe (1974) comments:

> The decline in numbers...south of the Canadian border has been officially attributed to pesticide contamination and is supposed to be recent–a concept which, if accepted, conveniently ignores and effectively conceals the historical record of a full century of unremitting, officially condoned, and often officially rewarded persecution, with extinction its stated goal.

The first major survey efforts to determine the distribution and abundance of nesting bald eagles in Washington were focused on the San Juan Islands (Nash et al. 1980). Aerial nest surveys of known nests in the San Juans were conducted from 1962-80, with the number surveyed growing from 5 in 1962 to a maximum of 60 in 1978 (Nash et al. 1980). A winter survey of the San Juans produced an estimate of 150 eagles for 1963 (Hancock 1964). Washington Department of Fish and Wildlife (Department of Game at that time) conducted nest surveys in the 1970s in northwestern Washington. The 1974 surveys checked 75 nests and recorded that 7 young were produced from 22 nests (Adkins 1974). The first extensive survey that covered the entire marine shoreline was conducted in 1975 (Grubb et al. 1975). The survey found 114 nesting pairs (100 active nests) located along marine shoreline areas of Puget Sound, the Strait of Juan de Fuca, and the Pacific Ocean coast; only three of these pairs were found nesting on interior lakes or rivers (Grubb 1976).

The USFWS and WDFW continued annual aerial surveys, primarily of the San Juan Islands, from 1976 through 1979. In 1980, the WDFW initiated annual, statewide inventories of nesting bald eagles. The 1980 survey effort located 105 nesting pairs. State-wide, comprehensive activity and productivity surveys were conducted annually from 1980-1992, and the nest activity surveys were continued through 1998. New nests, as well as improved survey efficiency and increasing reports from interested citizens, resulted in annual increases in the number of known nesting pairs of bald eagles (Table 4).

Washington: Present

The last statewide surveys conducted in 1998 at 841 known territories recorded 664 occupied sites. This accounts for 12% of the 5,748 bald eagle territories across the contiguous United States (Fig. 6; USFWS 1999). From 1981-1998 the nesting population in Washington had increased 427% or about 10% annually from 1980-98 (Fig. 7; $P < 0.001$). We estimated the number of statewide breeding pairs expected at carrying capacity by fitting population growth to a logistic curve based on the number of occupied territories found each year from 1980-98. By fitting the logistic curve to the population trend over time, and assuming the population is approaching a steady density, the carrying capacity and maximum intrinsic rate of growth can be estimated (Caughley 1977, Swenson et al. 1986) (see Appendix A). Starting with the 1980 populations of 102 pairs in western Washington, and 3 in eastern Washington, and based on the present growth rate of 16.7% per year for eastern Washington and 9.5% for western

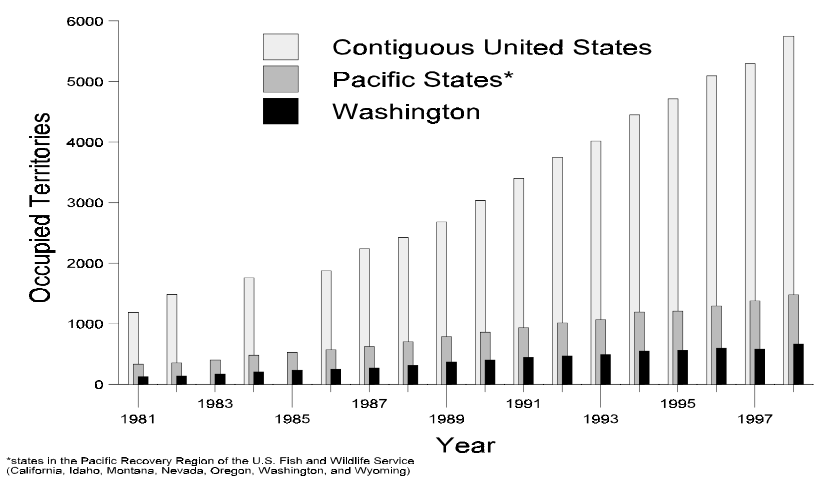


Figure 6. Comparative growth of the nesting population of bald eagles in the U.S and Washington, 1981-98.

Table 4. Number and productivity of nesting bald eagles in Washington, 1980-2000.

Year	No. territories surveyed	No.(%) Occupied[a] territories	Occupied territories successful (%)	Estimated no. of young produced[b]	No. nests with known outcome	Mean no. young/ occupied territory[b]
1980	154	105 (68)	64	95	91	0.90
1981	165	126 (76)	56	95	110	0.75
1982	189	138 (73)	55	102	118	0.74
1983	231	168 (73)	59	145	150	0.86
1984	254	206 (81)	67	195	188	0.95
1985	290	231 (80)	65	226	193	0.98
1986	301	250 (83)	73	277	218	1.11
1987	327	268 (82)	65	262	245	0.98
1988	361	309 (86)	66	302	279	0.98
1989	424	369 (87)	63	365	331	0.99
1990	477	403 (84)	70	431	357	1.07
1991	515	445 (86)	63	431	402	0.97
1992	560	468 (84)	69	464	425	0.99
1993	588	493 (84)	63	466	140	0.94
1994	636	547 (86)	70	557	237	1.02
1995	660	558 (85)	63	507	255	0.90
1996	709	594 (84)	64	554	236	0.93
1997	727	582 (80)	66	565	214	0.97
1998	841	664 (79)	74	731	315	1.10
1999[c]	486	387 (80)	80	492	165	1.27
2000[c]	408	325 (80)	80	408	89	1.26
total or	9305	7638 (82)	82	7608	4758	1.00

[a] Occupied territories had two adults present, young or eggs in the nest, or an adult in incubation posture.

[b] Estimated young were projected based on the average number of young produced by pairs with known outcome. Most surveys had nests known to be productive but without young counted.

[c] Nest activity and productivity surveys in 1999 and 2000 were for select portions of the state only.

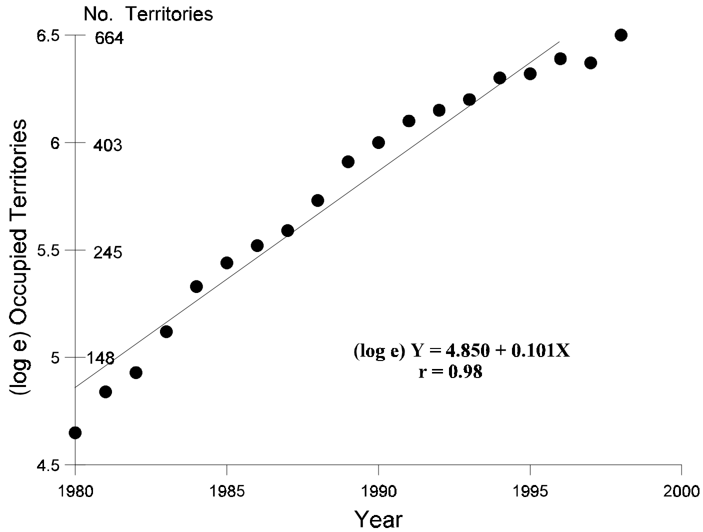


Figure 7. Growth in the number of occupied bald eagle nests in Washington, 1980-1998.

Washington, the Washington nesting population would be predicted to reach combined carrying capacity at 733 pairs. No comprehensive surveys have been conducted since 1998, so it is not known how closely this prediction was met. The true carrying capacity is unknown, but a recent decline in nest occupancy rate and the appearance of nests in developed areas suggests that nesting habitat in parts of western Washington is approaching saturation (S. Negri, pers. comm.). In contrast, some subpopulations in eastern Washington may still be increasing. For example, the number of territories on Lake Roosevelt increased from 2 in 1988 to 24 in 2000 (Murphy 2000).

Nesting density. Nest density in Washington in recent years approaches the averages for southern and northern British Columbia (Table 5). Selected shoreline areas of Washington, such as Clallam County, are similar to denser parts of British Columbia, but are not as high as some pristine areas of southeast

Table 5. Average density of active[a] bald eagle nests along shorelines of Washington, British Columbia, and Alaska.

Location	Active nests/ mi shoreline
Washington	
forested shorelines (fresh and marine)	0.119[b]
Clallam County	0.252[b]
Clallam, Jefferson and San Juan Counties (combined)	0.193[b]
British Columbia	
S. of Cape Caution (Hodges et al. 1984)	0.129
Gulf Islands (Vermeer and Morgan 1989)	0.193
Queen Charlotte Isl. (Harris 1978)	0.306 - 0.467[c]
several lakes (Hodges et al. 1984)	0.032 - 0.064
Seymour Canal, Alaska (Hodges 1982)	0.499

[a] Active nests are usually defined as nests showing evidence of actual breeding by a pair of eagles, such as the presence eggs, young, or an adult in breeding posture.
[b] Density of active nests in 1998.

[c] This survey was conducted by boat; the remaining studies used aircraft.

Alaska. Statewide there are about 5,090 mi of forested shoreline (salt and fresh), and 606 nests were active in 1998 (though not all are on shorelines, probably all are associated with shoreline foraging areas), for a density of about 1 active nest/8.4 mi of forested shoreline, or 0.119 active nests/mi.

Occupancy rate. The rate of territory occupancy is defined as the percentage of total known territories in use as indicated by two adults at the nest, eggs or young in the nest, or an adult in incubation posture. Mature bald eagles may or may not breed during any given year. Occupancy rate is affected by adult survival (i.e. high mortality creates a shortage of breeders) and the carrying capacity of an area. A recent change in occupancy rate in Washington suggests that nesting habitat may be reaching carrying capacity. Prior to 1984, annual occupancy rates in Washington were less than 76% but increased to the 80th percentile in the mid-1980's (Table 4). From 1980-98 nesting occupancy exhibited an increasing linear trend (Fig. 8; $P = 0.005$), but seemed to level off and remain relatively stable around 84-87% from 1988-96. Occupancy rates exhibit a statistical decline for the period 1993-98 ($P = 0.040$). When the habitat is saturated, the proportion of the adult eagle population that does not breed increases (Hansen and Hodges 1985, Hansen 1987). Occupancy rates may then decline slightly due to competition between breeders and nonbreeders (Brown 1969).

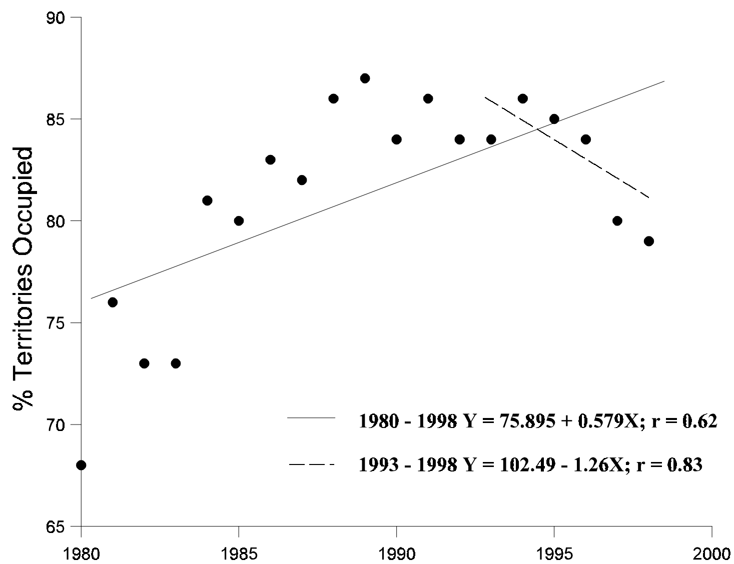


Figure 8. Trend in bald eagle territory occupancy in Washington, 1980 – 98.

Productivity rate. Productivity rate is defined as the number of eagles produced per occupied nest. Nesting bald eagles most often lay 2 eggs (range 1 to 3), but neither or only one may survive to fledging. Nesting failures are not uncommon, even in healthy populations. In Washington between 1980-98, an average of 35% of active nests produced no young, 1 young fledged at 35% of nests, 2 young at 29%, and 3 young at 1% (Watson, unpubl. data). Productivity rates as low as 0.14 and as high as 1.45 young per occupied site have been recorded throughout North America (Table 6). Rates below 0.52 young per occupied site have generally been characteristic of decreasing populations, many in the era when DDT was used. There is a wide range of productivity rates for stable or increasing populations because survival rates have a greater bearing on population trends than do productivity (Grier 1980, Buehler et al. 1991a, Harmata et al. 1999). From 1975-80, the San Juan Islands population was moderately productive (0.84 young/occupied territory) and increasing (Grubb et al. 1983). McAllister et al.(1986) reported a statewide productivity rate of 0.87 young/occupied territory for 1981-85 while the population increased from 124-227 known pairs. From the period 1980-98, the population had a productivity rate of 0.95 young/occupied territory, and the productivity rate increased linearly (Fig. 9; $P = 0.024$).

Table 6. Productivity and nest success of bald eagle populations that were increasing, stable and decreasing.

Region	n[a]	No. young/ occupied territory	% active territories successful	Period	Population trend	Source
Washington	**6,924**	**0.95**	**65**	**1980-98**	**increasing**	**WDFW data**
San Juan Islands, WA	**275**	**0.84**	**62**	**1975-80**	**increasing**	**Grubb et al. 1983**
Chesapeake Bay	145	1.18	69	1981-90	increasing	Beuhler et al. 1991a
Oregon	606	0.92	67	1978-82	increasing	Isaacs et al. 1983
Great Lakes	456	0.8	81	1990-93	increasing	Bowerman 1993
Prince Wm. Sound, AK	622	0.87	57	1990	increasing	Bowman et al. 1995
Copper River, AK	471	0.71	48	1989-94	increasing	Steidl et al. 1997
Arizona	183	0.69	45	1970-93	increasing	Driscoll et al. 1999
Florida	3,759	1.1	67	1980-89	increasing	Nesbitt 1998
Saskatchewan	264	1.17	73	1973-81	stable	Gerrard et al. 1983
Kodiak Is., AK	312	1.00	63	1963-70	stable	Sprunt et al. 1973
Wisconsin	492	1.00	66	1962-70	stable	Sprunt et al. 1973
Michigan (lower penn.)	243	0.52	37	1961-70	decreasing	Sprunt et al. 1973
Maine	241	0.35	26	1962-70	decreasing	Sprunt et al. 1973
Great Lakes	156	0.14	10	1961-70	decreasing	Sprunt et al. 1973

[a]Most studies, including those in Washington, show cumulative territory numbers sampled all years of the study.

However, for the years 1990-98 only, there was no trend in productivity for Washington eagles (P = 0.956), an indication that in the past decade bald eagle productivity has stabilized at about one young/occupied territory. Productivity in some areas remains high, with productivity on Lake Roosevelt in eastern Washington averaging 1.69 young/occupied territory for 1994-2000, during which time the number of nests grew from 8 to 24 territories (Murphy 2000). Productivity in some parts of the state remains low (see Lower Columbia and Hood Canal below).

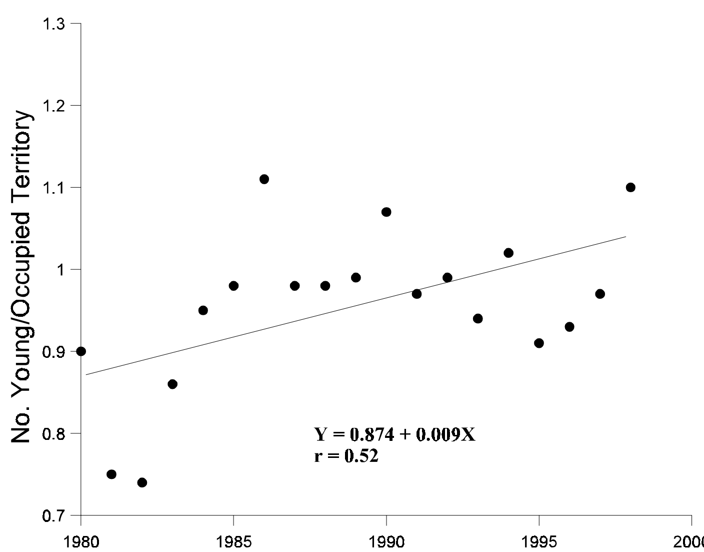


Figure 9. Trend in bald eagle nest productivity in Washington, 1980 - 98.

Nest success rate. A second measure of productivity, nest success, is the proportion of active nests that successfully produce at least 1 young. This parameter reflects the health of nesting adults, which can be affected by environmental factors such as contaminants or human disturbance. A summary of breeding populations during the era of active DDT use concluded that at least 50% of breeding pairs of bald eagles must be productive to maintain stability (Sprunt et al. 1973). Nest success in populations throughout North America in more recent years suggests that, assuming high adult survival, a minimum level of 45% nest success is needed for populations to at least remain stable (Table 6; although some of these populations may have experienced immigration). Nest success in western Washington was 55% in 1975, and 60% in 1980 (Grubb et al. 1983). From 1980-98, the population was characterized by a nest success rate of 65%, with an increasing trend (Fig. 10; *P* = 0.0306). However, from 1984-98, no trend was evident (*P* = 0.8058), nest success having stabilized between 63% and 74% annually.

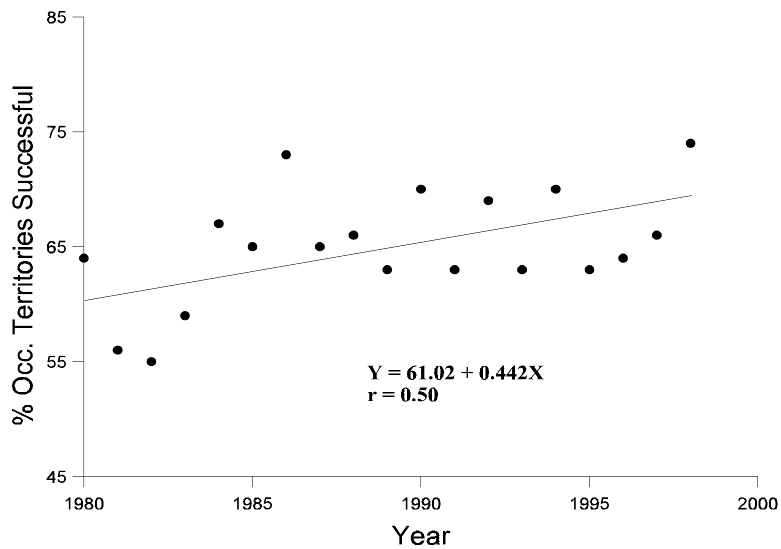


Figure 10. Trend in bald eagle nest success in Washington, 1980 – 98.

Lower Columbia River and Hood Canal. In spite of the high productivity of the upper Columbia (Lake Roosevelt) nests, and the overall health of the nesting population of Washington's bald eagles, two regional populations, the lower Columbia River and Hood Canal, have exhibited low reproductive success similar to those in decreasing populations (Table 6). From 1980-98, reproductive parameters of the lower Columbia population were below the state average (0.56 vs. 0.96 young/occupied territory; 41 vs. 65% occ. territories successful) as were those of Hood Canal (0.63 young/occupied territory; 43% occ. territories successful). Both populations increased during this period despite the low reproduction (lower Columbia 1 to 24 pairs; Hood Canal 3 to 33 pairs), probably due to recruitment of new adults from adjacent areas in Washington.

Studies found significant concentrations of DDE and/or PCBs in the eggs of bald eagles from both areas (Anthony et al. 1993, Mahaffy et al. 2001), and elevated dioxin (TCDD) levels were found in eagle eggs on the lower Columbia. A 1992-1997 study of contamination in the Hood Canal eagles was inconclusive. Concentrations of PCBs and compounds with dioxin-like activity were sufficiently high to raise concern, but were lower in eggs collected later in the study (Mahaffy et al. 2001), and levels of PCBs in fish and a small sampling of sediments were low.

Reproductive success on Hood Canal did not seem to be related to disturbance or habitat alterations (Watson et al. 1995, Leach 1996). Hood Canal bald eagle nests were, however, more widely-spaced than nearby territories with normal reproduction, and eagles exhibited lower overall foraging success resulting from poorer success at pirating prey (Watson and Pierce 1998b). Hood Canal foraging areas had a lower abundance of large fish (>30 cm), and possibly fewer potential piracy victims (gulls and ospreys).

In spite of the poor reproductive history of these populations, their reproductive health appears to be improving. There was an increasing linear trend for productivity (P = 0.001) and nest success (P < 0.001) for lower Columbia eagles, and productivity (P = 0.016) and nest success along Hood Canal (P = 0.008) from 1980-98 (Watson, unpubl. data). The lower Columbia accounted for 4% of nesting pairs in the state in 1998, and Hood Canal 5%. If these regional contaminant problems improve, the lower Columbia and Hood Canal bald eagle populations would contribute further increases in the nesting population in Washington.

Winter population. In winter, when bald eagles from the northern Canadian provinces, Alaska, Montana, and California arrive in Washington, the population may increase to three to four times that of the breeding population. Mid-winter surveys conducted in Washington from 1982-89, recorded about 1,000 to 3,000 individuals (Fig. 11; Appendix B). This winter population includes adult breeders and subadult eagles raised in Washington that have returned to the state following migration to the coastline of British Columbia, as well as wintering birds that breed elsewhere (Watson and Pierce 2001). The present size of the winter population is unknown since statewide surveys were discontinued in 1989. Using the statewide data, the population of winter migrants (total winter count - number of Washington breeders) increased linearly from 1982-89 (r = 0.78; P = 0.024). Based on this rate of increase, the predicted population of winter migrants in the year 2000 would be 3,193 individuals, and the total winter population around 4,500 if Washington breeders are included. The validity of this population estimate is unknown since the actual carrying capacity of eagle wintering habitat in Washington is unknown. Winter surveys that have continued on the Skagit River from Rockport to Newhalem by The Nature Conservancy and the National Park Service, and in Whatcom County by volunteers (coordinated by Sylvia Thorpe) indicate at least a modest increase in eagles detected from 1983-2000 (Fig.12). Peak winter detections on Nisqually have also increased from 12-40 birds during 1982-89 to a record 200 birds in 2001 (Taylor 1989, Stalmaster and Kaiser 1997a, M. Stalmaster, pers. comm.). Christmas Bird Count data from British Columbia also suggest a long term increase in wintering eagle numbers (Dunwiddie and Kuntz 2001). Year to year variation in these counts may not accurately reflect the entire wintering population due to variation in the timing of peak numbers, and eagle movements among several rivers. The size and trends of migrant, wintering bald eagles in

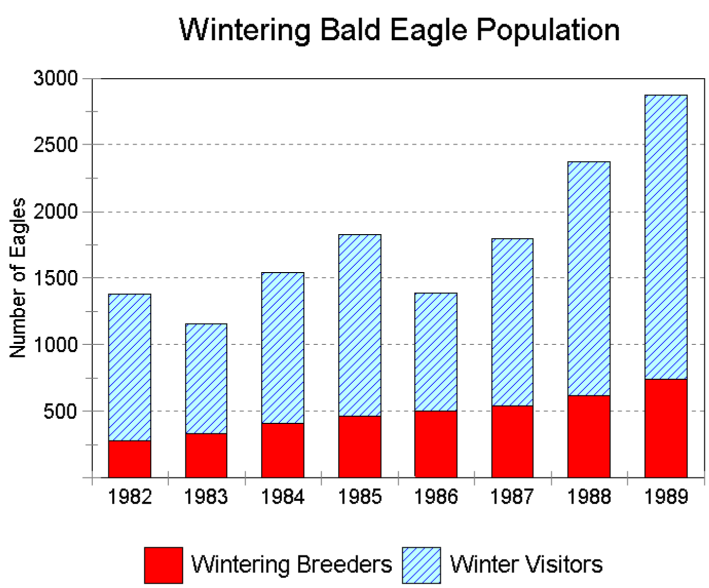


Figure 11. Number of bald eagles wintering in Washington, 1982-89 (based on mid-winter counts and number of known breeders).

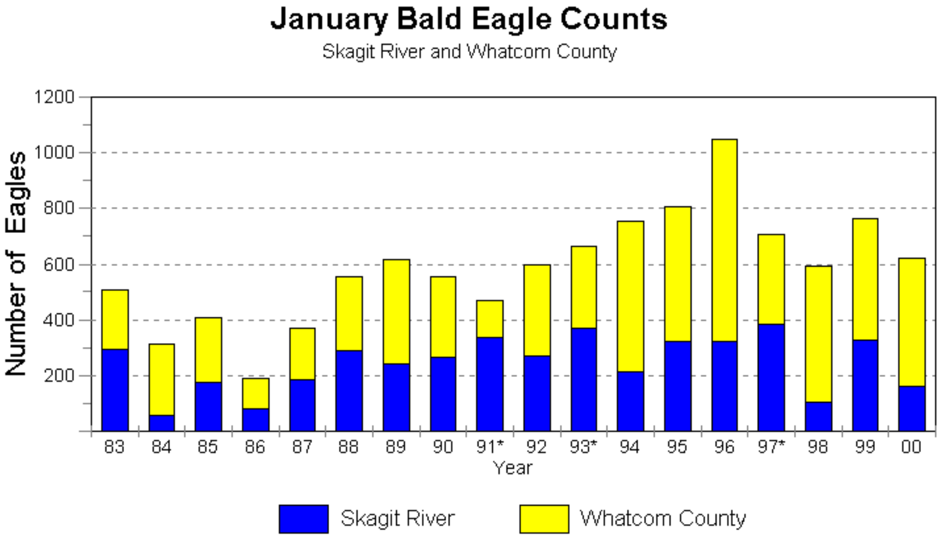


Figure 12. Bald eagles counted in Whatcom County and on the Skagit River in January, 1983-00 (* high water precluded boat counts on the Nooksack [Whatcom] in 1991, 1993, 1997; 1996 Skagit count incomplete; source TNC, NPS, and Sylvia Thorpe).

Washington is most dependent on the health of northern populations, with annual fluctuations likely affected by fall and winter prey populations north of Washington, such as the Fraser River and the coastline of British Columbia (Watson and Pierce 2001). As these migrants move south from breeding areas, their destinations and duration of time spent in specific areas in Washington depend on the availability of prey (e.g., chum and coho salmon carcasses) which vary annually (Witmer and O'Neil 1990, Hunt et al. 1992c).

Washington Population: Future

If the nesting eagle population is near carrying capacity, at least in portions of western Washington, then the number of occupied territories will soon stop increasing, and may fluctuate around our predicted carrying capacity of 733. Although nesting habitat may limit the number of breeding pairs, the total population of eagles will continue to increase because the pool of non-breeders (floaters) typically increases as raptor populations reach carrying capacity (Newton 1979). Using 733 nesting pairs at carrying capacity as the number of serviceable breeding locations, the total peak eagle population can be predicted based on Moffat's Equilibrium (Hunt 1998, Hunt and Law 2000). Survival and longevity information was reported from recent studies in stable populations. Average longevity in the Yellowstone ecosystem was 16 years (Harmata et al. 1999), and in Alaska productivity was 0.86 young/pair, and survival rates were 0.88 (adults), 0.95 (subadults), and 0.71 (juveniles) (Bowman et al. 1995). Moffat's model predicts the population would continue to increase for 1 generation (in this case 16 years) after all SBL's are occupied, and stabilize with 1,042 non-breeding adults (floaters), 1,907 subadults and juveniles, in addition to the 733 breeding pairs, for a total population of 4,415.

The model can also be used to predict the effect of changes in survival rates or productivity on the population. For example, assuming that all other parameters are constant, the population would decline if nest productivity declines 42% from 0.86 to 0.5 young/ pair, or if adult survival declines 14%, or if juvenile and subadult declines 11%.

Assuming predicted growth of the human and eagle populations are realized, and our assessment about the current eagle population is correct, then some generalizations can be made. Our hypothesized trends (Fig. 13) are based on known numbers in 1980 and 1998, and our estimate of the historic and future equilibrium populations. The historical declines from 1860-1970 were probably not a straight line, but were steeper after commercial exploitation of salmon began, logging of Puget lowlands occurred, and in periods of increased persecution (e.g. when modern rifle ammunition became inexpensive). Due to inevitable habitat changes that will occur with increasing human population, the number of nesting territories may slowly decline as more and more trees are lost, prey populations decline, and eagles compete with humans for foraging space. A reduction of 20% in SBLs would result in an 20% decline in the total eagle population from 4,415 to 3,532. How far and fast an actual decline would occur may depend on the degree of habitat protection afforded by regulatory processes, how adaptable the eagles are to using smaller trees in increasingly urbanized situations, impacts to breeding season prey populations, and the strength of salmon populations that are important post-breeding food sources.

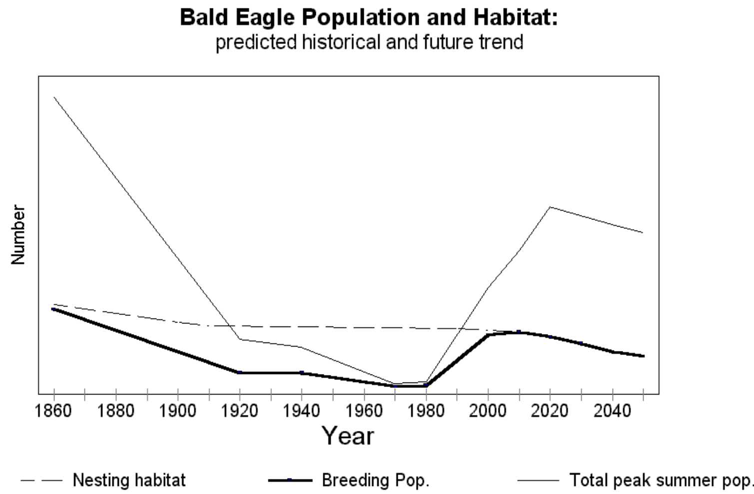


Figure 13. Hypothesized trends in the peak early summer bald eagle population and nesting habitat in Washington, 1860-2050.

HABITAT STATUS

Past

Historically, the abundant fish and marine life, waterbirds, and extensive forested shorelines of Puget Sound, the outer Coast, and large rivers of Washington probably provided excellent habitat for bald eagles. Historic accounts suggest that eagles were indeed abundant (Suckley and Cooper 1860). Early naturalists noted the abundance of bald eagles attracted to spawning salmon along the Columbia River, especially during late summer and early fall (Buechner 1953). Nesting densities along marine shores may have approached nesting concentrations found in parts of British Columbia and Alaska today (e.g. 1 nest every 2-6 miles; Hodges 1982, Blood and Anweiler 1994). The availability of large nest trees (average dbh= 75 in; Anthony et al. 1982) probably rarely limited local bald eagle nesting. Trees of this size and larger were presumably abundant along most of the shorelines of western Washington, since about 60-70% of the pre-logging forest in Washington was old growth (Booth 1991, Bolsinger et al. 1997). Gaps in old timber occurred from fires and wind events, but probably rarely eliminated all large trees to the water's edge. Wintering concentrations along Washington rivers where chum and coho were spawning were probably limited only by the abundance and predictability of the salmon runs, competition with other carnivores and native Americans, and factors such as weather that affected reproduction in British Columbia and Alaska.

Present

Foraging habitat. Eagles have adapted to a coastal existence because these areas are productive ecosystems with a wide variety and abundance of prey. Bald eagle foraging opportunities are quite different today. Some aspects of the prey base in the marine and freshwater areas of Washington are probably similar to what they were 200 years ago, but many things have changed. Since the early 1800s, the Puget Sound has lost an estimated 47% of its estuarine wetlands and losses in urban areas are 90-98% (WDNR 1998). Three million people now live near shores of the Pacific Ocean, Hood Canal, and Puget Sound (WDNR 1998). Puget Sound has lost 76% of its marsh, and there has been a substantial decline in mudflats and sandflats (Levings and Thom 1994). Coastal and riparian wetlands are affected by contamination, dredging, over-enrichment from residential and agricultural fertilizers and sewage, application of pesticides to oyster beds, the introductions of spartina (*Spartina alterniflora*), reed canary grass (*Phalaris arundinacea*), and purple loosestrife (*Lythrum salicaria*). Water quality is good in only 35% of Washington estuaries, and there are 5,100 ac with contaminated sediments. Spartina, a cordgrass native to the Atlantic coast, is rapidly covering the mud and sandflats of Willapa Bay, and eliminating the stop-over foraging habitat for >100,000 migrating shorebirds (Buchanan and Evenson 1997). Gerrard and Bortolotti's (1988:142) statement about habitat in North America is also true for Washington: "A great deal of historical eagle habitat has been made irrevocably unsuitable."

The Columbia and some other rivers have changed dramatically and some salmon runs are no longer abundant, and a few are extinct (*see* Salmon, p. 44). Other bald eagle prey, such as marine fish and waterfowl may be much reduced in local abundance due to habitat changes, or less available due to greatly increased utilization of these species by people (*see* Factors Affecting, Other Prey Populations, p.46).

Human-related changes have not all been negative for bald eagles, particularly in eastern Washington. A variety of freshwater fish have been introduced to Washington waters and reservoirs created habitat for fish and concentration areas for wintering waterfowl (*see* Reservoirs and introduced fishes, p. 47). Dam-caused fish fatalities may have made some fish species more available to eagles. European hares were introduced to the San Juans and Destruction Island, and chukar (*Alectoris chukar*) and pheasants (*Phasianus colchicus*) were introduced into eastern Washington providing new prey sources. The after-births and carcasses of dead livestock can be scavenged by eagles. The prevalence of rockfish in eagle diets suggest that commercial fishing discards may be a significant new food source (Knight et al. 1990). Hunter crippled waterfowl and other game are probably more available to the eagles, and road-killed deer is a significant new food source.

Nesting, perching and roosting habitats. Large trees (>100 years old) are a diminishing resource, particularly near shorelines that are valuable waterfront and view property for residential development. Most shorelines in Washington were logged early, primarily because of easy access and the ability to use water courses to transport the logs to mills along the waterfront. However, historical logging did not have the industrial efficiency it has today. As a result, many trees were spared and have grown to a large size, providing the bald eagle nesting habitat in use today. Though these smaller scraps of old growth remain, overall large trees, particularly Douglas-fir, western hemlock, western red cedar, and Sitka spruce, are dramatically diminished in abundance around shorelines of western Washington. Of the 1.1 million acres of old growth remaining in 1992, most is above 600 m in elevation, and too far from shorelines to be useful to nesting bald eagles. Nearly all the non-publicly-owned old growth forests are gone, and there is almost no late seral (>100 years old) forest remaining in the lowlands around Puget Sound (WDNR 1998). Witmer and O'Neil (1990) reported that a deficiency of roosting habitat and riparian perch trees may be limiting the number of wintering eagles in the lower Snohomish and Skykomish River basins which are primarily in private ownership. Late seral stands at higher elevations that provide important roost sites also continues to be lost. Outside of national forests (that are primarily above the lowlands) these late seral stands make up only 3% of the forest in western Washington. Much of what remains occurs in small patches that can be affected by blow-down and development, etc., and some remains because it was protected by Bald Eagle Management Plans developed between landowners and WDFW (WAC 232-12-292; see Plans p. 35).

Booth (1991) estimated that prior to logging, about 62% of western Washington and Oregon forests was old growth. If 62% of the land within ½ mile of marine shorelines contained old-growth, then about 482,150 ac existed prior to logging. This compares to about 33,000 ac of mature-to-old timber today (based on a spotted owl habitat GIS coverage that WDNR assembled from various data sources dating from 1987-94) for a decline of >93%. This probably excludes some small (<1 ac) parcels with large trees suitable for eagles, and includes some areas suitable for owls, but that do not provide the large trees with open flight paths needed by eagles. Much of this habitat is probably on public lands, such as the coastal portion of Olympic National Park.

In addition to the change in forest cover from older forest to young plantation, substantial portions of the Puget lowlands have been developed or converted to other uses. Between 1970-1997, 2.3 million acres of commercial timberland was converted to other uses (WDNR 1998). The forest types in which most bald eagles nest include the Puget Sound Douglas-fir Zone and the Sika Spruce Zone described by Cassidy et al. (1997). In their analysis of land cover, vertebrate species distributions, and land protection status (Washington GAP project), the Puget Sound Douglas-fir zone received a "moderately high" Conservation Priority Index because it is among zones that has been largely converted to agriculture or development (Cassidy et al. 1997, Cassidy et al. 2001). Only 1.13% of the Puget Sound Douglas-fir zone is found in lands primarily dedicated to the conservation of biodiversity (Cassidy et al. 1997). The proportion of private ownership of the zone is so high that "meaningful biodiversity management will be difficult or impossible without the assistance of private land owners, thus the persistence of many species... will continue to depend on management practices on private land" (Cassidy et al. 1997:82).

Land ownership. Washington's marine shorelines are overwhelmingly privately owned (80%), and many of the shorelines of rivers and lakes are also private land. It follows that most of the bald eagle nest trees and lands in territories (defined for this analysis as ½ mi radius around nest trees so that the shoreline area typically used for perching and foraging is included) are privately owned (Fig. 14 and Appendices D, E). The lands in 1/3 of territories are partly public and partly private, but two thirds of nest trees (540) and 47.6% of nesting territories (389) are entirely within private ownership, and 55.8% of the land in territories is ≥90% private (Table 7). Most nest territories (81.4%) contain some private lands. Private lands near shore are highly valued for residential development. Despite some restrictions on clearing of habitat imposed by the Shoreline Management Act (WAC 173-26), and the bald eagle protection rules (WAC 232-12-292), these areas continue to lose the large trees and cover needed for nesting. Some shoreline areas have been subdivided into narrow lots to maximize the number of waterfront lots. These "spaghetti" lots and other areas that allow high density residential development are likely to become

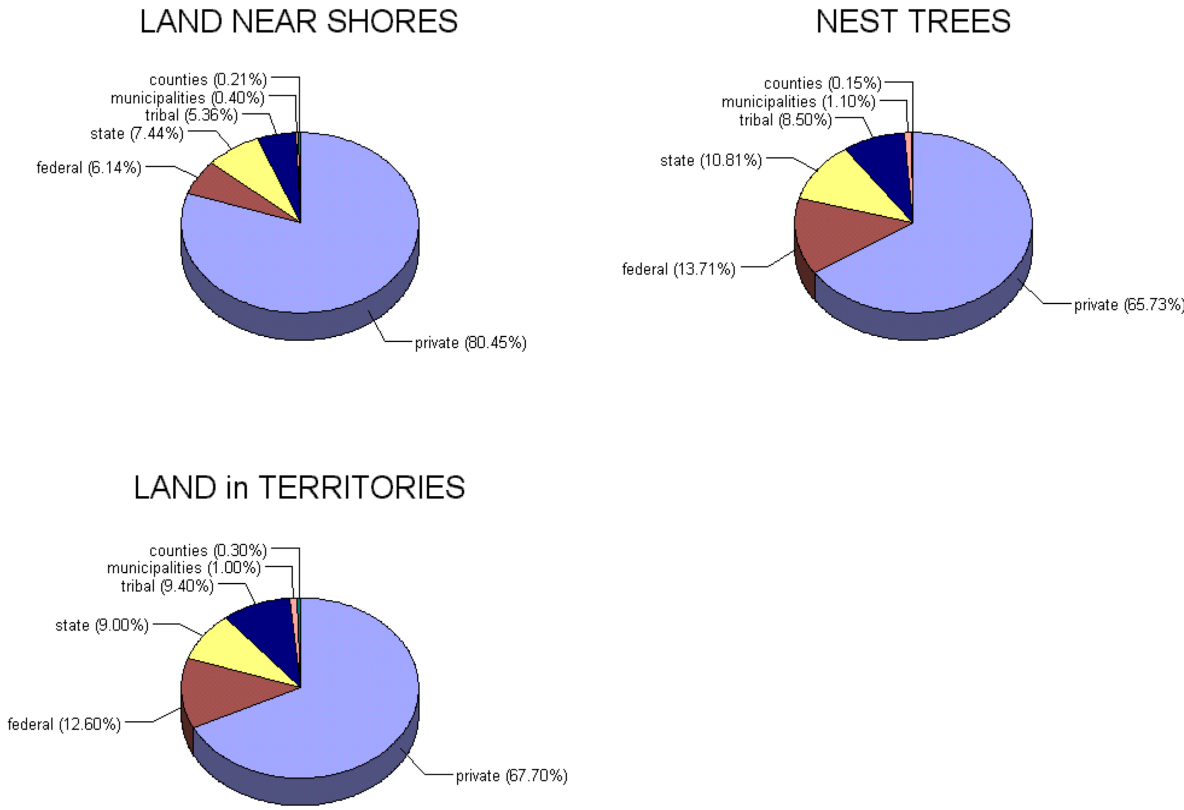


Figure 14. Percent ownership of lands within ½ mi of marine shores, most recently used nest trees, and aggregate land in territories, for 817 bald eagle territories (½ mi radius around nest) in Washington, 2000.

inhospitable to nesting eagles as many are developed. Many private landowners have developed lots so as to minimize impacts to eagles, and they value the presence of eagles and in some cases trees will be allowed to grow to large size after residences are built (*see* Bald Eagle Management Plans, p. 35). However, as the human population grows, the pressure to subdivide wherever zoning allows it, will likely lead to further losses of habitat. Though lands near nests may continue to be subject to bald eagle

Table 7. Number and percent of bald eagle nest territories in percent ownership categories.

	n	Public lands			Private lands			
		100%	>70%	>50%	≥50%	≥70%	≥90%	100%
No. territories [ab]	817	152	182	219	557	510	456	389
Percent[b]	100	18.6	22.3	26.8	68.2	62.3	55.8	47.6

[a] Territories active in at least 1 year since 1995; territories defined as ½ mi radius of nest for analysis. Analysis excluded water, so acreage within territories varied.

[b] Row total exceeds 100% and 817 nests due to overlap in categories (e.g. all territories that are 100% public are included in the >70% and >50% categories), see Appendix E for data by county.

protection rules, the options for eagles to relocate outside of these areas will continue to diminish. The Nature Conservancy owns a very small number of the nests (3 or 4) that are on private lands, and a few others are protected by restrictive conservation easements. Indicative of the difference in land uses and eagle suitability that occur on public vs. private lands is the larger proportion of nests on public lands (34%) compared to the proportion of public ownership of lands near shore (20%; Fig. 14). The types of land uses that affect bald eagles on public lands are somewhat different from those on private lands. Public lands, though not free from development pressures, are subject to closer scrutiny during environmental review, and more often are managed partly for conservation purposes. The Department of Natural Resources (WDNR; 5.1%) and the National Park Service (4.6%) are the non-tribal government agencies that control the largest public portions of land within eagle territories (Table 8). Tribal governments control 9.4% of the public lands within territories.

State, county, and municipal lands are subject to the provisions of the bald eagle protection rules, and management must consider providing for large trees and nesting and minimizing disturbances to nesting eagles. These non-federal public lands support about 100 nests and about 10.2% of lands within

Table 8. Ownership or jurisdiction of nest trees and aggregate lands in bald eagle territories (½ mi radius around nest) with active nests in Washington, 1996-2000.

Management	Aggregate lands in eagle territories		Nest trees	
	% of total	area (ac)	%	Number
Private	67.8	192,153	65.7	540
Tribal governments	9.4	26,719	8.5	70
Washington Dept. Natural Resources	5.1	14,436	4.7	39
National Park Service[a]	4.6	12,989	5.1	42
Washington State Parks and Rec.	2.7	7,686	4.7	39
Bureau of Reclamation	2.4	6,845	2.2	18
U.S. Dept. of Defense	2.2	6,313	2.7	22
U. S. Forest Service	1.7	4,713	1.6	13
U. S. Fish and Wildlife Service[a]	1.3	3,670	1.7	14
Cities	1.0	2,670	1.1	9
Washington Dept. Fish & Wildlife[a]	0.8	2,137	1.0	8
Bureau of Land Management	0.3	863	0.4	3
Counties	0.3	715	0.1	1
U. S. Dept. of Energy	0.2	500	0.1	1
Washington universities	0.2	467	0.4	3
Washington Dept. of Corrections	0.1	299	0.0	0
Total	100.0	283,473	100.0	822

[a]Habitat security is very high for these jurisdictions; the remaining landowners offer uncertain or mixed security at best.

territories. Most WDNR lands (39 nests) are managed to benefit public school trusts and forestry is a common land use. Some eagle nests (15 nests) are located in WDNR managed Natural Area Preserves and Natural Resource Conservation Areas that are managed for conservation and recreational uses. Thirty-nine nests (nearly 5%) are located on State Park ownership and high levels of human activity are typical in state parks during the summer. Wildlife agencies (WDFW and USFWS combined) control < 3% of nests and only about 2% of lands within territories. The state bald eagle protection rules do not apply to federal and tribal lands. Federal lands include national forests, national parks, military bases, recreation areas, historic landmarks, light house properties, and wildlife refuge lands. Recreational uses can be quite high and timber harvest occurs on some lands, but the rate of construction activities is generally less than on private lands. While the bald eagle is listed under the Endangered Species Act, agencies must seek approval through Section 7 consultations with the USFWS for activities on federal lands that may impact eagles. The National Park Service manages an important area of coastal nesting habitat in the Olympic National Park that contains 35 or more nest territories.

A shortage of roost and riparian perch trees may limit the number of wintering eagles in some locations that are predominantly private lands, such as the lower Snohomish River basin (Witmer and O'Neil 1990). We have location information for 133 known or suspected communal roost sites. Many of these sites have no data on the number of eagles present, but based on limited data, 33 roosts have had 15 or more eagles present. Of these 33 largest roosts, 17 (>50%) are entirely on private land, 7 are entirely on public land, and 9 have mixed public/private ownership. However, this may underestimate the number of large roosts on private land because we probably have more count data from public lands. There are probably more roosts on private lands that host >15 eagles that are not on the list.

The pattern of ownership indicates that without the nesting habitat that exists on private lands, the breeding population of bald eagles in Washington could eventually decline by 65% or more. This assumes that nesting and roosting habitat on public lands is secure, but after federal de-listing bald eagles may not receive the same high level of protection.

Future

Trends in the human population suggest that available nesting habitat and the quality of foraging habitat in many bald eagle territories may decline. The human population in Washington is expected to increase from the current 5.6 million to 7.7 million by 2020, and may double to 11 million by the mid-21st century (equivalent to adding 29 new cities the size of Tacoma or Spokane; WDNR 1998). From 1970 to 1995 the amount of land devoted to houses and businesses doubled in the central Puget Sound region. Urbanization takes its toll on bald eagle habitat suitability through degrading water quality, decreased prey abundance and diversity, and decreased perching opportunities, and increased disturbance. For example, eagles were once abundant at Tacoma (Bowles 1906), but there are very few there now. Nests are absent from much of the Puget Sound shore from Tacoma to Mukilteo.

It is expected that there will be continued development of the shorelines that are the bald eagle's primary habitat. Besides the attendant disturbance levels which the birds may be slow, or unable to adapt to, there may be steady removal of trees from the shorelines. Many trees left during construction of homes or commercial buildings will likely be removed when they become large enough to pose a threat to life or property should they fall. Some of the large old trees that serve as nest trees today will eventually succumb to disease. Some of these trees are currently over 300 years old. Each decade that passes, there are fewer trees maturing to such advanced age and associated large size. Therefore, the future may hold much reduced opportunities for bald eagles to find a stable nesting platform. More nesting attempts will occur in smaller trees where wind-caused failures are more frequent. The challenge for the future is finding a way to maintain stands of conifers in shoreline areas that include large, old trees and replacement nest trees that will provide nesting structures and screening from human activities continually, decade after decade.

There are also a variety of ecosystem health concerns that bear upon bald eagle habitat suitability in the future. Prey populations are at least equal to large trees as a prerequisite for successful and prolonged nesting. Prey must be relatively abundant and available to the eagles. These features of bald eagle habitat will not be maintained without effective conservation of prey resources and a commitment to reducing contaminants in the environment. Certain contaminants, most notably chlorinated hydrocarbons, have been implicated in reproductive failures, depressing the productivity of bald eagles in local areas such as the lower Columbia River and Hood Canal (Anthony et al. 1993, Watson and Pierce 1998b). The expectation of human population growth underscores the importance of a strong public commitment to natural resource protection, and policies which ensure safe use and disposal of potentially harmful environmental contaminants. Without these commitments, the long term future of bald eagles as well as the scenic, recreational, and aquatic resource values of Washington's shorelines are uncertain.

State bald eagle habitat protection rules may facilitate the protection of some nesting habitat (*see* Bald Eagle Management Plans p. 35, *and* Adequacy of Existing Regulatory Mechanisms: State bald eagle rules, p. 42). Loss of nesting habitat and large trees outside of eagle territories may be slowed somewhat by new regulations intended to protect and recover listed salmonids. Small patches of large trees in commercial timberlands may slowly become more widespread under the new rules intended to protect fish habitat in the State Forest Practice code (WAC 222) developed from the "Forest and Fish" agreement approved by the legislature in 1999 (*see* Forest and Fish, p.43).

LEGAL STATUS

"The legislature hereby declares that the protection of the bald eagle is consistent with a societal concern for the perpetuation of natural life cycles, the sensitivity and vulnerability of particular rare and distinguished species, and the quality of life of humans."

Washington Legislature, 1984.

Federal laws. Bald eagles in Washington (along with Oregon, Minnesota, Michigan, and Wisconsin) were listed as Threatened under the federal Endangered Species Act in 1978 (it was already listed as Endangered in the remaining coterminous states; Table 9). The bald eagle is expected to be removed from protection under the ESA in 2001 (USFWS 1999). The bald eagle will still be protected by the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act. The Bald Eagle Protection Act of 1940 (amended in 1962 to include golden eagles) protects eagles and their eggs and nests from "take" which "includes pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest, or disturb..." (16 USC 668-668d) (see Pop Status, North America, p.15). Penalties include a $5,000 fine and 1 year in jail, and a maximum $250,000 fine or 2 years in jail for a felony conviction. The Act also authorizes rewards for information leading to the arrest and conviction of persons who violate the Act. Bald eagles are also protected by provisions of the Lacey Act that make it a Federal offense to take, possess, trade, or transport wildlife that are taken in violation of any state, tribal or U.S. law.

State laws. Washington State lists the bald eagle as Threatened, a subcategory within the state's Protected Wildlife classification (WAC 232-12-014). Bald eagle protection rules (WAC 232-12-292) outline the process for protecting bald eagle habitat through management planning under the authority granted the WDFW by the legislature in 1984 (RCW 77.12.655 "Habitat buffer zones for bald eagles") (Appendix H). These rules apply to all non-federal and non-tribal lands in the state. State Forest Practices regulations (WAC 222-16-080) specify that logging operations within 1/4 mile of nests and roosts (within ½ mi of active nests 1 Jan-15 Aug) require a bald eagle management plan, or the application is designated a Class IV Special. Forest Practices designated as Class IV Special have the potential to significantly impact state Threatened or Endangered species; impacts to bald eagles would have to be considered during review under the Washington State Environmental Policy Act (SEPA).

Table 9. Significant events affecting bald eagle conservation in Washington (1960-2000).

Year	Event
1940	Bald Eagle Protection Act enacted by Congress.
1958	Charles Broley reports reproductive failure of eagles in Florida, and suggests that DDT is responsible (Broley 1958).
1960s	Data from many states clearly showed widespread, serious decline in population (Sprunt 1969).
1972	DDT banned from use in the US.
1976	Skagit Bald Eagle Natural Area established.
1978	Bald eagle in Washington, Oregon, Michigan, Minnesota, and Wisconsin listed as federally Threatened; Endangered in remaining 48 states.
1979	Annual Mid-winter Survey initiated; conducted 1979-1989.
1980	Annual statewide nesting surveys began; conducted 1980-98.
1980	Washington Bald Eagle Symposium held in Seattle.
1984	State bald eagle protection and buffer zone acts passed by the legislature (RCW 77.12.650).
1986	Bald eagle protection and plan rule approved by Washington Wildlife Commission.
1986	U.S. Fish and Wildlife Service's Pacific States Bald Eagle Recovery Plan completed.
1991	Lead shot prohibited for hunting waterfowl.
1999	USFWS proposes de-listing of the bald eagle under the Endangered Species Act.

MANAGEMENT ACTIVITIES

Consideration of bald eagles in land use management has increased tremendously since the federal listing of the species in 1978. In Washington, the special needs of bald eagles are incorporated in land management plans developed by all of the major federal landowners, including the U.S. Forest Service, the National Park Service, the Bureau of Land Management, the Department of Energy, and the Department of Defense. Washington tribes, most notably the Quinault and Colville Indian tribes, are also committed to monitoring and managing the bald eagles under their jurisdiction.

The Endangered Species Act also extends additional consideration of bald eagle needs to every project which receives federal funds or requires a federal permit. This requirement produces benefits to bald eagles through project modifications and mitigation associated with a wide variety of activities including transportation projects, developments in or near wetlands, hydroelectric dam licensing, irrigation systems operation, airport operations, and any work done with federal grant monies.

Surveys

Nesting Surveys. The U.S. Fish and Wildlife Service and Washington Department of Game (WDG) conducted annual aerial surveys, primarily of the San Juan Islands, from 1976 through 1979. In 1980, the WDG initiated annual inventories of nesting bald eagles. These state-wide, comprehensive activity and productivity surveys (usually 2 aerial surveys) were conducted annually from 1980-1992. Statewide single flight nest activity surveys were continued through 1998. Aerial surveys of portions of western Washington where eagles are most abundant and development conflicts are most frequent were done in 1999 and 2000. The USFWS is developing a population monitoring scheme as part of the proposed federal de-listing of the species.

Mid-winter Bald Eagle Surveys. Winter counts of bald eagles began in1962 when data was collected during the Mid-winter Waterfowl Inventory conducted by personnel from the USFWS and WDG. In 1979, the National Wildlife Federation assumed the task of coordinating a nation-wide combined agency and private volunteer winter count that involved 26,000 participants (Knight et al. 1981). WDG coordinated the Washington portion of the effort that involved 359 individuals in 1979. In subsequent years, the mid-winter survey involved as many as 1,100 volunteer observers (Taylor 1988, 1989). In 1982, the survey was standardized to 1,241 geographic survey units, 8 x12 mi in area. The standardized Mid-winter Survey was conducted each winter from 1982-89 (Appendix B). The state-wide Mid-winter Survey, which required much WDFW staff time to coordinate, compile, and report, was discontinued when it became apparent that the bald eagle was recovering and that much of the year-to-year variation in the number of wintering eagles was at least in part produced by conditions outside of Washington, such as prey abundance in British Columbia. Mid-winter surveys have been continued by volunteers and other agencies for discrete parts of the state (e.g. Skagit River, Whatcom County, Lake Roosevelt, etc.).

Bald Eagle Management Plans

In 1984, the Washington legislature enacted state laws to protect the bald eagle and its habitat based on public concern for the species' precarious status, recognition of its role within ecological systems, and its value to human quality of life (Appendix H). Bald eagle protection rules were developed by a group with broad representation from interest groups, including farmers, realtors, tribes, timber companies, environmentalists, counties, and state agencies (Solomon and Newlon 1991). The Washington Wildlife Commission subsequently adopted the rules in November 1986. The rules specifically directed the Washington Department of Wildlife to work with landowners to cooperatively develop site-specific bald eagle management plans when landowner-proposed activities may adversely impact bald eagle habitat. Bald eagle plans consider the unique characteristics of individual eagle pairs, nest and roost sites, and surrounding land uses, as well as the goals of the landowner. Plans apply to individual landowners, and since most territories have multiple landowners, these plans are not a comprehensive territory management plan.

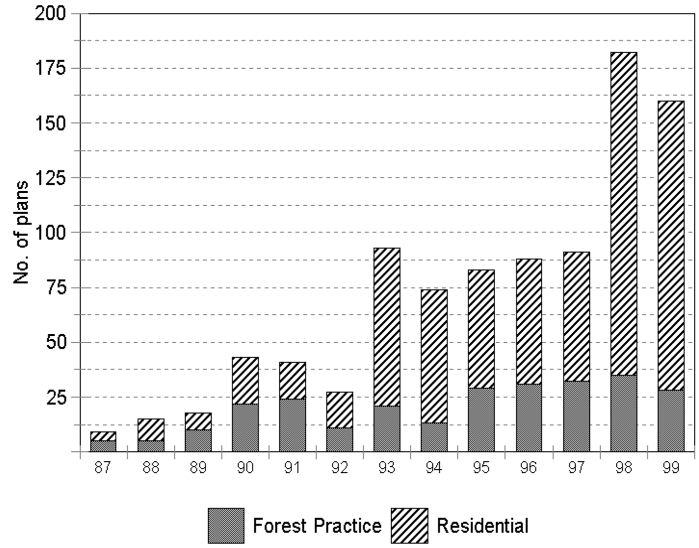


Figure 15. Number of bald eagle management plans in Washington by activity type, 1987-1999.

Bald eagle plan development by WDFW biologists began in earnest in 1987. From the inception of Washington's bald eagle protection rules to present, 1,154 bald eagle plans have been developed between WDFW and various landowner entities for activities on private, state, and municipal lands in 26 of 39 (67%) counties in Washington (Waterbury 2000). These bald eagle plans represent agreements for 393 discrete bald eagle occurrences (nest territories or roosts) throughout the state (mean = 2.9 plans/ occurrence, range = 1-19). The number of bald eagle plans developed per year (Figure 15) showed a steady rise from 9 plans in 1987 to 122 in 1999. The highest number of bald eagle plans were developed in Island County (41.4%), followed by Kitsap (10.2%), San Juan (9.1%), Jefferson (7.7%) and Clallam (6.9%) counties (Appendix C).

Table 10. Land use activity type initiating bald eagle plans (Waterbury 2000).

Activity type	No. of Plans	Percent of total Plans
Residential development[a]	831	72
Forest practice or assoc. road building	270	23
Other development[b]	22	2
Forest conversion	11	1
Non-residential commercial	10	1
Road building	6	<1
Shoreline development	4	<1
Total	1,154	100

[a]Combines single-family and multi-residential development.
[b] Included a sewage treatment facility upgrade, state park developments, lake dredging, railroad right-of-way clearing, vault toilet installation, rock quarry expansion, and access management for hang gliders.

Land use activities prompting the development of bald eagle plans fall under 8 general categories: residential development, forest practice, forest practice with road building, forest conversion (i.e. to non-forestry use, usually residential development), non-residential commercial development, road building, shoreline development, and other development (Table 10).

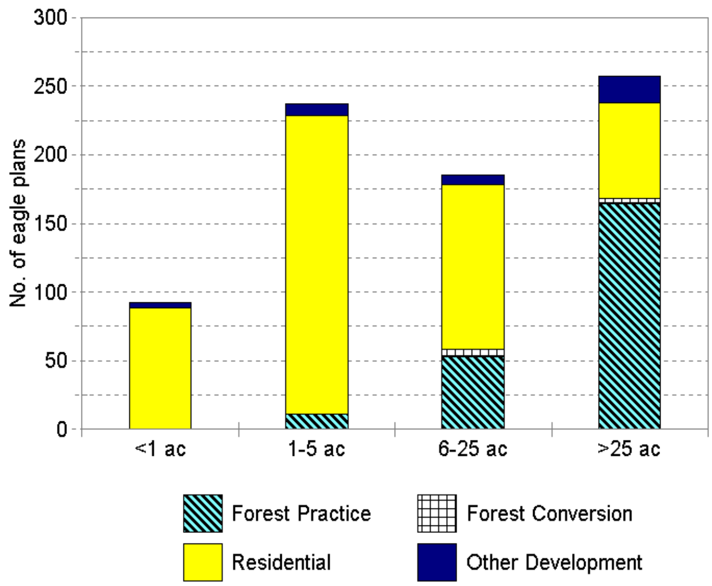


Figure 16. Number of bald eagle management plans for 4 activity types by area category.

Residential development, which combined single family and multi-residential development activity, accounted for 72% (n = 831) of bald eagle plans. Based on trends since 1987, this proportion is expected to increase with development emphasis near marine shorelines, whereas the proportion of forest practice-related plans (23%) will likely remain relatively static. The remaining land use activity types each accounted for <2% of total bald eagle plans.

The number of bald eagle plans initiated by residential development (including both single- and multi-residential development) showed a substantial increase in 1997 (Waterbury 2000). Forest practice plans showed only modest increases since 1987. As plan acreage increases, the variety of land uses involved in plans increases, and the main activity type switches from residential to forest practices (Figure 16). Bald eagle territories are usually associated with foraging areas in marine, river, or lake waters. Waterbury (2000) used the water body closest to nests to categorize plans. Plans developed for territories in the marine geographic category accounted for 85% (n = 978) of all plans, generally reflecting the distribution of bald eagles across Washington. River and lake geo-categories accounted for 10% (n = 121) and 5% (n = 56), respectively. When land use activity types were analyzed by marine, river, and lake geographic categories, shifts in predominant activities were detected. For bald eagle plans in the marine geo-category, 81% (n = 794) involved residential development activity (vs. 72% of total Plans). Forest practice activities accounted for 12% (n = 120) of plans in marine areas (vs. 18% of total Plans; Waterbury 2000). Most plans in the river geo-category, 87% (n = 106) consisted of forest practice and associated road-building activities (vs. 23% of total Plans), only 6% (n = 7) represented residential development (vs. 72% of total Plans; Waterbury 2000).

Roost management plans. The majority of bald eagle plans developed for roost sites were near rivers. Bald eagle roost site plans were initiated by activities of two types: forest practice/road building (84%, n=38) and multi- residential development (16%, n=7) (Waterbury 2000). For roost site plans that specified type and acreage of forest practice activity (n=36), 72% involved clear cut prescriptions, while 28% were partial cuts. Of the 26 clearcuts 10 were >100 ac,13 were 26-100 acs, and 3 were <25 acs.

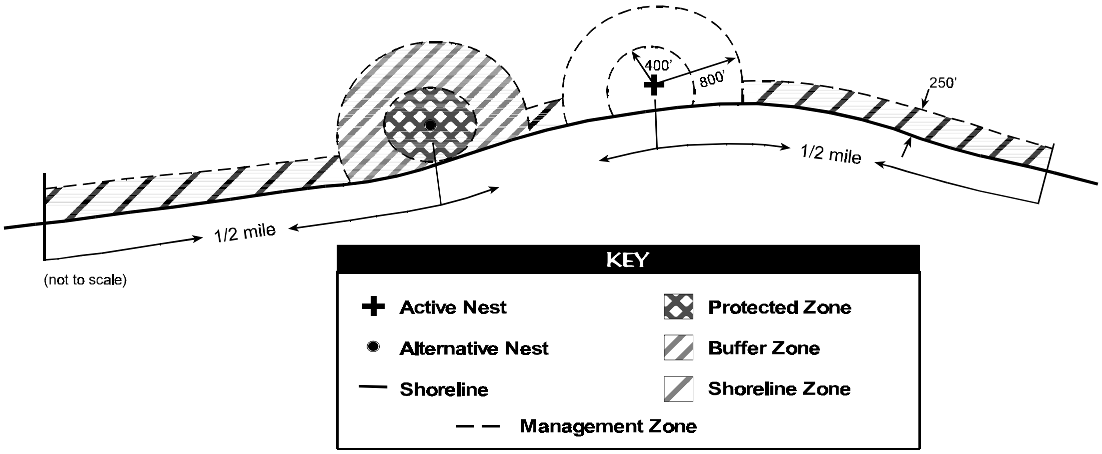


Figure 17. Generalized bald eagle habitat management zones used in generic county plans.

Most (9 of 10) of the partial cut units were between 6 and 100 ac. All multi-residential development roost site plans fell within the 6-25 acre category (Waterbury 2000).

County generic plans. In response to escalating shoreline development within the Puget Sound region, WDFW and county governments developed abbreviated, template bald eagle plans tailored for single family- and small multi-residential development. These plans specify habitat protections and/or timing restrictions for properties falling within 800 feet of a bald eagle nest or roost, or between 800 and 2,640 ft, but within 250 ft of the shore or high bank bordering a shoreline where important eagle foraging perches are typically found (Fig. 17). These plans are still signed and enforced by WDFW. Properties within 400 ft of nests or roosts still require a site-specific WDFW approved plan. These abbreviated bald eagle plans are issued at county permitting agencies when landowners seek grading, septic, and/or building permits. County generic plans account for an increasing proportion of eagle plans signed per year. Island County alone issued more than 80 bald eagle plans in 1999. County bald eagle plans accounted for 28% (n = 22), 64%(n = 110), and 70% (n = 108) of all bald eagle plans developed in 1997, 1998, and 1999, respectively, and are now 35% (n = 399) of the total number of plans (Waterbury 2000). County plans developed in 2000 surpassed the numbers of previous years as of September 2000 (n =154). Comparing acreage categories between custom WDFW and generic county bald eagle plans, custom plans occurred with higher frequency in acreage categories ≥6 acres (Figure 18). The development of generic county

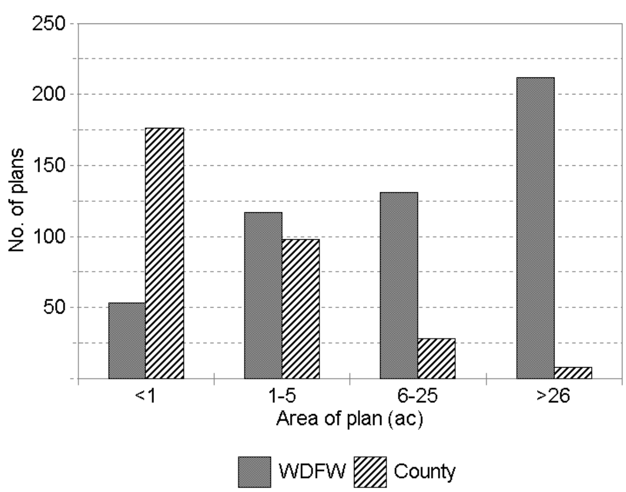


Figure 18. Number of county vs. WDFW generated bald eagle management plans by area category.

plans issued at County offices has stream-lined the process where dense shoreline development is occurring.

Plan conditions. A key component of the management plan process is determining habitat protection and/or timing conditions based on landowner objectives and site specific factors. The conditions negotiated in bald eagle plans then become the key components of a legally-binding contract between WDFW and landowners. Nearly all plans (97%) assigned habitat protection or a combination of habitat protection and timing conditions (Waterbury 2000). The remaining 3% (n=31) involved only timing restrictions and were typically for forest practice/ road building activities. In bald eagle plans prescribing habitat protection measures, four general types of vegetation management strategies were employed: no cut buffer; partial retention of trees; large tree retention; and tree planting, often in combination. 'Partial retention' was most frequently used, appearing in 76% (n=845) of total bald eagle plans. The 'no cut buffer' prescription was used in 38% (n=416) of plans, 'large tree retention' occurred in 18% (n=201), and 'tree planting' was included in 9% (n=101). In several bald eagle plans conditions were negotiated to relocate proposed home sites and roads, reconfigure lots in residential developments, maintain community open space in planned unit developments and curtail pedestrian access in residential commons. A review of plan conditions for minimum distance-to-activity revealed 39% of bald eagle plans permitted conditioned activity within 400 feet of bald eagle nests or roost sites (Waterbury 2000). This occurs primarily in territories where land is platted in many small lots.

Roost site eagle management plans (n = 45) applied combinations of no cut buffers, partial retention of trees, and large tree retention as conditions. The 'no cut buffer' strategy was the most prevalent condition, appearing in 38 (84%) roost site plans and as the sole habitat protection in 21. The 'partial retention of trees' condition occurred singularly and in combination in 21 (47%) roost site plans, while 'large tree retention' appeared in combination in 6 (13%) of roost site plans (Waterbury 2000).

Amendments. Bald eagle plans are sometimes amended when there is a change in eagle use or landowner needs. Examples of factors triggering plan amendments included changes in land ownership, discovery of new nest trees within a territory, changes in habitat conditions or timing restrictions, danger tree removal, and salvage of windthrown trees (Waterbury 2000). Of the 1,154 bald eagle plans, 9% (n=103) were amendments of earlier eagle plans. Of these plan amendments, 74% (n=81) were amended once, 16% (n=18) were amended twice, 5% (n=5) were amended three times, and one plan was amended 6 times.

Compliance. A total of 36 violations of environmental protection laws were referenced in bald eagle plans, representing a minimum violation rate of 3% and a compliance rate of up to 97% (Waterbury 2000). Violation types were variable, with most involving a combination of infractions of State Forest Practice Act rules, bald eagle protection rules, active bald eagle plans, the Shoreline Management Act, and county or local ordinances that regulate grading, septic, and building permitting. Several bald eagle plans were initiated or amended as mitigation for violations. Monitoring of habitat in territories and compliance with plans in the past was done opportunistically during nest survey flights. The dramatic increase in the number of plans and cutbacks in the bald eagle surveys will make future compliance monitoring more difficult. Planning requirements have protected substantial amounts of habitat and reduced disturbance of eagles, likely contributing to the recovery of the bald eagle population in Washington (*see* Adequacy of Existing Regulatory Mechanisms, p.42.)

Research

The bald eagle is one of the most studied species in the world, and the basics of reproduction, development, behavior, diet, and habitat use are well understood. There are still many unknowns about patterns of habitat use, the effects of various types of disturbance, etc. Filling some important gaps that remain in our knowledge require long term and often expensive studies of parameters such as survival rates, dispersal distance from natal nest to adult nesting location, and mean longevity. Research conducted in Washington is varied and includes most aspects of eagle ecology. Most of the earlier work is summarized in books by Stalmaster (1987) and Gerrard and Bortolotti (1988). There are numerous recent publications about work in Washington on: population inventory and monitoring (McAllister et al. 1986, Taylor 1989, Watson and Pierce 1998a); diet, foraging, and carrying capacity (Knight et al.1990, Knight and Anderson 1990, Hunt et al. 1992c, Watson et al. 1991, Watson and Pierce 1998a); the effects of habitat change and human disturbance (Knight et al. 1991, McGarigal et al. 1991, Stalmaster and Kaiser 1997b,1998, Parson 1994, Watson and Pierce 1998a); contaminants (Anthony et al. 1993, Mahaffy et al. 2001); migration and movements (Watson and Pierce 1998a, 1998b, 2001); and perch and roost trees (Eisner 1991).

Habitat Acquisition

Conservation of bald eagles and their habitats was already underway before the federal listing of the Washington population in 1978. The Skagit River Bald Eagle Natural Area was created when The Nature Conservancy completed purchases of 5,500 ac in 1975-77 (Krause 1980). When added to lands already owned by the WDG, the combined ownerships totaling 9,139 ac protected a critical wintering area for bald eagles along the Skagit River that was threatened by residential development. The Nature Conservancy purchases were made easier by sales that were “below market value” by Scott Paper, Simpson Timber, and Mr. Fred Martin. Also, from 1990-98, 22 parcels of land encompassing a total of 2,267 ac of riparian and wetland habitat were acquired through state grants from the Washington Wildlife & Recreation Program that protected habitat for bald eagles.

Miscellaneous Activities

Landowner contributions. The contribution of many private landowners that have willingly retained nest, perch, and screening trees should not be underestimated. Many people appreciate having eagles on their property and have made sacrifices to accommodate them. Unfortunately, because these choices are usually made before the bald eagle management plan is on paper, they have not been documented. Therefore, the number, frequency, and value of these contributions can not be readily quantified. Farmers and ranchers sometimes purposely leave carrion in their fields to provide food for eagles.

Lead shot ban. Lead shot was banned from use in hunting waterfowl in 1991, in part because of documented deaths of bald eagles and other protected species from lead poisoning. Eagles and other predators ingest shot incidental to consumption of waterfowl (*see* Lead poisoning, p.55). The switch to non-toxic shot types for waterfowl hunting has probably reduced eagle fatalities due to lead poisoning, and poisonings should continue to decline as residual lead shot deposits break down or become unavailable to waterfowl.

Rehabilitation. Injured eagles have long been treated and cared for by licensed rehabilitators around the state. The Woodland Park Zoo has rehabilitated numerous injured bald eagles and released them at the Skagit River in fall and winter. A telemetry study of the fate of rehabilitated bald eagles in Minnesota found that 13 of 19 survived at least 6 weeks after release, and one female was known to have nested for 3 years after release (Martell et al. 1991).

Artificial perches. The Chelan Public Utility District erected 4 artificial perches along a treeless area upstream from Rocky Reach Dam on the Columbia River in Chelan County (P. Fielder, pers. comm.). These perches are frequently used by wintering eagles. Artificial perches were also erected by the Bureau of Reclamation near Grand Coulee Dam so that eagles would have a place to perch while viewing the tailrace area for dead and injured fish (Wenatchee World, 13 Nov 1984).

California reintroductions. Washington eagles were used in the reintroduction of bald eagles to the Channel Islands, California in the 1980s. A total of 33 chicks were taken from nests in the Pacific Northwest, including 14 from Washington (6 in 1980, 5 in 1981, 3 in 1982) (Garcelon et al. 1989, Garcelon and Roemer 1990). The reintroduction was a qualified success. The island now has 4 breeding pairs and 10 subadults and chicks, but persistent pesticide contamination problems in the Channel Islands (a legacy from past dumping of wastes by a DDT manufacturer) has hampered eagle reproduction (P. Sharpe, pers. comm.). The population is maintained by intensive manipulation of chicks and eggs, including artificial incubation of the abnormally fragile eggs, fostering of chicks (17 since 1989), and the release of 16 additional eagles through hacking (Institute for Wildlife Studies: www.iws.org).

EagleCam. The EagleCam was the first WDFW WildWatchCam project to appear on the agency website. It was initiated in May 2000, using newly available surveillance technology where a camera was installed at a Puget Sound bald eagle nest. The project was possible through a loan of cameras, volunteer installation by Tim Brown, and the involvement of the owners of the home below the nest. The project brought the home life of a family of eagles into homes all over the world via the internet (www.wa.gov/wdfw/). The website has been visited by over 400,000 people and provided an incredible opportunity to inform and educate the public about eagles and their conservation.

FACTORS AFFECTING CONTINUED EXISTENCE

Adequacy of Existing Regulatory Mechanism

Federal protection. Bald eagles have been technically protected from efforts to injure or kill them since the passage of the Migratory Bird Treaty Act of 1918 and the Bald Eagle Protection Act of 1940. However, many immature bald eagles were still shot due to their resemblance to golden eagles. A loophole in the Bald Eagle Protection Act granted broad authority for states to issue permits that allowed shooting of golden eagles by ranchers (Beans 1996). The listing under the Endangered Species Act in 1978 as a Threatened species has been significant in terms of increased awareness of the eagle's decline and the identification and subsequent protection of important nesting, roosting, and wintering habitat. The USFWS's intervention in habitat issues involving private and state lands has been very limited in part due to Washington's eagle habitat rule and commitment to eagle conservation. Federal listing was important to fully involve federal agencies (Forest Service, Bureau of Land Management, Bureau of Reclamation, Dept. of Energy, U.S. Army Corp of Engineers, Depts. of Navy, Army, and Air Force) in bald eagle protection and conservation. The bald eagle is expected to be removed from protection under the ESA in 2001. Eagles, their nests, and eggs would still be protected under the Bald and Golden Eagle Protection Act, the Migratory Bird Treaty Act, and the Lacey Act. The degree to which habitat might be protected by prohibitions against molesting or disturbing eagles under the Bald and Golden Eagle Protection Act is uncertain, and how well eagle habitat will be protected on multiple-use federal and military lands remains to be seen.

State bald eagle rules. The state's bald eagle protection rules of 1986 (WAC 232-12-292) established a legal requirement for private, state, and municipal landowners to reach agreement with WDFW on measures to protect breeding and roosting habitat. These rules are the most important mechanism for the protection of habitat on private and state lands in Washington. Bald eagle management plans under these rules seek to protect nesting and roosting eagles from disturbance, and preserve habitat by the retention of large current and future nest, perch, and roost trees, as well as trees providing a visual screen and windthrow buffer.

Definitive data that would demonstrate the value of bald eagle management planning is difficult to obtain because bald eagle planning has been an uncontrolled experiment. Since the implementation of the planning rules, no known development has occurred near nests without plans. Existing plans also do not document the changes in proposed development that occurred due to verbal negotiation, prior to plan preparation (e.g. location of house on lot, or additional trees retained). An analysis of a small sample of nests around Puget Sound indicated that nest occupancy and productivity were not significantly different for nests with and without plans, or before and after plan implementation, suggesting that plans were effective at minimizing impacts (Parson 1992, Schirato and Parson 1998). Schirato and Parson (1998) concluded that management plans prevented decreases in occupancy, productivity, and activity for Puget Sound bald eagles.

Management plans have been useful, but are not perfect habitat protection; they involve compromises between landowner goals and eagle needs. The rules do not protect habitat that is not occupied by eagles, and shoreline areas that lose all the large trees will not support nesting eagles in the future (*see* Disturbance and habitat alteration, page 49). The rules also require WDFW to consider the rights, goals, and options of the landowner. Even where plans exist, houses are sometimes built within 100 ft of active nests when the landowner has no other option. Habitat may be protected by plans in the short-term, but plans do not provide long-term security. Habitat is only protected while eagles are using it (present within previous 5 years), and plan amendments can result in additional habitat being lost. Ultimately, the success or failure of protection rules depends on the will of the public to conserve eagles, and the value that they place on a functioning ecosystem and the continued presence of bald eagles in Washington.

Nonetheless, the planning requirement has protected substantial amounts of habitat and reduced disturbance of eagles, likely contributing to the recovery of the bald eagle population in Washington. The retention of future nest and perch trees, in addition to currently used trees, has probably been an important contribution of the regulation. The bald eagle rules have almost certainly protected enough habitat that eagle recovery, particularly in western Washington, has been greater than might have occurred without habitat protection. Planning has also been a valuable avenue of communication between WDFW and landowners. The amount of privately owned, but undeveloped lands near shore (much already subdivided) indicates that the need for planning will continue to be important for some time. If habitat protection rules were rescinded, the number of nesting pairs would likely decline over the coming decades, perhaps rather dramatically.

Forest and Fish. New “Forest and Fish” Forest Practices rules(FFR) intended to protect habitat of fish and certain stream amphibians in the State Forest Practice code (WAC 222) may provide current and future benefits to eagles nesting on commercial timberlands. The western Washington rules include minimum 50 ft. no-harvest buffers, and limited entry buffers up to 150 ft on rivers and fish-bearing streams, as well as no-harvest patches at stream intersections, and on unstable slopes and seeps. Most of the habitat improvements produced by the Forest and Fish rules, however, will occur further inland than most eagles nest. Also, most eagle nests (85%) are >100 ft from water, so many will be beyond these linear riparian buffers. Forest Practices and associated roads accounted for 23% of bald eagle management plans, while residential development of marine shorelines accounted for most potential impacts to eagle nests. Forest practices accounted for a greater portion (38 of 45, or 84%) of communal roost site plans. Roosts are often located on slopes above rivers, so it is unclear how often FFR would protect those sites. Where suitable nesting or roosting habitat does not currently exist, FFR will eventually produce potential nest sites, although it will require several decades. The FFR rules are complex and magnitude of benefits for eagles and other wildlife requires further study.

Shoreline Management Act. Loss of nesting habitat and large trees outside of eagle territories may have been slowed somewhat by restrictions on timber harvest by the Shoreline Management Act. The current regulation restricts harvest to 30% timber removal every 10 years within a buffer that extends 200 ft from mean high tide for “shorelines of statewide significance.” In the past, timber companies have not found it economical to return and remove additional trees, so many trees have been left in buffers. However, if converted to non-forestry uses, the timber can be clearcut (unless restricted by local regulations). Proposed revisions of the Shoreline Master Program Guidelines intended to protect listed salmonids (WAC 173-26, Part III and IV) incorporate protection of vegetation, primarily within 100 ft of shorelines, and may protect some additional potential eagle nest and roost trees. Although most eagle nests (85%) in Washington are more than 100 ft from the shoreline, the regulations may offer some protection for habitat. WDOE predicted that “over time, the rate of habitat degradation on shorelines should slow...”(Washington Dept of Ecology 2000). However, these new regulations are on hold, and may not take effect. The regulations also include a partial exemption for existing small residential lots, and small lots drastically reduce the options and opportunities for protecting eagle nests in bald eagle management plans.

County ordinances. Bald eagles nest in at least 32 counties in Washington. County ordinances vary widely in the degree of recognition and environmental review required for eagle nest and roost sites. Most counties require some review of projects affecting critical wildlife areas for impacts to the habitat or species. This may involve a written environmental assessment describing how impacts are avoided, minimized, or mitigated. Some counties will specifically require the applicant to follow WDFW management guidelines, while others only ensure that WDFW and others have the opportunity to provide recommendations, and may or may not require that they be followed. The degree to which existing ordinances are enforced, WDFW recommendations followed, and exemptions or variances granted, depends a great deal on the personnel and elected officials of each county. Many counties rely heavily on the input of WDFW staff, and often will require that the project follow WDFW’s recommendations. Of the counties that have eagle nests, most (27) have critical habitat provisions in their critical area ordinances and 23 counties have their critical wildlife habitats mapped. Most counties (24 of 32) rely largely or entirely on WDFW Priority Habitats and Species (PHS) maps as the source of information for identifying critical wildlife areas. PHS maps contain spatially referenced point and polygon data for species and habitats identified as priorities for management and preservation. This includes bald eagle nests and roosts, but nesting locations change so the maps are not always up to date.

All counties except 4 require some review for state Threatened or Endangered species: Grays Harbor and Klickitat counties provide no regulatory review for rare species or habitats; Snohomish specifically protects only federally listed Threatened and Endangered species; Yakima County seems to only regulate species found in wetlands. If the bald eagle is down-listed to state Sensitive, at least 26 counties that contain a total of 425 nest trees (52%), would still require some form of review because the species is Sensitive, or because it is listed among state PHS species (Appendix F). At least 10 counties, including San Juan County that contains at least 78 eagle nest territories on private lands, have ordinances that refer specifically to protections under the state bald eagle rules (WAC 232-12-292). How these counties would respond if those rules were no longer in effect is unknown. Ninety-nine eagle territories (12%) exist in counties that would no longer require project review.

Salmon

The distribution, abundance, and annual variation of anadramous fishes can have major effects on the productivity, phenology, and population dynamics of bald eagles and many other wildlife species (Willson and Halupka 1995). Cedarholm et al. (2000) list and describe the ecological connections between salmon and wildlife. The generally poor state of wild salmon stocks, particularly in the Puget Sound and Columbia River has been attributed in part to over-fishing, habitat degradation (including dams), and some poorly designed hatchery programs (WDF et al. 1993). However, there is increasing evidence suggesting that oceanic climate cycles, like the Pacific Interdecadal Oscillation, greatly affect salmon populations (Johnson et al. 1997a). Of 294 wild salmon and wild steelhead stocks (i.e. stocks that are sustained by natural spawning and rearing in natural habitat) with known status, 38% are depressed and 4% are critical (Johnson et al. 1997b). Fortunately many of the large and medium spawning populations (43% of wild stocks, and perhaps >80% of the salmon) are rated healthy. Historically, spawning salmon represented a huge recycling of nutrients from the North Pacific back to inland watersheds. According to a recent estimate, the reduction in size and number of salmon have produced a decline of 93-95% in the marine derived nitrogen and phosphorous once delivered annually to Pacific Northwest ecosystems (Gresh et al. 2000). This nutrient deficit may have had widespread and profound effects on the productivity of riparian ecosystems. The possible impacts to various prey populations and ultimately bald eagles is unknown.

Declines in salmon have probably primarily affected the distribution and abundance of post-breeding and wintering bald eagles because most salmon spawn September - January, with a few in late summer. Many summer runs are present in rivers, but diet studies of nesting eagles suggest that eagles do not often prey on live salmon during that time (Watson and Pierce 1998a). Summer runs typically do not spawn until August or September.

Chum and pinks. Salmonids, inluding chum, pink, coho salmon, and steelheads, are an important fall and winter food for bald eagles. Of these, chum salmon are the most important due to their spawning time and the concentration of carcasses. Chum salmon are abundant in the Puget Sound region and have increased substantially in recent years as a result of a favorable climate pattern and successful fishery management. Wild chum salmon make up the majority of wild salmon in the region, and are distributed throughout streams of the Puget Sound, Hood Canal, and Strait of Juan de Fuca. A recent NMFS coast-wide review concluded that Puget Sound chum are “at or near historic levels,” with recent escapements averaging >300,000 natural spawners for the Puget Sound/Strait of Georgia region (Johnson et al. 1997a). Pink salmon are also “close to historic levels” in the Puget Sound region, with escapements averaging >880,000 (Hard et al. 1996). The Skagit, Snohomish, Stillaguamish, and Nooksack River systems have the largest runs. Pink salmon are abundant (in odd-numbered years), but do not seem to be a major food source. Pink carcasses are not available before most Washington breeders migrate north during May - August (Watson and Pierce 1998a, 2001). Pink salmon may be important to a few eagles that do not migrate, or migrate back to nesting territories in Washington along local tributaries (Watson and Pierce 1997).

Coho and steelhead. Although most chum and pink salmon runs are healthy, many coho runs are not: only 37 of 90 are rated as healthy, 34 are depressed, 1 is critical, and 18 are unknown (WDF et al. 1993). Depressed stocks include the lower Columbia, Lewis, Cowlitz, Snohomish, and Skagit Rivers, all of which are used by wintering eagles (Taylor 1989). Recent population trends for Puget Sound steelhead have been predominantly downward, though the trend was upward for the Skagit until 2000 (Busby et al. 1996, P. Castle, pers. comm.). Coho and steelhead carcasses are more widely dispersed in tributaries and off-channel spawning sites, so they do not attract the concentrations of wintering eagles that chum salmon do. Coho and steelhead, however, may be important in late winter and spring for eagles that remain in Washington until lakes in their breeding area thaw (Watson and Pierce 2001). Steelhead spawn February to June, when eagles are nesting, and although steelhead have never been as abundant as chum salmon, they may also provide a significant food source for eagles that nest along rivers.

Skagit River. Wintering bald eagles concentrate on and move between several Washington rivers to feed on salmon carcasses, including the Skagit, Nooksack, Stillaguamish, Skykomish, Nisqually, Okanogan, upper Columbia, and Spokane. The Skagit River usually attracts the highest numbers with up to several hundred eagles gathering in the river basin to feed primarily on chum salmon, but also coho and steelhead (Taylor 1989; Dunwiddie and Kuntz 2001). Watson and Pierce (2001) state that the Skagit provides an important prey cushion during a time of reduced foraging opportunities in mid-to-late winter. Although chum salmon are abundant, coho stocks on the Skagit are rated as depressed due to a sharp decline in spawning escapement. Spawning and rearing habitat quality has generally deteriorated over the years due to impacts of flood control, logging, agriculture, and urbanization (WDFW and Western Washington Treaty Indian Tribes 1994b). Approximately 25-35% of potential fresh water coho production has been lost due to flood control, logging, hydropower, agriculture, and other activities (WDFW and Western Washington Treaty Indian Tribes 1994b). Diking, which eliminated side channels and distributaries, probably has had the greatest impact. It has also been estimated that 90% of the river delta wetlands have been lost.

Columbia River. Columbia River salmon stocks are in particularly poor shape: only 26 % of stocks were rated healthy (WDF and WDW 1993). Total salmon and steelhead commercial landings on the Columbia declined from 2 million fish in 1938 to 67,000 in 1999 (WDFW and ODFW 1999:9). The Grand Coulee and Chief Joseph Dams blocked access to over 550 miles of the Columbia watershed to spawning, and dams blocked most of the Snake River watershed. Early writers noted the abundance of bald eagles feeding on salmon carcasses on the Columbia, particularly near its mouth in late summer and fall (Bendire 1892, Buechner 1953). It is unknown if the eagles were focused on chum, or if chinook and other species were important. The Columbia River historically supported the harvest of hundreds of thousands of fall chum with landings of ½ million as recently as 1942; only 47 fish were caught in 1994 (Johnson 1999). Spawned chinook may have provided an important seasonal food source for eagles from August- October, although today few eagles are in Washington during that period, but are feeding on salmon further north. The Columbia once had large runs of spring and summer chinook, many weighing 50-60 lbs. The upper Columbia spring chinook are now listed under the ESA as Endangered, and chinook runs in the lower Columbia and Snake River are listed as Threatened, as are Columbia summer chum. About 75% of salmon returning to the Columbia are now the product of hatcheries (WDFW and ODFW 1999).

Lake Washington sockeye. An introduced stock of sockeye in the Lake Washington system represents a potential food source for eagles, with spawner escapement averaging more than 200,000. Most of the sockeye spawn in the Cedar River, and Bear and Issaquah Creeks. Spawning occurs from September through November, with some fish present as late as February. WDFW staff have noted limited, but increasing use by bald eagles of sockeye carcasses (J. Ames, pers. comm.).

Hatcheries and carcasses. Although hatcheries produce fish for human harvest, they generally have not replaced the carcasses that once provided food for eagles. Many salmon from hatcheries are donated to food banks (400,000 lbs in fall 2000). In recent years carcasses have also been distributed on some streams with the help of volunteers to help provide nutrients, and increase juvenile salmon growth and survival. For example, about 2,000 carcasses were placed along tributaries of the upper Naches River in December 1998, 1999, and 2000. Some carcasses that are distributed for nutrient enrichment of streams would be available for eagles and other wildlife.

Escapement goals and eagles. Dunwiddie and Kuntz (2001) examined eagle detections on the Skagit in relation to chum and coho escapement on the Skagit and 4 other western Washington rivers. They concluded that the single most important factor affecting trends in Skagit bald eagle detections in the last decade was the availability of chum on other Washington rivers. WDFW has never added an eagle food component when setting salmon escapement goals because it has been assumed that the goals set based on salmon productivity are high enough to meet eagle needs (J. Ames, pers. comm.). Winters when carcass numbers are low likely result when actual escapement falls far below the goal. For example, the escapement goals for Skagit chum salmon are 116,000 for even years, and 40,000 fish for odd year returns. Actual escapements for even years between 1991-2000 averaged 87,100 fish, but ranged from 22,300 to 121,800. For odd years, actual escapement averaged 25,200, and ranged from 14,400-38,700 fish. Salmon escapement and carcass availability and eagle numbers on the main wintering rivers can be modeled to determine if escapement goals were adequate to support the desired winter eagle population goals (see Appendix G). Providing ample salmon carcasses to sustain a predetermined number of eagles through winter is most important in years when eagle numbers on Washington's rivers are high (i.e. near carrying capacity). This may indicate poor feeding conditions on rivers in the northern portion of the winter range. The Skagit and other northwestern Washington rivers may function as buffers for late-winter foraging (Watson and Pierce 2001). In some years not all carcass concentrations are exploited by Skagit River eagles (Watson and Pierce 2001), and the carrying capacity may not be reached when feeding conditions are favorable further north (Hunt et al. 1992).

Other Prey Populations

The abundance and availability of prey is probably the most important factor determining the presence and density of eagle territories (Hansen 1987, Hunt et al. 1992b, Dzus and Gerrard 1993, Dykstra 1995). Changes in the abundance and distribution of prey likely contributed to historical declines in eagles, and will continue to affect them. However, historical changes in prey available to eagles includes not only declines, but local increases and changes in timing of salmonid spawning, and new prey species. While the populations of several different kinds of bald eagle prey are known to be declining in Washington, there are also hundreds of reservoirs, an abundance of introduced fishes, introduced game birds, and sources of carrion that did not exist prior to European settlement. With the exception of the observed effect of reduced numbers of salmonids on eagle distribution (Knight and Anderson 1990, Restani et al. 2000), other effects of reduced prey on bald eagle populations are poorly understood.

Marine fishes. Populations of 13 marine fish have dropped dramatically in the past 20 years (WDNR 1998:48). Herring stocks have declined by half. Some Puget Sound stocks of Pacific cod, Pacific hake, walleye pollock, and Pacific herring (*Clupea pallasii*) are candidates for listing as state sensitive, threatened, or endangered. They were recently evaluated for listing under the federal Endangered Species Act in 1999-2000. the National Marine Fisheries Service recently determined that listing of the cod, pollock and herring was “not warranted,” because they did not meet the definition of “species” under the ESA (NMFS 2000,2001).

Knight et al. (1990) reported rockfish, possibly fishing boat discards, were a frequent food item for bald eagles. Juvenile rockfish also provide food for many seabirds (O’Neil et al. 2001), that are in turn occasional prey of bald eagles and very important prey to certain nesting territories. Fisheries by-catch mortality has probably contributed substantially to the serious declines reported in many rockfish species (West 1997, Bloeser 1999). Three species of rockfish were also candidates for federal listing, but listing was recently deemed “not warranted.” These species and an additional 8 species of rockfish are candidates for state listing.

Reservoirs and introduced fishes. Dams and introduced fishes may mitigate to some extent the impact that salmon declines may have had on eagles. Eagles may be able to nest or winter at locations that historically did not have sufficient prey to support them. Water development projects including >1000 dams (those holding $\geq$10 ac - ft) have added hundreds of reservoirs to Washington’s landscape and expanded the area of many natural lakes. Eastern Washington’s 4,051 lakes and reservoirs total more than twice the area (436,662 ac) of those in western Washington, and a high proportion are reservoirs (Scott and De Lorme 1988). Only one of the 15 largest lakes is natural (Lake Chelan), and only 10 of the 30 largest are natural lakes. Of 76 fish species found in Washington’s inland waters, 30 were introduced to Washington (Wydoski and Whitney 1979). Some introduced species may be more available to eagles during the late nesting period than are live salmon. Although, natural lakes had populations of pike minnows (*Ptychocheilus oregonensis*), mountain whitefish (*Prosopium williamsoni*), and suckers, introductions may have greatly increased the fish biomass, while dams increased the area and number of potential eagle foraging areas. Introduced fishes that are known to be eaten by bald eagles include American shad, carp, black crappie, striped bass (*Morone saxatilis*), walleye, smallmouth bass, brown bullhead (*Ictalurus nebulosus*), lake whitefish (*Coregonus clupeaformis*), channel catfish, and yellow perch (Wood 1979, Fielder 1982, Knight et al. 1990, Watson et al. 1991, Science Applications International 1996, Watson and Pierce 1998a). American shad are a frequent prey item of nesting eagles in the Columbia River estuary (Watson et al. 1991). Shad were introduced to west coast rivers in 1871 (Wydoski and Whitney 1979), and have since increased steadily, with runs exceeding 2-4 million fish during the 1990s (WDFW and ODFW 1999). Predictable summer die-offs of yellow perch and brown bullheads may be important to individual eagle territories on lakes. Other introduced fishes that may occasionally fall prey to, or be scavenged by bald eagles include largemouth bass (*Micropterus salmoides*,), brook trout (*Salvelinus fontinalis*), lake trout (*S. namaycush*), brown trout (*Salmo trutta*), and sunfishes (*Lepomis* spp.) (Wydoski and Whitney 1979).

Waterfowl and seabirds. Many marine bird populations have declined in number and density in the greater Puget Sound over the last 20 years. A comparison of winter aerial transects conducted during the periods 1978-79 and 1992-99 indicated clear and dramatic declines ($p< 0.001$) in several species, including: scoters (*Melanitta* spp. -57%); scaup (*Aythya* spp. -72%); long-tailed duck (*Clangula hyemalis* -91%); grebes (western, *Aechmophorus occidentalis*:-95%; red-necked, *Podiceps grisegena*: -89%; horned, *P. auritus*: -82%); loons (common, *Gavia immer*: -64%; 3 loon spp. combined, *G. immer, G. arctica, G. stellata*:-79%); marbled murrelet (*Brachyramphus marmoratus*: -96%, p<.004); cormorants (*Phalacrocorax* spp.:-53%), and possible declines in pigeon guillemot (*Cepphus columba*) and black brant (*Branta bernicla*) (Nysewander et al. 2001a). The only species showing a clear increase was the harlequin duck (+189%, p<0.001). It is uncertain whether these changes relate to cyclic phenomenon such as the North Pacific Decadal Oscillation or to local declines in forage fish stocks. Bird species that feed primarily on fish or depend upon spawning events of Puget Sound forage fish have declined more than species that have a diverse diet that includes invertebrates (Nysewander et al. 2001b).

Marine bird populations face several potential threats, including gillnet mortality, reduced food due to commercial fishing, and oil spills. Scaup and scoter populations in North America and in parts of the Pacific Flyway have declined since the mid-1980s (Nysewander and Evanson 1998, Nysewander et al. 2001b). Surf, white-winged, and black scoters (*Melanitta perspicillata, M. fisca*, and *M. nigra*) are the most abundant diving duck in Washington’s marine waters and are collectively used as an indicator species. The decline in scoters may in part be attributed to dramatic declines in spawning forage fish, such as the Cherry Point herring run (now a State candidate species). Scoters historically concentrated in large numbers in late winter and early spring to feed on abundant herring roe before migrating north to breeding grounds (Nysewander and Evenson 1998). Of Puget Sound herring stocks, 22% were rated as depressed or critical, and the status of 39% is unknown (WDNR 1998). Shellfish are also important food for diving ducks and contamination of shellfish may be affecting populations of these birds, but data have been inconclusive (Nysewander and Evenson 1998). Scoters have also been known to accumulate contaminants (heavy metals, PCBs, DDE) during their winter stay in the Pacific Northwest (Henny et al. 1991); scoters from Commencement Bay contained selenium levels associated with reproductive problems in other aquatic birds.

The common murre, a colonial-nesting seabird, has declined in Washington in recent decades, and some birds may have shifted to colonies further south in Oregon or California. Murres historically nested at 18 colonies along the outer coast, with attendance in 1979 totaling about 31,000 (Wilson 1991). Total attendance at colonies (except Tatoosh Island) plummeted from 29,000 in 1982 to 3,000 in 1983 during an El Niño year. Unlike colonies in Oregon and California, total attendance at Washington colonies has not rebounded, and remained at 20% of that reported in the 1970s, and declined further during the 1997-98 El Niño event (U.Wilson, pers. comm.). The apparent lack of recovery may result from a change in ocean conditions or a combination of El Niños, oil spills, gillnet mortality, bald eagle predation and disturbance, and U. S. Navy disturbance of breeding colonies (Wilson 1991, U. Wilson, pers. comm.).

Tufted puffins (*Fratercula cirrhata*) nesting on Protection and Smith Islands, and in the San Juans declined from 1,066 historically to only 74 in 1989 (Mahaffy et al. 1994). Only 13 pairs nested on Protection Island in 1993.

Marine invertebrates. Crabs or mollusks comprised 8.7% of prey items collected at 67 eagle nests and observations indicate that invertebrates may be even more important than is indicated by prey remains (Watson and Pierce 1998a). The intensity of harvest of invertebrates has increased dramatically in the past decade as a result of subsistence fishing by recent immigrants that exploit many organisms that were not previously subject to harvest (West 1997, A. Rammer, pers. comm.). WDFW began regulating harvest of "unclassified marine invertebrates" in 1999. In addition to new intense harvests, shellfish are impacted by past and chronic contamination of sediments.

Disturbance and Habitat Alteration

The USFWS identified habitat destruction and degradation through cutting of shoreline trees during shoreline development, human disturbance associated with recreational use of shores and waterways, and contamination as the major threats to the bald eagle population for the foreseeable future (USFWS 1994:35589). In a review, Fraser (1985) concluded that it is fairly clear that "chronic disturbance results in disuse of areas of human activity....thus, human activities that chronically exceed the limits of eagle tolerances, may be considered a form of habitat destruction." In contrast to several other protected threatened and endangered species in Washington that now occur overwhelmingly on public lands, such as the grizzly bear, gray wolf, and lynx, most bald eagle habitat is on private lands, and private lands near shore are highly valued for residential development.

Passive displacement. In addition to the issues of active disturbance and habitat alteration discussed below, passive displacement often goes unnoticed, but may significantly adversely impact habitat that otherwise is undegraded. Passive displacement occurs when human use prevents eagles from using a site. For example, a pair of eagles may avoid an area of 400 m radius around a boat that is anchored while fishing; this would temporarily prevent the use of 50 ha of high-value foraging area whenever a boat is present. Another example would include the presence of humans harvesting clams on a mudflat that prevents eagles from foraging there during that low tide. Passive displacement has not been widely investigated, but may be more prevalent and important than active disturbance that briefly affects birds (McGarigal et al. 1991, Anthony et al. 1995).

Disturbance and habitat alteration - nesting. Bald eagles generally select nesting areas with large trees, low human disturbance, and high prey diversity or availability (Livingston et al. 1990). The response of nesting eagles to human activity can range from behavioral, such as flushing, or reduced nest attendance, to nest failure (Juenemann 1973, Young 1980, Fraser et al. 1985, McGarigal et al. 1991, Grubb and King 1991, Grubb et al. 1992, Anthony et al. 1994, Steidl and Anthony 1996, Watson and Pierce 1998a, Driscoll et al. 1999). Human activities may be temporary or perpetual. Examples of temporary activities are those occurring in conjunction with ongoing habitat alterations such as timber harvest and home construction. Perpetual activities are those such as highway traffic and activity around residences following habitat alteration. Eagle pairs can vary widely in their response to disturbance depending on previous nesting history, the birds' previous experience with humans, the availability of alternative nest sites, and the amount of development in the area (Therres et al. 1993). Studies of the types, levels, and distances at which habitat alterations and disturbance affect nesting success of bald eagles have shown fairly wide variation in the effects on nesting eagles depending on the study design, objectives, and location. In a review, Fraser (1985) states that some observers have reported nest failure caused by disturbance, while others have not found a relationship between human activity and nest success. The interpretation of study results are complicated because the levels of human activity (e.g., residential disturbance) are not necessarily correlated with the degree of habitat alteration (e.g. clearcuts) (Watson and Pierce 1998a). A study of eagle habitat use on the Chesapeake Bay in the 1980s found no clear indication that eagles were adapting to disturbance and disturbed habitats (Buehler et al. 1991b). In recent years, however, a few bald eagles in Washington have shown a remarkable ability to nest in suburban areas with unusually close and high levels of human activity (Watson et al. 1999, S. Negri, pers. comm.). Eagles nesting in small numbers at suburban sites, or showing greater tolerance for disturbance, have also been reported in Michigan, Minnesota, Maryland, and Florida (Grubb et al. 1992, Evening Telegram, Superior, WI, 23 Jan 2001; G. Therres, S. Nesbitt, R. Baker: minutes from the Bald Eagle Monitoring Workshop, 19-21 Sept 2000, Patuxent, MD), (*see* Adaptation, p.53).

Despite the complexity of interpreting studies of disturbance in different populations some generalizations about disturbance and eagle nesting can be made:

1) <u>The magnitude of response varies inversely with distance and increases with disturbance duration, the number of vehicles or pedestrians per event, visibility, sound, and position above</u> (Grubb and King 1991). The distance to disturbance is the single most important element of any potential disturbance. Eagles that breed and forage along rivers may be more vulnerable to disturbance because the encounter distances tend to be shorter than in marine shore situations (Steidl and Anthony 2000). "Human activities that are distant, of short duration, out of sight, few in number, below, and quiet have the least impact"(Grubb and King 1991).

2) <u>Bald eagles vary in their sensitivity to disturbance, but generally when given a choice, eagles nest away from human disturbance</u>. In Washington for example, the lower density of nesting eagles along heavily urbanized areas of Puget Sound relative to the San Juan Islands (Fig. 1), shows a lack of nesting habitat or associated high levels of human activity prevents many eagles from nesting even where food is available. Eagles are also largely absent from other heavily urbanized locations that had historic use (e.g. Niagra and Hudson Rivers, Lake Erie, cities in New York, New Jersey, and Pennsylvania) (Grinnell 1929, Gerrard and Bortolotti 1988). Buehler et al. (1991b) found that bald eagles were seldom found in developed segments of the Chesapeake Bay shoreline. Larger set-back distances for buildings were correlated with greater bald eagle use. Bald eagles avoided segments of shoreline with pedestrians or boats within 1640 ft (500 m). The authors concluded that shoreline development causes an irretrievable loss of eagle habitat. Chandler et al. (1995) found the best predictors of eagle use on Chesapeake Bay shorelines were development density and distance from water to the nearest tree.

Nests near lakes in Washington are further from water than are nests near marine shores or rivers (see Nesting Habitat, p. 11), perhaps because most western Washington lake shores have been densely developed. Nests built in areas with shoreline homes in the Chippewa National Forest in Minnesota were further from water than nests built in areas without shoreline homes (Fraser et al.1985). Livingston et al. (1990) reported that bald eagles in Maine also avoided areas with high levels of human disturbance, including areas with extensive timber harvest or roads.

Hodges and King (1984) reported that in coastal British Columbia, adult eagles and active nests were found in higher than expected numbers in undisturbed habitat, and that disturbed habitat with no remnant old-growth contained far fewer adult birds and no active nests.

3) <u>The presence of homes close to nests (< 197 ft [60 m], Watson and Pierce 1998a; or <295 ft [90 m], Parson 1994) negatively affects nest success.</u> Watson and Pierce (1998a), who tracked productivity of individual territories from 1978-92, found a negative correlation between nest productivity and clearing <984 ft (300 m) from nests. Parson (1994) examined habitat conditions and measures of reproductive success at a single point in time. She reported that successful nests had lower densities of human residences within 90 m than unsuccessful nests. Unsuccessful nests were characterized by >0.30 residences/ac within 460 ft radius of nest. Most bald eagle nests were found in "islands" of less altered

habitat where densities of human residences were < 0.30/ac within 460 ft radius of the nest and their nesting appeared not to have been adversely affected by habitat alterations. Most other indicators (e.g. roads, etc.) did not clearly affect nest productivity, however, there was very little habitat change close to the nests studied (Parson 1994, Watson and Pierce 1998a). Watson and Pierce (1998a) indicated that habitat change was virtually absent within <400 ft (131 m) of nests (n = 68), and the distance from successful nests to habitat alteration was >295 ft in the other two Washington studies (Grubb 1976, Parson 1994). Grubb (1980) found no significant relationships between nest activity or success and indicators of human presence at distances > 1312 ft (400 m). In Oregon, Anthony and Isaacs (1989) recommended against clearcut logging, road building, hiking trails, and boat launches <1312 ft (400 m) from bald eagle nests based on their finding that such alterations or the associated human activities, were correlated with reduced nest success. In studies of disturbance to breeding eagles in Michigan and Arizona, Grubb et al. (1992) reported the threshold of alert response was about 1690 ft (500 m), and for flight response was 656 ft (200 m); variation in response demonstrated the need for specificity in management.

4) <u>Disturbance reduces the time eagles spend incubating, and incubation time affects nesting success.</u> Incubation is the most critical period in determining the success of a nesting attempt. Watson and Pierce (1998a) reported that the presence of homes within 197 ft (60 m) of nests negatively affects incubation time. Unsuccessful nests were incubated an average of 14 minutes/hour less than successful nests. Successful nests had been subjected to an average of less than half the rate of pedestrian, aircraft, and total human activities compared to unsuccessful nests (Watson and Pierce 1998a:18)

5) <u>In the Puget Sound area, pedestrian activity is the most frequent cause of disruption of eagle nesting activity</u>. Pedestrian activity <656 ft (200 m) from the nest negatively affected nest success (Watson and Pierce 1998a:24). Most other activities (e.g. aircraft) were rarely close enough to disrupt eagle behavior. Other studies have also shown that auto traffic and aircraft tend not to cause eagles to flush, whereas pedestrian traffic is more disturbing (Fraser 1985, Grubb and King 1991, Grubb et al. 1992). Results of experimental pedestrian disturbances suggested restrictions of pedestrian activities within 394 ft (120 m) of nests and high screening cover would be most effective in reducing eagle disturbance (Watson and Pierce 1998a). In Alaska, Steidl and Anthony (2000) found that humans camped 328 ft (100 m) from nests for 24 hours caused clear and consistent changes to behavior in breeding eagles, including a reduction of 29% in the amount of prey fed to nestlings. Watson et al. (1995) found that nesting bald eagles on Hood Canal, Washington showed little indication of disturbance from boats involved in a geoduck clam (*Panopea abrupta*) fishery. Boat traffic can be disturbing or cause little disturbance (Fraser 1985). Grubb et al. (1992) reported that canoes were less disturbing than power boats, and elicited half the response at half the distance.

6) <u>Maintaining high levels of nest screening and tall nest trees reduces visible and audible disturbance to nesting eagles</u> (Therres et al. 1992, Watson and Pierce 1998a). Vegetative screening and distance were the two most important factors determining the impact of disturbances (Watson and Pierce 1998a). Heavy vegetative screening dramatically reduced eagle response to human activity. Eagles exhibited lower responses to disturbance when nest trees were >164 ft tall. Tall nest trees effectively help increase the distance from the nest to activities on the ground.

Human disturbance - roosts and foraging areas. Human activity that results in disturbance of wintering bald eagles on foraging areas can have a wide range of effects on eagles from brief disturbance flights to displacement from a local area (Stalmaster and Kaiser 1998). Disturbances that cause eagles to flush reduce their food intake, increase energy expenditure during critical winter periods and force eagles to use marginal habitats (Stalmaster and Kaiser 1997b). The 26 roosts studied by Watson and Pierce (1998a) all had evidence of human activity (roads, houses, or timber harvest) within 1,640 ft (500 m). Timber harvest in and around roosts can affect the microclimate of the roost, decrease the energetic benefits of the site, and increase the likelihood of windthrow (Stalmaster et al. 1985). Hansen et al. (1980) and Knight et al. (1983) reported abandonment of roosts when the roost trees were harvested.

Several studies on northwestern Washington rivers have documented eagle responses to various types of human activities, particularly boating, angling, and non-consumptive recreation (Stalmaster and Newman 1978, Knight and Knight 1984, Knight et al. 1991, Skagen et al. 1991, Stalmaster and Kaiser 1997b, Stalmaster and Kaiser 1998). Other studies have focused on the feeding behavior and energetic demands of wintering eagles (Stalmaster and Gessaman 1984, Knight and Knight 1983, Knight and Anderson 1990, Stalmaster and Plettner 1992, Hunt et al. 1992c). Recommended conditions to reduce disturbance in these habitats have included spatial buffers out to 1,312 ft (400 m) from feeding areas that may be reduced if screening cover is present (Stalmaster and Newman 1978, Stalmaster and Kaiser 1998). Temporal buffers, such as restrictions on human activities during peak morning feeding, have also been recommended (Stalmaster and Kaiser 1998).

Knight et al. (1991) determined that anglers influenced the scavenging behavior of bald eagles at gravel bars along the South Fork of the Toutle River. Bald eagles were more frequently observed on the ground during days when anglers were not present, and more frequently in the trees on days when anglers were present. Feeding periods shifted to late afternoon and less fish was consumed on days when anglers were present. Crows fed despite the presence of anglers and consumed fish that otherwise would likely have been eaten by bald eagles. Skagen et al. (1991) also concluded that human recreational activity favors consumption of salmon carcasses by gulls and crows which were more tolerant.

Stalmaster and Kaiser (1998) found that eagle feeding activity on the Skagit River declined exponentially with increases in disturbance events associated with recreation. Foot traffic flushed more birds than motorboats per event, but encounters with motorboats were much more frequent. When more than 40 recreational events occurred per day there was an 89% reduction in bald eagle feeding time. Eagles fed at the river 30% less on weekends when recreational use was high than on weekdays. Eagle feeding rates were high on Mondays and Tuesdays after weekends when birds fed little due to recreational activities. On the weekends, intolerant eagles simply left the river and a few tolerant eagles remained on the river and fed despite the continued presence of humans. Most recreationists underestimated their effect on eagles. Only 26% of anglers and eagle watchers believed their activities were adversely affecting eagles on the river and only 10% of anglers supported restrictions on boating hours (Stalmaster and Kaiser1998). Watson and Pierce (2001) also reported that hikers/bank fishermen were the most disturbing to eagles, followed by motorboats; rafts created the least disturbance.

Stalmaster and Kaiser (1998) clearly demonstrated that recreationists affected foraging time by eagles on the main river; but the consequences for individuals, or to the population as a whole, is unknown. Watson and Pierce (2001) monitored 3 telemetered eagles intensely for 25 days, and did not find their foraging activities greatly affected by human activities. However, of the birds with transmitters, those 3 birds may have been the most tolerant of human disturbance. All the wintering birds they studied that returned to the Skagit remained in the local area for several weeks in spite of existing human activities (Watson and Pierce 2001). Hansen and Hodges (1985) suggested that fall and winter foraging success may directly affect the birds ability to successfully reproduce the following spring. Since most of the eagles wintering on Washington rivers breed further north, the affect on reproduction would not be evident in the population of Washington breeders. Despite the reduction of feeding due to disturbances, Taylor (1989) and Utzinger et al. (1993) indicate an increasing trend in wintering bald eagle numbers on the Skagit River between 1982 and 1993.

In a study of wintering eagle response to military activities at Ft. Lewis, Washington, Stalmaster and Kaiser (1997) reported that, although some sensitive eagles left the area during firing, most were not overly disturbed by artillery and small arms fire. Habituation to regular events and the need for the food and habitat in the area caused eagles to be tolerant of firing exercises. Heavy artillery impacts as close as 1 km were tolerated, but low helicopter overflights (<300 m) and close boat encounters (<100 m) caused most eagles to flush. The military activity at Fort Lewis was not disruptive enough to preclude high eagle use of the area.

Adaptation to human disturbance. Disturbance experiments suggested that eagles habituated somewhat over 24 hours to camping 328 ft (100 m) from nests, but that the tendency was not cumulative, with each disturbance being essentially independent of the last (Steidl and Anthony 2000). Eagle tolerance of disturbance may depend in part on prior experience and the level of the nesting population relative to carrying capacity. A small but apparently growing number of bald eagles in Washington are exhibiting an unexpected tolerance to human presence and activities, and nesting successfully in close proximity to homes (Watson et al.1999, S. Negri, pers. comm.). This may be the result, in part, from a local shortage of nesting habitat. Eagles show strong year-to-year fidelity to a nest territory and are reluctant to abandon a territory despite increased disturbance and habitat alteration. This fidelity may be stronger when the population is at carrying capacity and no vacant suitable sites are available.

A second factor that may be very important is a decrease in persecution. The effect of persecution on eagle behavior is summed up by Fraser (1985): “persecution by man produced a population of eagles too timid to live in habitat that is frequented by humans...given the variability of flush distance eagles exhibited, it is probable that some eagles (the tamest birds) are more likely to be shot than others. This removal of tame birds constitutes a selective pressure favoring birds that flush when humans approach them.” In parks where animals are protected from persecution, individuals lose their fear of man. The small, recent increase in eagle tolerance of humans in Washington may be a result of reduced persecution. This also suggests that, beyond the death of an eagle, shooting incidents have the potential to affect the behavior of other eagles for many years thereafter.

Contaminants

Pesticides and other chemicals. Contaminant-free prey is necessary to maintain the reproductive health and survival of bald eagles. Although the use of DDT was banned in 1972, and most uses of PCBs were banned in 1978, these compounds and derivatives are still present in the environment. A recent study in the Columbia Basin of eastern Washington found ∑DDT present in 94% of fish samples (Munn and Gruber 1997). Residual DDT and PCBs continue to accumulate and concentrate through life as individuals consume contaminated prey. Some eagles may contain elevated levels of DDE in their tissues that prevents successful reproduction, or their territory may contain contaminated prey that continues to affect the resident eagles (Jenkins and Risebrough 1995). Also, eagles at least occasionally die of DDE poisoning when extraordinary stress results in rapid catabolism of fat reserves (Garcelon and Thomas 1997). DDE accounted for 28 of 89 nesting failures from several locations in Oregon (Anthony et al. 1994). Eagles in the Columbia River estuary have exhibited chronic low nest productivity, apparently due to a variety of contaminants, including DDE, PCB's, and dioxins (Anthony et al. 1993). Contaminants collect in the lower Columbia from a variety of sources, probably including hydroelectric dams and bleached-pulp paper mills; they are then re-released in the ecosystem during river dredging. DDE and PCBs continue to affect bald eagle nest productivity on Lake Michigan and Lake Huron, but low productivity on Lake Superior seems to be related to prey availability (Dykstra 1995).

The cause of low productivity of the Hood Canal eagle population is not clear, and seems to include reduced foraging opportunities (Watson and Pierce 1998b). Nonetheless, 10 eggs collected from 1992-95 had PCB concentrations from 5-23.4 ppm; concentrations above 4 ppm may affect hatching success (Mahaffy, et al. 2001). Concentrations of PCBs and compounds with dioxin-like activity were lower in eggs collected later in the study. The total dioxin-like potency of the planar chlorinated compounds in the eggs were summarized as TCDD toxic equivalents (TEQs). The geometric mean TEQ value for 8 fresh eggs collected 1992-93 was 351 pg/g, compared to 158 pg/g for 5 addled eggs collected between 1994-97 (Mahaffy, et al. 2001). Eggs collected outside the Hood Canal had a geometric mean of 106 pg/g. Elliott et al. (1996b) suggested using a no-observed-effect level of 100 pg/g and a lowest-observed-effect of 210 pg/g. Hood Canal eagle eggs exhibited some egg-shell thinning (6%), but below the level at which reproductive problems are known to occur (15-20%). Eagles seemed to be exposed to contamination through their prey, but local fish and sediment samples had low PCB levels (Mahaffy, et al. 2001). Bald eagle chicks near pulp mills in British Columbia contained elevated concentrations of PCDDs (dioxin) and PCDFs (furan) (Elliott et al. 1996b). These compounds are known to induce a wide range of effects on embryonic development, and some substances may have a neuro-toxic effect that exhibits itself in greater sensitivity to disturbance. PCBs and similar substances have affected hatching success in doves (*Streptopelia risoria*), herring gulls (*Larus argentatus*), and terns (*Sterna forsteri* and *S. hirundo*) (Bosveld and Van den Berg 1994, Thomas 1997), and occasionally have caused acute poisoning in eagles (Elliott et al. 1995).

In addition to the insidious effects of persistent and continued environmental contamination, eagles also die as a result of poisoning by pesticides. Secondary poisoning of raptors may be a relatively common occurrence (Porter 1993). Organophosphorous and carbamate compounds generally replaced organochlorine pesticides, which were more persistent in the environment. However, under some conditions or uses, pesticides can still kill eagles. Between 1982 and 1994, 139 eagles from 25 states were killed by organophosphorous and carbamate pesticides including famphur, carbofuran, fenthion, aldicarb, phorate, terbufos, parathion, and coumaphos (Franson et al. 1995). Additional bald eagle fatalities were documented in Canada (Bowes et al. 1992, Elliott et al. 1996a, Peterson et al. 2001). Eagle poisonings occurred incidental to approved uses, due to carelessness, or after illegal use in bait for predator control (Allen et al. 1996). In some cases, eagles died after feeding on the carcasses of livestock that had received topical application of a pesticide (Henny et al. 1987). Harmata et al. (1999) indicated eagles may be killed by illegal pesticide use for controlling ground squirrels. In 1996, 11 bald eagles in Washington were killed by secondary poisoning when a topical treatment for cattle containing famphur (Warbex®), was illegally used for starling control. Some pesticide forms may no longer pose a risk to raptors, such as granular carbofuran, which was phased out in the early 1990s (Anonymous 1993, Buehler 2000).

Avian Vacuolar Myelinopathy. The recent deaths of 69 bald eagles from a neurological disorder at lakes in several southeastern states has been attributed to a toxin that has yet to be identified (Buehler 2000; Ornithological Newsletter 142:2-3 [June 2001]). During the winter of 1994-95, 29 bald eagles and numerous coots were found dead at DeGray Lake, Arkansas; 26 eagles died in the winter of 1996-97.

Deaths and the same aberrant neurological symptoms have been observed at 9 different reservoirs in Arkansas, Texas, Georgia, North Carolina, and South Carolina. The disease, now called Avian Vacuolar Myelinopathy (AVM), is identified by lesions in the white matter of the central nervous system. The disease interferes with normal transmission of nerve impulses, and affected eagles have been observed overflying stoops and crashing into trees and ledges. Affected coots and other waterfowl exhibit a reluctance to fly, erratic flight, inability to fly, and bizarre swimming patterns due to partial paralysis. Several compounds are known to cause similar lesions, but none of these have been detected in the affected birds (Ornithological Newsletter 142:2-3 [June 2001]). So far, AVM has only been observed in the southeastern United States, but it indicates that the era of mysterious bird deaths due to chemical contaminants is not past.

Lead poisoning. Bald eagles are particularly vulnerable to lead poisoning because they often feed on hunter-crippled or lead-poisoned waterfowl. Waterfowl carcasses placed in agricultural areas of the Fraser River Delta in British Columbia were usually (77.8 % of the time) discovered by scavengers, including bald eagles, within 24 hours (Peterson et al. 2001). Waterfowl seem to actively select shot as grit (Moore et al. 1998), and lead poisoning killed an estimated 2-3% of the North American waterfowl population annually between 1938 and 1954 (Anderson et al. 2000). Poisoning as a result of incidental ingestion by eagles of the lead shot in waterfowl and from bound residues in waterfowl tissues has been a significant source of mortality in bald eagles (Pattee and Hennes 1983, Cohn 1985, Elliott et al. 1992, Kramer and Redig 1997). Of 1,429 carcasses examined, 158 (11%) had been poisoned, and over half of these were poisoned by lead (National Wildlife Health Lab 1985). The incidence of lead poisoning in carcasses received during 1980-84 varied from 4.6-15 %. Wayland and Bollinger (1999) reported that, of 127 bald and golden eagles found dead in the prairie provinces of Canada in1990-96, 12% had been lead-poisoned, and an additional 4% had sub-lethal levels of lead.

The use of lead for waterfowl hunting in the U.S. was phased out from 1986-91, and non-toxic shot was required for waterfowl hunting nationwide in 1991 (USFWS 1999:36461). Lead shot use for waterfowl hunting was prohibited in British Columbia in 1995, within 200 m of any water course in Canada in 1997, and throughout Canada in 1999. WDFW began requiring the use of non-toxic shot for all hunters at the Skagit Wildlife Area in 1988, and by all hunters at 10 wildlife management areas with high hunter densities in 2000. A recent analysis of over 15,000 mallard gizzards in the Mississippi Flyway found that 2.8% had ingested lead pellets (Anderson et al. 2000). Lead ingestion was higher for diving ducks; over 6% of 749 ring-necked ducks contained lead pellets. Compliance with the lead shot ban has been high (98-99%), and nationwide losses of mallards to lead poisoning declined by about 64% between the 1938-54 period and 1996-97 (Anderson et al. 2000). Nevertheless, in 1996-97, 25% of the spent pellets available to ducks were lead, indicating that lead shot deposited prior to the ban continues to be a problem (Moore et al. 1998, Anderson et al. 2000). Swans appear to be particularly susceptible. A total of over 300 dead and dying trumpeter swans were picked up in northwest Washington during the last 2 winters (1999-2000, 2000-2001). The location where the swans are ingesting the lead shot is unknown.

The number of bald and golden eagles admitted to the University of Minnesota Raptor Center for lead poisoning did not decline after lead shot was banned for waterfowl (Kramer and Redig 1997). There was a shift from a higher percentage of acutely poisoned eagles before the ban (1980-90), to a higher percentage of chronically exposed eagles after the ban (1991-95). Subclinical or chronic lead exposure decreases an eagle's hunting abilities and predisposes it to hazards like power lines and vehicles (Kramer and Redig 1997). The eagles in the study may have consumed the lead in Canada where it was still used in 1995 (Kramer and Redig 1997). Lead fishing weights (sinkers) ingested by waterfowl have been suggested as a potential source of poisoning in eagles, but Anderson et al. (2000) could find only 1 sinker in over 16,000 duck gizzards. Two eagles in the Greater Yellowstone Ecosystem that died from lead poisoning had ingested large caliber bullets possibly while feeding on ungulate carcasses (Harmata et al. 1999). Other potential sources of lead exposure for the eagles may include sinkers ingested by fish and lead shot in injured upland game birds.

Oil spills. Oil spills have resulted in the deaths of bald eagles in the past and continues to represent a localized threat to eagles. After the 1989 *Exxon Valdez* disaster in Alaska, 153 bald eagle carcasses were found and it was estimated that 247 eagles died as a direct result of the oil spill (although some estimates were as high as 900 birds; White et al. 1995, Bowman et al. 1997). The Prince William Sound eagle population was able to recover to pre-spill levels by 1995 (Bowman et al. 1997). A major oil spill in the Strait of Juan de Fuca or Puget Sound could, depending on the season and conditions, have a serious impact on the Washington eagle population. The ability of the eagle population to recover would, in part, be determined by the availability of non-breeding adults to replace those lost by oiling mortality, and the subsequent recovery of prey populations.

Other Human-related Factors

Shooting. There is no comprehensive, unbiased dataset for eagle fatalities. Most dead eagles are probably eaten by scavengers, and there is no clearinghouse for data on all of the carcasses that are discovered. Gunshot was the cause of death in about 14% of bald eagle carcasses turned into the National Wildlife Health Lab, Madison, Wisconsin over a 30-year period (Franson et al. 1995). The sample of birds received by the Lab may be birds with unknown cause of death, because in recent years many birds with an obvious cause of death are sent to the USFWS forensics lab in Ashland, Oregon, or to the Eagle Repository in Denver, Colorado. In the 1970s, it was estimated that 10-20 bald eagles in Washington died annually from shooting incidents (Grubb 1977). Shooting is probably less common than it was at the time of federal listing due in part to education efforts and some high-profile prosecutions. Shooting is still an occasional source of mortality for eagles in Washington. The bodies of 5 bald eagles that had been shot were found in 2 separate incidents in the state in July 2000, and 2 more in 2000 (S. Ament, D. Anderson, S. Garlichs, pers. comms.). Native Americans may apply to receive eagle feathers and parts from the USFWS eagle repository in Denver. A black market in eagle parts, however, apparently still exists. Federal and Canadian agents are currently investigating two cases involving the smuggling of parts of 130 eagles which may have been killed on Vancouver Island, British Columbia; one defendant is currently awaiting trial (T. Chisdock, pers. comm.). Shooting incidents not only create a source of adult mortality, but may also selectively remove the eagles most tolerant of humans. Also, eagles that survive become wary of humans, and as a result may be more sensitive to disturbance and unwilling to feed or nest in proximity to humans (*see* Adaptation to human disturbance. p. 53).

Electrocutions on power lines. Wildlife is the third leading, identifiable cause of power outages in the United States (Harness and Wilson 2001). Electrocution occurs when an animal touches 2 energized wires or a wire and ground wire. Bald eagles make up 1-10% of the raptors electrocuted by power lines each year (Olendorff et al. 1996:18). Harness and Wilson (2001) list 118 electrocutions of bald eagles along rural electrical distribution lines in the western United States from 1986-96. Of bald eagle carcasses submitted to the National Wildlife Health Lab during the early 1960s-90s, 12% died from electrocution (Franson et al. 1995). In part of the Klamath Basin, Oregon, 24 bald eagles were electrocuted in a winter concentration area during a 6-year period (Olendorff et al. 1996). Harmata et al.

(1999) reported that 20% of known eagle fatalities in the Yellowstone ecosystem between 1979-97 resulted from either electrocutions or collisions with powerlines.

Although bald eagle electrocutions are relatively rare, fatalities do occur in Washington, and contribute to the reduction of eagle survival rates caused by human factors. During 2000, about 14 bald eagles are known to have been electrocuted in Whatcom, Skagit, and Island counties (T. Chisdock, pers. comm.). Given that many birds may be electrocuted, but never discovered or reported, perhaps 15-25 bald eagles are killed each year in Washington. The frequency varies greatly, being much higher where eagles congregate and hazardous lines exist. Pacific Power, which has power lines in parts of 6 states, (including a small part of Washington) records about 30-40 eagle electrocutions per year, but only 1-2 of these are bald eagles (M. Garrett, pers. comm.).

Most electrocutions occur on distribution lines, not transmission lines which require larger separations between phases, grounds, and support structures (Harness and Wilson 2001). Large birds are particularly capable of spanning the separation between conducting equipment of distribution lines. If electrocution is to be reduced as a source of mortality for eagles, raptor-safe designs must be incorporated during the planning and design of power distribution systems (Olendorff et al. 1996). Though the technology is available, it is not always used when power lines are erected. Electrical distribution equipment can be retro-fitted to prevent electrocutions, but retrofitting the >300,000 miles of distribution lines and millions of poles in the United States would be prohibitively expensive (Olendorff et al. 1996). Management usually focuses on specific sites where power poles have caused electrocutions, or where distribution lines and eagle activity create a serious hazard to eagles and the potential for outages.

Unfortunately, in the past there was no systematic recording of bird electrocutions in most of Washington. Some utilities, such as Pacific Power and Idaho Power have had a system for recording and reporting bird electrocutions for over 10 years. These data are used to identify problem sites and equipment, so that the equipment can be modified to prevent electrocutions. Some Washington utilities, including Puget Sound Energy, and Snohomish County PUD are currently developing procedures for data collection so that problem sites can be identified, and hazardous situations eliminated. Puget Sound Energy has recently become proactive in evaluating electrocution hazard to birds and identifying sites for equipment changes. They recently retrofitted >20 sites with protective equipment in Skagit, Whatcom, and Island counties and are evaluating at least 60 additional sites for possible retrofits (M. Walters, pers. comm.).

Vehicle and train collisions. Bald eagles are occasionally killed by vehicles or trains. Eagles and carnivores become vulnerable when they feed on previously killed ungulates and other wildlife on roads or train tracks. Among the wildlife killed along the Mountain Subdivision of the Canadian Pacific Railway in eastern British Columbia from 1993-98 were 5 bald eagles (Wells et al. 1999). A particularly dangerous situation is created for wildlife where railroads and highways run closely parallel (Ruediger et al. 1999).

Urban crows. Urbanized areas have very high populations of crows which may reduce the productivity of otherwise suitable nesting habitat. Thompson (1998) reported several instances where eagle nesting attempts failed, and 2 territories that were abandoned apparently due to intense harassment by crows. This problem may be more widespread than previously recognized and prevent eagles that are otherwise adapted to urban habitats from being productive.

CONCLUSIONS AND RECOMMENDATION

Recovery and up-listing. While the bald eagle population is far below the historic numbers of the early 18th century, the number of nesting pairs in Washington has more than quadrupled since the ban on use of DDT. Assuming that no new environmental contaminant or other factor causes widespread mortality or reproductive failure in the future, the greatest threat to continued future viability of the species is the security of nesting and roosting habitat. Despite the dramatic increase in the past 20 years, two thirds of the State's nests are on private lands, and only 10% would be considered secure in the absence of a habitat protection rule (Table 11).

As part of management activities for the species in Washington, a spatially explicit population viability analysis should be conducted. Such an analysis should develop population and habitat management goals for management zones in the state that would provide long term security (≈100 years) for the species. In the interim, the species should be reviewed for up-listing as threatened or endangered if a decline of >20% in occupied territories from the 1998 numbers occurs in either eastern or western Washington. This will require a regular monitoring effort to assess territory occupancy.

Table 11. Relative security of bald eagle nests, and aggregate lands in territories in the absence of state habitat protection rules based on ownership and management status.

Security status	Aggregate lands in territories		Nest trees	
	%	ac	%	No.
Protected areas[a]	7.8	22,025	10.0	82
Uncertain protection[b]	24.4	69,295	24.7	203
Not secure (private lands)	67.8	192,153	65.3	537
total	100	283,473	100	822

[a] National Parks, National Wildlife Refuges, State Wildlife Areas (WDFW), Natural Area Preserves and Natural Resource Conservation Areas (WDNR).
[b] All other public and tribal land designations.

Management activities that should be conducted and outlined in a state management plan include:

1. Develop a strategy to monitor the distribution and abundance of nesting pairs in Washington that is capable of detecting a 20% change in the number of occupied nest sites over 20 years. The strategy needs to meet both the immediate need for information about nest status driven by management planning, and be compatible with a national monitoring strategy being developed by USFWS.

2. Develop a regional, spatially explicit, population viability model that will predict persistence of populations of various sizes and distribution, and the population response to disasters like a major oil spill.

3. Develop habitat management goals specific to recovery zones based on insights derived from the population viability modeling, present knowledge of bald eagle biology, and biogeography.

4. Update and improve database of communal eagle roosts.

5. Evaluate cost and feasibility of reinitiating a winter count program to monitor trends, including the potential for a region-wide effort that includes rivers in southern British Columbia.

6. Develop wintering eagle population goals and salmon escapement needs for the main wintering river systems.

7. Prioritize existing territories, roosts, and habitat for protection based on the condition of the habitat, threats to the habitat, proximity to foraging areas, and location relative to maintaining a well distributed, secure population.

8. Investigate methodology for monitoring shoreline habitat of key portions of the bald eagle population.

9.Periodically review management guidelines including timing restrictions and buffer distances. As the human population increases, eagles may adapt to greater human disturbance, or abandon territories in developed areas.

10. Evaluate up-listing and develop de-listing criteria based on modeling and the status of the population and habitat.

Recommendation. The bald eagle population has increased dramatically in the past 20 years, but two thirds of the State's nests are on private lands, and only a small portion of the remaining habitat would be secure in the absence of the state's habitat protection rule. The human population of Washington is expected to increase by 2 million to 7.7 million by 2020, and double to 11 million by 2050 (WDNR 1998), and shorelines afford the water views so desirable for residential development. Forest near shorelines is rapidly being cleared and the needs of eagles and desires of humans are increasingly in conflict. State bald eagle protection rules, the Shoreline Management Act, zoning restrictions, and some concerned landowners all may moderate the rate of forest clearing. Without protection of nesting and roosting habitat, however, the bald eagle could again decline dramatically and require re-listing as threatened or endangered in the state. Any change in legal status for the bald eagle in the state should involve retaining the habitat protections embodied in the state bald eagle rule.

Washington statute (RCW 77.12.655) directs WDFW to adopt and enforce rules protecting bald eagle habitat. The state habitat protection rule (WAC 232-12-292) as currently written, however, applies to the bald eagle while it is listed as state Threatened or Endangered. De-listing or down-listing of the species in the State, without any revision to the habitat protection rule, would remove many of the protections in state and county laws that have helped allow the recovery witnessed in the last 20 years, and not comply with the statute. It might also put Washington landowners in potential conflict with the Bald and Golden Eagle Protection Act, but without the planning process that WDFW has administered since 1986. The prospects for the eagle population would be very uncertain without these habitat protections in place. A state Sensitive species is defined as a species "...that is likely to become endangered or threatened in a significant portion of its range within the state without cooperative management or removal of threats" (WAC 232-12-297).

For these reasons the Department recommends that the bald eagle be down-listed to Sensitive in the State of Washington contingent on the revision of the bald eagle protection rule (WAC 232-12-292) to apply to the bald eagle as a Sensitive species.

REFERENCES CITED

Adkins, J. 1974. Bald eagle nesting survey. p. 123-128 *in* Small Game Management Report: 1973-74. Washington Dept. of Game, Olympia, WA.

Adkins, J. 1977. Bald eagle research and management program. Unpubl. rept., Washington Dept. of Game, Olympia, WA. 10 pp.

Allen, G. T., R. L. Knight, and M. V. Stalmaster. 1980. An annotated bibliography of Bald and Golden Eagles in Washington. Washington Dept. of Game, Olympia, WA. 66 pp.

Allen, G. T., J. K. Veatch, R. K. Stroud, C. G. Vendel, R. H. Poppenga, L. Thompson, J. Schafer, W. E. Braselton. 1996. Winter poisoning of coyotes and raptors with Furadan-laced carcass baits. J. of Wildlife Diseases 32:385-389.

Anderson, W. L., S. P. Havera, and B. W. Zercher. 2000. Ingestion of lead and nontoxic shotgun pellets by ducks in the Mississippi Flyway. J. Wildlife Management 64:848-857.

Anonymous. 1993. New generation pesticides cause deaths of bald eagles. unpublished, Research Info. Bull., U. S. Dept. of Interior, Fish and Wildlife Service, No. 28, 2pp.

Anthony, R. G., R. W. Frenzel, F. B. Isaacs, and M. G. Garrett. 1994. Probable causes of nesting failures in Oregon's bald eagle population. Wildlife Society Bull. 22:576-582.

Anthony, R. G., and F. B. Isaacs. 1989. Characteristics of bald eagle nest sites in Oregon. J. Wildlife Management 53:148-159.

Anthony, R. G., R.W. Frenzel, F. B. Isaacs, M. G. Garrett. 1994. Probable causes of nesting failures in Oregon’s bald eagle population. Wildlife Society Bull. 22: 576-582.

Anthony, R. G., M. G. Garrett, and C. A. Schuler. 1993. Environmental contaminants in bald eagles in the Columbia River estuary. J. Wildlife Management. 57:10-19.

Anthony, R. G., R. L. Knight, G. T. Allen, B. R. McClelland, and J. I. Hodges. 1982. Habitat use by nesting and roosting bald eagles in the Pacific Northwest. Trans. N. American Wildlife and Natural Resource Conference 47:332-342.

Anthony, R. G., R. J. Steidl, and K. McGarigal. 1995. Recreation and bald eagles in the Pacific Northwest. pp. 223-241, *in* R. L. Knight and K.J.Gutzwiller. Wildlife and Recreationists: coexistence through management and research. Island Press, Washington, D.C. 372 pp.

A.O.U. (American Ornithologists’ Union). 1998. Check-list of North American Birds. 7th edition. American Ornithologists’ Union, Washington, D.C.

Bald Eagle Working Team for Oregon and Washington. 1990. Working Implementation Plan for Bald Eagle Recovery in Oregon and Washington. Washington Dept. of Wildlife, Olympia, WA.

Beans, B. E. 1996. Eagle’s Plume: the struggle to preserve the life and haunts of America’s bald eagle. Scribner, New York, NY. 318 pp.

Beebe, F. L. 1974. Field Studies of the Falconiformes of British Columbia: Vultures, Hawks, Falcons, Eagles. Occasional Paper No. 17, British Columbia Provincial Museum, Victoria, BC. 163 pp.

Belding, L. 1890. Land birds of the Pacific district. California Academy of Sciences Occas. Paper No. 2.

Bendire, C. E., 1892. Life Histories of North American Birds. U. S. National Museum Special Bull. No 1. (*Not seen, in* Allen et al. 1980).

Biosystems Analysis, Inc. 1980. Impacts of a proposed Copper Creek Dam on bald eagles. Report for Seattle City Light, Seattle, WA. 143 pp.

Bloeser, J. A. 1999. Diminishing Returns: the status of west coast rockfish. Pacific Marine Conservation Council.

Blood, D. A. and G. G. Anweiler. 1994. Status of the Bald Eagle in British Columbia. Wildlife Working Report No. WR-62, Wildlife Branch, Ministry of the Environment, Lands, and Parks, Victoria, BC.

Bolsinger, C. L., N. McKay, D. R. Gedney, C. Alerich. 1997. Washington's public and private forests. Resource Bulletin PNW-RB-218. USDA Forest Service, Pacific Northwest Research Station, Portland, OR. 144 pp.

Booth, D. E. 1991. Estimating pre-logging old-growth in the Pacific Northwest. J. Forestry 89:25-29.

Bosveld, A. T. C., and M. Van den Berg. 1994. Effects of polychlorinated biphenyls, dibenzo-p-dioxins, and dibenzofurans on fish-eating birds. Environ. Rev. 2:147-166.

Bowes, V., R. Puls, and M. Peters. 1992. Fenthion toxicity in bald eagles. Canadian Veterinary J. 33:678.

Bowles, J. H. 1906. A list of the birds of Tacoma, Washington, and vicinity. Auk 23:138-148.

Bowman, T. D., P. F. Schempf, and J. A. Bernatowicz. 1995. Bald Eagle survival and population dynamics in Alaska after the *Exxon Valdez* oil spill. J. Wildlife Management 59(2):317-324.

Bowman, T. D., P. F. Schempf, and J. I. Hodges. 1997. Bald eagle population in Prince William Sound after the *Exxon Valdez* oil spill. J. Wildlife Management 61:962-967.

Broley, C. L. 1958. The plight of the American bald eagle. Audubon 60 (July-August): 162-163, 171.

Brown, J. L. 1969. Territorial behavior and population regulation in birds. Wilson Bulletin 81:293-329.

Buchanan, J. B., and J. R. Evenson. 1997. Abundance of shorebirds at Willapa Bay, Washington. Western Birds 28:158-168.

Buechner, H. K. 1953. Some biotic changes in the State of Washington, particularly during the century 1853-1953. Research Studies of the State College of Washington. 21(2):154-192.

Buehler, D. A., 2000. Bald Eagle (*Haliaeetus leucocephalus*). Birds of North America No. 506. The Birds of North America, Inc., Philadelphia, PA. 40 pp.

Buehler, D. A., J. D. Fraser, J. K. D. Seegar, G. D. Therres, and M. A. Byrd. 1991a. Survival rates and population dynamics of bald eagles on Chesapeake Bay. J. Wildlife Management. 55(4):608-613.

Buehler, D. A., T. J. Mersmann, J. D. Fraser, and J. K. D. Seegar. 1991b. Effects of human activity on bald eagle distribution on the northern Chesapeake Bay. J. Wildlife Management 55(2):282-290.

Busby, P. J., T. C. Wainwright, G. J. Bryant, L. J. Lierheimer, R. S. Waples, F. W. Waknitz, and I. V. Lagomarsino. 1996. Status review of west coast steelhead from Washington, Idaho, Oregon, and California. National Marine Fisheries Service, NOAA Technical Memorandum NMFS-NWFSC-27.

Cassidy, K. M., C. E. Grue, M. R. Smith, R. E. Johnson, K. M. Dvornich, K. R. McAllister, P. W. Mattocks Jr., J. E. Cassady, K. B. Aubry. 2001. Using current protection status to assess conservation priorities. Biological Conservation 97:1-20.

Cassidy, K. M., M. R. Smith, C. E. Grue, K. M. Dvornich, J. E. Cassady, K. R. McAllister, and R. E. Johnson. 1997. Gap Analysis of Washington State: an evaluation of the protection of biodiversity. Washington Cooperative Fish and Wildlife Research Unit, Univ. of Washington, Seattle. 192 pp.

Caughley, G. 1977. Analysis of vertebrate populations. John Wiley and Sons, New York, NY. 234 pp.

Cedarholm, C. J., D. H. Johnson, R. E. Bilby, et al. 2000. Pacific Salmon and Wildlife-Ecological Contexts, Relationships, and Implications for Management. Special Edition Technical Report, Wildlife-Habitat Relationships in Oregon and Washington (project). Washington Dept. Fish and Wildlife, Olympia, WA. 138 pp.

Chandler, S. K., J. D. Fraser, D. A. Buehler, and J. K. D. Seegar. 1995. Perch trees and shoreline development as predictors of bald eagle distribution on Chesapeake Bay. J. of Wildlife Management 59:325-332.

Cohn, J. P. 1985. Lead shot poisons bald eagles. Bioscience 35(8):474-476.

Dale, F. H. 1936. Eagle “control” in northern California. Condor 38:208-210.

Dawson, W. L. and J. H. Bowles. 1909. The Birds of Washington. Occidental Publishing, Seattle, WA.

Doyle, F. I. 1995. Bald eagle, *Haliaeetus leucocephalus*, and northern goshawk, *Accipiter gentilis*, nests apparently preyed upon by a wolverine(s), *Gulo gulo*, in the southwestern Yukon territory. Canadian Field-Naturalist 109:115-116.

Driscoll, D. E., R. E. Jackman, W. G. Hunt, G. L. Beatty, J. T. Driscoll, R. L. Glinski, T. A Gatz, and R. I. Mesta. 1999. Status of nesting bald eagles in Arizona. J. of Raptor Research 33:218-226.

Dunwiddie, P. W., and R. C. Kuntz II. 2001. Long-term trends of bald eagles in winter on the Skagit River, Washington. J. Wildlife Management 65: 290-299.

Dykstra, C. J. 1995. Effects of contaminants, food availability, and weather on the reproductive rate of Lake Superior bald eagles. PhD. Dissert. Univ. Wisconsin, Madison. 247 pp.

Dzus, E. H., and J. M.Gerrard. 1993. Factors influencing bald eagle densities in northcentral Saskatchewan. J. Wildlife Management 57:771-778.

Edwards, C. C. 1969. Winter behavior and population dynamics of American eagles in Utah. PhD. Dissert., Brigham Young Univ., Provo, UT (*not seen, in* Buehler 2000).

Edson, J. M. 1908. Birds of the Bellingham Bay region. Auk 25:425-439.

Eisner, S.A. 1991. Bald eagles wintering along the Columbia River in southcentral Washington: factors influencing distribution and characteristics of perch and roost trees. M.S. Thesis, Univ. Montana, Missoula. 58 pp.

Elliott, J. E., K. M. Langelier, A. M. Scheuhammer, P. H. Sinclair, and P. E. Whitehead. 1992. Incidence of lead poisoning in bald eagles and lead shot in waterfowl gizzards from British Columbia, 1988-91. Progress Notes No. 200. Canadian Wildlife Service. 7 pp.

Elliott, J. E., L. K. Wilson, K. M. Langelier, and R. J. Norstrom. 1995. Chlorinated hydrocarbon residues and autopsy data from British Columbia bald eagles (*Haliaeetus leucocephalus*), 1989-1993. Organohalogen Compounds 24:401-404.

Elliott, J. E., K. M. Langelier, P. Mineau, and L. K. Wilson. 1996a. Poisoning of bald eagles and red-tailed hawks by carbofuran and fensulfothion in the Fraser Delta of British Columbia, Canada. J. of Wildlife Diseases 32:486-491.

Elliott, J. E., R. J. Norstrom, A. Lorenzen, L. E. Hart, H. Philibert, S. W. Kennedy, S. J. Stegeman, G. D. Bellward, and K. M. Cheng. 1996b. Biological effects of polychlorinated dibenzo-p-dioxins, dibenzofurans, and biphenyls in bald eagle (*Haliaeetus leucocephalus*) chicks. Environmental Toxicology and Chemistry 15:782-793.

Fielder, P. C. 1976. The impact of the Grand Coulee Third Powerhouse Extension on fish and wildlife populations, Columbia River, Washington. Washington Dept. of Game. Olympia, WA. 55 pp.

Fielder, P. C. 1982. Food habits of bald eagles along the mid-Columbia River, Washington. Murrelet 63:46-50.

Fielder, P. C., and R. G. Starkey. 1987. Bald eagle winter abundance and distribution in eastern Washington. Northwest Science 61:226-232

Fitzner, R. E., and W. C. Hanson. 1979. A congregation of wintering bald eagles. Condor 81: 311-313.

Fitzner, R. E., D. G. Watson, and W. Rickard. 1980. Bald eagles of the Hanford National Environmental Research Park. Pages 207-218 *in* R. L. Knight, G. T. Allen, M. V. Stalmaster, and C. W. Servheen, eds. Proceedings of the Washington Bald Eagle Symposium, Seattle, Washington, USA.

Folk, M. J. 1992. Cooperative hunting of avian prey by a pair of bald eagles. Florida Field Naturalist 20:110-112.

Franson, J. C., L. Sileo, and N. J. Thomas. 1995. Causes of eagle deaths. p 68 *in* LaRoe, E. T., G. S. Farris, C.E. Puckett, P. D. Doran, and M.J. Mac. (eds.). Our living resources: a report to the nation on the distribution, abundance, and health of U.S. plants, animals, and ecosystems. U. S. Dept. of Interior, National Biological Service, Washington, DC. 530 pp.

Fraser, J. D. 1985. The impact of human disturbance on breeding bald eagle populations - a review. Pages 68-84 *in* J. M. Gerrard and T. N. Ingram, eds. Proc. of bald eagle days, 1983. The Eagle Foundation, Apple River, IL.

Fraser, J. D., L. D. Frenzel, and J. E. Mathisen. 1985. The impact of human disturbance on breeding bald eagles in north-central Minnesota. J. Wildlife Management 49:585-592.

Fretwell, S. 1981. Interview with a Bald Eagle. p. 1-2 *in* The Bird Watch. Bird Populations Institute, Kansas State University, Manhattan, KA. (*not seen, in* Gerrard and Bortolotti 1988).

Garcelon, D. K., R. W. Risebrough, W. M. Jarman, B. Chartrand and E. F. Littrell. 1989. Accumulation of DDE by bald eagles *Haliaeetus leucocephalus* reintroduced to Santa Catalina Island in southern California. p. 491-494 *in* B. U. Meyburg and R. D. Chancelor, eds. Raptors in the Modern World. World Working Group on Birds of Prey and Owls. International Council for Bird Preservation. London.

Garcelon, D. K., and G. W. Roemer. 1990. The reintroduction of bald eagles to Santa Catalina Island, California, pp. 63-68. *in* P. J. Bryant and J. Remington (eds.), Memoirs of the Natural History Foundation of Orange County, Vol. 3. Natural History Foundation, Newport Beach, CA.

Garcelon, D. K., and N. J. Thomas. 1997. DDE poisoning in an adult bald eagle. J. Wildlife Diseases 33:299-303.

Garrett, M. G., J. W. Watson, and R. G. Anthony. 1993. Bald eagle home range and habitat use in the Columbia River Estuary. J. of Wildlife Management 57:19-27.

Gende, S. M., M. F. Willson, B. H. Marston, M. Jacobson, and W. P. Smith. 1998. Bald eagle nesting density and success in relation to distance from clearcut logging in southeast Alaska. Biological Conserv. 83:121-126.

Gerrard, J. M. 1983. A review of the current status of Bald Eagles in North America. p. 5-21 *in* D. M. Byrd (ed.) Biology and Management of Bald Eagles and Ospreys. Proceedings of 1st International Symposium on Bald Eagles and Ospreys, Montreal, 28-29 October 1981. MacDonald Raptor Research Centre of McGill University and Raptor Research Foundation, Inc. 325 pp.

Gerrard, J. M., and G. R. Bortolotti. 1988. The bald eagle: haunts and habits of a wilderness monarch. Smithsonian Institution Press, Washington and London. 177 pp.

Gerrard, J. M., G. R. Bortolotti, and D. W. A. Whitfield. 1983. A 14-year study of bald eagle reproduction on Besnard Lake, Saskatchewan. p. 47-57 *in* D. M. Byrd (ed.) Biology and Management of Bald Eagles and Ospreys. Proceedings of 1st International Symposium on Bald Eagles and Ospreys, Montreal, 28-29 October 1981. MacDonald Raptor Research Centre of McGill University and Raptor Research Foundation, Inc. 325 pp.

Gerrard, J. M., P. N. Gerrard, P. Naomi Gerrard, G. R. Bortolotti, and E. H. Dzus. 1992. A 24-year study of bald eagles on Besnard Lake, Saskatchewan. J. of Raptor Research 26:159-166.

Greenwood, P.J. 1980. Mating systems, philopatry and dispersal in birds and mammals. Animal Behaviour 28:1140-1162.

Gresh, T. J. Lichatowich, and P. Schoonmaker. 2000. An estimation of historic and current levels of salmon production in the northeast Pacific Ecosystem: evidence of a nutrient deficit in the freshwater systems of the Pacific Northwest. Fisheries 25(1):15-21.

Grier, J. W. 1980. Modeling approaches to bald eagle population dynamics. J. Wildlife Management 316-323.

Grier, J. W., F. J. Gramlich, J. Mattsson, J. E Mathisen, J. V. Kussman, J. B. Elder, and N. F. Green. 1983. The Bald Eagle in the Northern United States. Bird Conservation 1:46-66.

Grinnell, G. B. 1920. Recollections of Audubon Park. Auk 37:372-380.

Grubb, T. G., D. A. Manuwal, and C. M. Anderson. 1975. Nest distribution and productivity of bald eagles in western Washington. Murrelet 56:2-6.

Grubb, T. G. 1976. A survey and analysis of bald eagle nesting in western Washington. M. S. Thesis, University of Washington, Seattle. 87 pp.

Grubb, T. G. 1977. Research and management outline. Pages 1-3 *In* Adkins, J. 1977. Bald eagle research and management program. Unpubl. rept., Washington Dept. Game, Olympia, WA. 10 pp.

Grubb, T. G. 1980. An evaluation of bald eagle nesting in western Washington. Pages 87-103 *in* R. L. Knight, G. T. Allen, M. V. Stalmaster, and C. W. Servheen, eds. Proceedings of the Washington Bald Eagle Symposium, Seattle, Washington, USA.

Grubb, T.G., W. W. Bowerman, J. P. Giesy, and G. A Dawson. 1992. Responses of breeding bald eagles, *Haliaeetus leucocephalis*, to human activities in northern Michigan. Canadian Field-Naturalist 106:443-453.

Grubb, T. G. and R. M. King. 1991. Assessing human disturbance of breeding bald eagles with classification tree models. J. Wildlife Management 55(3):500-511.

Grubb, T. G., R. L. Knight, D. M. Rubink, C. H. Nash. 1983. A five-year comparison of bald eagle productivity in Washington and Arizona. pp. 35-45, *in* D. M. Byrd (ed.) Biology and Management of Bald Eagles and Ospreys. Proceedings of 1st International Symposium on Bald Eagles and Ospreys, Montreal, 28-29 October 1981. MacDonald Raptor Research Centre of McGill University and Raptor Research Foundation, Inc. 325 pp.

Hancock, D. 1964. Bald eagles wintering in the southern Gulf Islands, British Columbia. Wilson Bull. 76:111-120.

Hansen, A. J. 1977. Population dynamics and night roost requirements of bald eagles wintering in the Nooksack River Valley, Washington. Problem Series. Huxley College of Environmental Studies, Bellingham, Washington, USA.

Hansen, A. J. 1987. Regulation of bald eagle reproductive rates in southeast Alaska. Ecology 68:1387-1392.

Hansen, A. J., and J. I. Hodges. 1985. High rates of nonbreeding adult bald eagles in southeastern Alaska. J. of Wildlife Management 49:454-458.

Hansen, A. J., M. V. Stalmaster, and J. R. Newman. 1980. Habitat characteristics, function, and destruction of bald eagle communal roosts in western Washington. Pages 221-230 *in* R. L. Knight, G. T. Allen, M. V. Stalmaster, and C. W. Servheen, eds. Proceedings of the Washington Bald Eagle Symposium, Seattle, Washington, USA.

Hard, J. J. , R. G. Kope, W. S. Grant, F. W. Waknitz, L. T. Parker, and R. S. Waples. 1996. Status review of pink salmon from Washington, Oregon, and California. National Marine Fisheries Service. NOAA Technical Memorandum NMFS-NWFSC-25.

Harmata, A. R., and D. W. Stahlecker. 1993. Fidelity of migrant bald eagles to wintering grounds in southern Colorado and northern New Mexico. J. Field Ornithology 64:129-134.

Harmata, A. R., G. J. Montopoli, B. Oakleaf, P. J. Harmata, M. Restani. 1999. Movements and survival of bald eagles banded in the Greater Yellowstone Ecosystem. J. of Wildlife Management 63:781-793.

Harness, R. E. and K. R. Wilson. 2001. Electric-utility structures associated with raptor electrocutions in rural areas. Wildlife Society Bulletin 29:612-623.

Harris, B. S. 1978. Eagle nest inventory southern Queen Charlotte Islands, Spring 1978. Report to Islands Protection Committee. 16 pp. (*not seen, in* Blood and Anweiler 1994)

Henny, C. J., E. J. Kolbe, E. F. Hill, and L. J. Bliss. 1987. Case histories of bald eagles and other raptors killed by organophosphorus insecticides topically applied to livestock. J. Wildlife Diseases 23:292-295.

Henny, C. J., L. J. Blus, R. A. Grove, and S. P. Thompson. 1991. Accumulation of trace elements and organochlorines by surf scoters wintering in the Pacific Northwest. Northwestern Naturalist 72:43-60.

Herman, S. G., and J. B. Bulger. 1979. Effects of a forest application of DDT on nontarget organisms. Wildlife Monograph 69: 1-62.

Hodges, J. F., Jr. 1982. Bald Eagle nesting studies in Seymour Canal, southeast Alaska. Condor 84:125-127.

Hodges, J. F., E. L. Boeker, and A. J. Hansen. 1987. Movements of radiotagged bald eagle, *Haliaeetus leucocephalus*, in and from southeastern Alaska. Canadian Field Naturalist 101:136-140.

Hodges, J. I. Jr., J. G. King, and R. Davies. 1984. Bald eagle breeding population survey of coastal British Columbia. J. Wildlife Management 48:993-998.

Hodges, J. I., Jr., and F. C. Robards. 1982. Observations on 3,850 bald eagle nests in southeast Alaska. Pages 37-47 in W. N. Ladd and P. F. Schempf, eds. Proceedings of a symposium and workshop on raptor management and biology in Alaska and western Canada. U. S. Fish and Wildlife Service, Anchorage, AK.

Hoffman, R. 1927. Birds of the Pacific States. Houghton Mifflin Co., Boston. 353 pp.

Hunt, W. G., 1998. Raptor floaters at Moffat's equilibrium. Oikos 82:191-197.

Hunt, W. G., and B. S. Johnson. 1981. Impacts of a proposed Copper Creek dam on bald eagles: second winter study. Rep. to Seattle City Light, Office of Environ. Affairs. Biosystems Analysis, Inc., San Francisco, Calif. 113 pp.

Hunt, W. G., R. E. Jackman, J. M. Jenkins, C. G. Thelander, and R. N. Lehman. 1992a. Northward post-fledging migration of California bald eagles. J. Raptor Research 26:19-23.

Hunt, W.G., J. M. Jenkins, R. E.Jackman, C. G. Thelander, and A. T. Gerstell. 1992b. Foraging ecology of bald eagles on a regulated river. J. Raptor Research 26:243-256.

Hunt, W. G., B. S. Johnson, and R. E. Jackman. 1992c. Carrying capacity for bald eagles wintering along a northwestern river. J. Raptor Research 26:49-60.

Hunt, W. G., and P. R. Law. 2000. Site-dependent regulation of population size: comment. Ecology 81:1162-1165.

Isaacs, F. B., R. G. Anthony, and R. J. Anderson. 1983. Distribution and productivity of nesting bald eagles in Oregon,1978-1982. Murrelet 64:33-38.

Jacobson, M. J., and J. I. Hodges. 1999. Population trend of adult bald eagles in southeast Alaska, 1967-97. J. Raptor Research 33:295-298.

Jenkins, J. M. and R. E. Jackman 1993. Mate and nest site fidelity in a resident population of Bald Eagles. Condor 95:1053-1056.

Jenkins, J. M. and R. W. Risebrough. 1995. Chronic reproductive failures at a bald eagle (*Haliaeetus leucocephalus*) nesting territory in northern California. J. Raptor Research 29:33-36.

Jewett, S.A., W. P. Taylor, W. T. Shaw, and J. W. Aldrich. 1953. Birds of Washington State. University of Washington Press, Seattle, WA.

Johnsgard, P. A. 1990. Hawks, Eagles, & Falcons of North America. Smithsonian Institution Press., Washington, DC. 403 pp.

Johnson, O. W., W. S. Grant, R. G. Kope, K. Neely, F. W. Waknitz, and R. S. Waples. 1997a. Status review of chum salmon from Washington, Oregon, and California. National Marine Fisheries Service. NOAA Technical Memorandum NMFS-NWFSC-32.

Johnson, O. W. 1999. Summary and analysis of information considered by the NMSF for a final listing of chum salmon in the Pacific Northwest under the U.S. Endangered Species Act. pp 152-165 *in* S. Hawkins, C. Kondzela, R. Wilmot, C. Guthrie, J. Pohl, and H. Nguyen. Proceedings of the 19th Northeast Pacific Pink and Chum Salmon Workshop, March 3-5 1999, Juneau, AK. National Marine Fisheries Service, Juneau, AK.

Johnson, T. H., R. Lincoln, G. R. Graves, and R. G. Gibbons. 1997b. Status of wild salmon and steelhead stocks in Washington State. pp 127-144, *in* D. J. Stouder, P. A. Bisson, R. J. Naiman and M. G. Duke (eds.). Pacific Salmon & Their Ecosystems. Chapman & Hall, New York, NY.

Juenemann, B. G. 1973. Habitat evaluation of selected bald eagle sites on the Chippewa National Forest. M.S. Thesis, Univ. of Minnesota, Minneapolis.

Kaiser, G. W. 1989. Nightly concentration of bald eagles at an auklet colony. Northwestern Naturalist 70:12-13.

Keister, G. P., Jr. 1981. An assessment of bald eagle communal roosting in northwestern Washington. unpubl. report submitted to Washington Dept. of Game, Olympia, WA. 39 pp.

Keister, G. P., Jr., and R. G. Anthony. 1983. Characteristics of bald eagle communal roosts in the Klamath Basin, Oregon and California. J. Wildlife Management 47:1072-1079.

Keister, G. P. Jr., R. G. Anthony, and H. R. Holbo. 1985. A model of energy consumption in bald eagles: an evaluation of night communal roosting. Wilson Bulletin 97:148-160.

Kitchin, E. A. 1934. Distributional check-list of the Birds of the State of Washington. Northwest Fauna Series No. 1:1-28. Pacific Northwest Bird and Mammal Society, Seattle, WA.

Kitchin, E. A. 1939. Distributional check-list of the birds of Mount Rainier National Park. Murrelet 20:27-37.

Kitchin, E. A. 1949. Birds of the Olympic Peninsula. Olympic Stationers, Port Angeles, WA. 262 pp.

Knight, R. L., and D. P. Anderson. 1990. Effects of supplemental feeding on an avian scavenging guild. Wildlife Society Bull. 18:388-394.

Knight, R. L., D. P. Anderson, and N. V. Marr. 1991. Reponses of an avian scavenging guild to anglers. Biological Conservation 56(1991):195-205.

Knight, R. L., R. C. Friesz, G. T. Allen, and P. J. Randolph. 1981. A summary of the mid-winter bald eagle survey in Washington. Washington Dept. of Game, Olympia. 74 pp.

Knight, R. L., and S. K. Knight. 1984. Responses of wintering bald eagles to boating activity. J. Wildlife Management 48:999-1004.

Knight, R. L., P. J. Randolph, G. T. Allen, L. S. Young, and R. J. Wigen. 1990. Diets of nesting bald eagles, *Haliaeetus leucocephalus*, in western Washington. Canadian Field-Naturalist 104:545-551.

Knight, R. L., V. Marr, and S. K. Knight. 1983. Communal roosting of bald eagles in Washington. *In* Anthony, R. G., F. B. Isaacs, and R. W. Frenzel (eds.). Proceedings of a workshop on habitat management for nesting and roosting bald eagles in the western United States. Sept. 7-9, 1983. Corvallis, OR.

Knight, S. K., and R. L. Knight. 1983. Aspects of food finding by wintering bald eagles. Auk 100:477-484.

Kramer, J. L., and P.T. Redig. 1997. Sixteen years of lead poisoning in eagles, 1980-95: an epizootiologic view. J. Raptor Research 31:327-332.

Krause, F. F., 1980. The Skagit River Bald Eagle Natural Area and the Nature Conservancy. pp75-78 *in* R. L. Knight, G. T. Allen, M. V. Stalmaster, and C. W. Servheen, eds. Proceedings of the Washington Bald Eagle Symposium, 14-15 June, 1980, Seattle, Washington, USA. 254 pp.

Lawrence, R. H., 1892. A preliminary list of the birds of the Grays Harbor region, Washington. Auk 9:39-47.

Laycock, G. 1973. Autumn of the Eagle. Charles Scribner's Son, New York, NY. 239 pp.

Leach, C. L. 1996. An analysis of habitat characteristics and diet in relation to productivity of the Hood Canal bald eagle population. Senior Thesis, University of Washington, Seattle.

Levings, C. D. and R. M. Thom. 1994. Habitat changes in Georgia Basin: implications for resource management and restoration. pp 330-349, *in* R. C. H. Wilson, R. J. Beamish, F. Aitkins, and J. Bell (eds.) Review of the marine environment and biota of Strait of Georgia, Puget Sound, and Juan de Fuca Strait: Proceedings of BC/Washington Symposium on the Marine Environment, Jan 13 & 14, 1994. Canadian Technical Report Fisheries Aquatic Science. 390 pp.

Lichatowich, J. 1999. Salmon Without Rivers. Island Press. 317 pp.

Livingston, S. A., C. S. Todd, W. B. Krohn, and R. B. Owen, Jr. 1990. Habitat models for nesting bald eagles in Maine. J. Wildlife Management 54(4):644-653.

Lord, W. R. 1913. A First Book upon the Birds of Oregon & Washington. Revised edition. J. K. Gill Co., Portland, OR. 308 + iv pp.

Mabie, D. W., M. T. Merendino, and D. H. Reid. 1994. Dispersal of bald eagles fledged in Texas. J. of Raptor Research 28:213-219.

Mahaffy, M.S., K. M. Ament, A.K. McMillan, and D. E. Tillit. 2001. Environmental contaminants in bald eagles nesting in Hood Canal, Washington, 1992-1997. Final Report, Study: 13410-1130-1F05, U. S. Fish and Wildlife Service, Olympia, Washington.

Mahaffy, M. S., D. R. Nysewander, K. Vermeer, T. R. Wahl, and P. E. Whitehead. 1994. Status, trends and potential threats related to birds in the Strait of Georgia, Puget Sound and Juan de Fuca Strait. pp 256-281 *in* R. C. H. Wilson, R. J. Beamish, F. Aitkins, and J. Bell (eds.) Review of the marine environment and biota of Strait of Georgia, Puget Sound, and Juan de Fuca Strait: Proceedings of BC/Washington Symposium on the Marine Environment, Jan 13 & 14, 1994. Canadian Technical Report Fisheries Aquatic Science. 390 pp.

Martell, M., P. Redig, J. Nibe, G. Buhl. 1991. Survival of released rehabilitated bald eagles: final report. The Raptor Center, University of Minnesota. 21 pp.

McAllister, K. R., T. E. Owens, L. Leschner, and E. Cummins. 1986. Distribution and productivity of nesting bald eagles in Washington, 1981-1985. Murrelet 67:45-50.

McClelland, B. R., L. S. Young, P. T. McClelland, J. G. Crenshaw, H. L. Allen, and D. S. Shea. 1994. Migration ecology of bald eagles from autumn concentrations in Glacier National Park, Montana. Wildlife Monograph 125.

McClelland, B. R., P. T. McClelland, and R. E. Yates. 1996. Fledging and migration of juvenile bald eagles from Glacier National Park, Montana. J. of Raptor Research 30:79-89.

McCollough, M.A. 1986. The post-fledging ecology and population dynamics of bald eagles in Maine. Ph.D. Dissert. University of Maine, Orono. 132 pp.

McGarigal, K., R. G. Anthony, F. B. Isaacs. 1991. Interactions of humans and bald eagles on the Columbia River estuary. Wildlife Monograph 115:1-47.

McKelvey, R. W. and D.W. Smith. 1979. A black bear in a Bald Eagle nest. Murrelet 60:106-107.

Mersmann, T. J., D. A. Buehler, J. D. Fraser, and J. K. D. Seegar. 1992. Assessing bias in studies of bald eagle food habits. J. Wildlife Management 56:73-78.

Miller, R. C., E. D. Lumley, and F. S. Hall. 1935. Birds of the San Juan Islands, Washington. Murrelet 16:51-65.

Moore, J. L., W. L. Hohman, T. M. Stark, and G. A.Weisbrich. 1998. Shot prevalences and diets of diving ducks five years after ban on use of lead shotshells at Catahoula Lake, Louisiana. J. Wildlife Management 62:564-569.

Morisita, M. 1965. The fitting of the logistic equation to the rate of increase of population density. Res. Population Ecology 7:52-55.

Moul, I. E. 1990. Environmental contaminants, disturbance and breeding failure at a great blue heron colony on Vancouver Island. M.S. Thesis. University of British Columbia, Vancouver, BC. 58 pp.

Munn, M. D. and S. J. Gruber. 1997. The relationship between land use and organochlorine compounds in streambed sediment and fish in the central Columbia plateau, Washington and Idaho, USA. Environmental Toxicology and Chemistry 16:1877-1887.

Murphy, J. R. 1980. The bald eagle: yesterday, today...and tomorrow? pp 15-20 *in* R. L. Knight, G. T. Allen, M. V. Stalmaster, and C. W. Servheen, eds. Proceedings of the Washington Bald Eagle Symposium, 14-15 June, 1980, Seattle, Washington, USA. 254 pp.

Murphy, M. 2000. Bald eagle nest production, Lake Roosevelt, Washington, 1987-2000. Final Report, Grant No. 1425-7-FG-10-03000, Bureau of Reclamation, USDI, Boise, ID. 13 pp.

Nash, C., M. Pruett-Jones, G. T. Allen. 1980. The San Juan Islands bald eagle nesting survey. p.105-115, *in* R. L. Knight, G. T. Allen, M. V. Stalmaster, and C. W. Servheen, eds. Proceedings of the Washington Bald Eagle Symposium, 14-15 June, 1980, Seattle, Washington, USA. 254 pp.

National Wildlife Health Laboratory. 1985. Bald Eagle mortality from lead poisoning and other causes, 1963 - 1984. unpubl. report. 48 pp + appendix.

Newton, I. 1979. Population Ecology of Raptors. Buteo Books, Vermillion, SD. 399 pp.

Nisbet, I. C. T., 1989. Organochlorines, reproductive impairment and declines in bald eagle *Haliaeetus leucocephalus* populations: mechanisms and dose-response relationships. pp. 483-489 *in* B. U. Meyburg and R. D. Chancelor, eds. Raptors in the Modern World. World Working Group on Birds of Prey and Owls. International Council for Bird Preservation. London.

NMFS (National Marine Fisheries Service). 2000. Endangered and Threatened Species: Puget Sound populations of Pacific hake, Pacific cod, and walleye pollock: notice of determination. Federal Register 65:227:70514-70521.

NMFS (National Marine Fisheries Service). 2001. Endangered and Threatened Species: Puget Sound populations of copper rockfish, quillback rockfish, brown rockfish, and Pacific herring: notice of determination of status review. Federal Register 66:64:17659-17668.

Norman, D. M., A. M. Breault, and I. E. Moul. 1989. Bald eagle incursions and predation at great blue heron colonies. Colonial Waterbirds 12:215-217.

Nysewander, D. R., and J. R. Evenson. 1998. Status and Trends for selected diving duck species examined by the Marine Bird Component, Puget Sound Ambient Monitoring Program (PSAMP). Washington Dept. of Fish and Wildlife. pp 847-867 *in* Puget Sound Research '98: from basic science to resource management. Proceedings of 4th Puget Sound Research Conference, 12-13 Mar 1998, Seattle, WA. Puget Sound Water Quality Action Team. (www.wa.gov/puget_sound).

Nysewander, D. R., J. R. Evenson, B. L. Murphie, T. A. Cyra. 2001a. Report of Marine Bird and Marine Mammal Component, Puget Sound Ambient Monitoring Program, for July 1992 to December 1999 Period (Draft). Washington Dept. of Fish and Wildlife and Puget Sound Action Team, Olympia, WA.

Nysewander, D. R., J. R. Evenson, B. L. Murphie, T. A. Cyra. 2001b. Status and trends for a suite of key diving marine bird species characteristic of greater Puget Sound, as examined by the Marine Bird Component, Puget Sound Ambient Monitoring Program (PSAMP). *Poster presentation for:* Puget Sound Research Conference, 12-14 February, Bellevue, WA. Washington Dept. of Fish and Wildlife and Puget Sound Action Team, Olympia, WA.

Olendorff, R. R, A. R. Ansell, M. G. Garrett, R. N. Lehman, A. D. Miller. 1996. Suggested practices for raptor protection on power lines: the state of the art in 1996. Avian Power Line Interaction Committee. Edison Electric Institute and the Raptor Research Foundation, Washington, DC. 125 pp + appendices.

O'Neil, T.A., D. H. Johnson, C. Barrett, M. Trevithick, K.A. Bettinger, C.Kiilsgard, M.Vander Heden, E. L. Greda, D. Stinson, B.G. Marcot, P.J. Doran, S. Tank, and L. Wunder. 2001. Matrixes for Wildlife-Habitat Relationships in Oregon and Washington: CD-Rom. *In* D. H. Johnson and T. A. O'Neil (directors). Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR. 736 pp + CD ROM.

Palmer, R. H. 1927. Birds of the Olympic Peninsula, Washington. Part II. Murrelet 8:59-70.

Parrish, J.K. 1995. Influence of group size and habitat type on reproductive success in Common Murres (*Uria aalge*). Auk 112:390-401.

Parson, W. 1992. Effects of Bald Eagle Management Plans and habitat alterations on nesting bald eagles. unpubl. rept. to Washington Dept. of Wildlife, Olympia.WA. 24 pp. + tables, appendices.

Parson, W. 1994. Relationships between human activities and nesting bald eagles in western Washington. Northwestern Naturalist 75:44-53.

Pattee, O. H., and S. K. Hennes. 1983. Bald eagles and waterfowl: the lead shot connection. Trans. North Am. Wildl. Nat. Resour. Conf. 48:230-237.

Perkins, D. W., D. M. Phillips, and D. K. Garcelon. 1996. Predation on a bald eagle nestling by a red-tailed hawk. J. Raptor Research 30:249.

Peterson, C.A., S. L. Lee, J. E. Elliott. 2001. Scavenging of waterfowl carcasses by birds in agricultural fields of British Columbia. J. Field Ornithology 72:150-159.

Porter, S. L. 1993. Pesticide poisoning in birds of prey. pp. 239-245, *in* P.T. Redig, J. E. Cooper, and D. B. Hunter (eds.) Raptor Biomedicine. Univ. Minnesota Press, Minneapolis. (*not seen, in* Elliot et al. 1996a).

Ratcliffe, D. A. 1967. Decrease in eggshell weights in certain birds of prey. Nature CCXV (July 8, 1967), 210. (*not seen, in* Laycock 1973:139).

Rathbun, S. F. 1902. A list of the land birds of Seattle, Washington, and vicinity. Auk 19:131-141.

Restani, M., A. R. Harmata, E. M. Madden. 2000. Numerical and functional responses of migrant bald eagles exploiting a seasonally concentrated food source. Condor 102:561-568.

Retfalvi, L. 1970. Food of nesting bald eagles on San Juan Island, Washington. Condor 72(3):358-361.

Robinette, R. L. and C. M. Crockett. 1999. Bald eagle predation on crows in the Puget Sound region. Northwestern Naturalist 80:70-71.

Ruediger, B., J.J. Claar, and J.F. Gore. 1999. Restoration of carnivore habitat connectivity in the northern Rocky Mountains. 20 pp. *in* G. L. Evink, P. Garrett, and D. Zeigler (eds.). Proceedings of the Third International Conference on Wildlife Ecology and Transportation (ICOWET III), 13-16 September, Missoula, MT. Florida Dept. of Transportation report FL-ER-73-99.

Schempf, P. 1997. Bald eagle longevity record from southeastern Alaska. Journal of Field Ornithology 68:150-151.

Schirato, G., and W. Parson. 1998. Bald eagle management in urbanizing habitat of Puget Sound, Washington. unpublished manuscript. 14 pp.

Science Applications International. 1996. Lake Roosevelt Bald Eagle Study: Final Report. Prepared for Bureau of Reclamation, PNW Region, Boise ID. 75 pp.

Scott, J. W., and R. L. De Lorme. 1988. Historical Atlas of Washington. University of Oklahoma Press, Norman, Oklahoma.

Seeley, R. H. and J. E. Bell. 1994. Adult harbor seal retrieves dead pup from bald eagles. Maine Naturalist 2:31-32.

Servheen, C., and W. English. 1979. Movements of rehabilitated bald eagles and proposed seasonal movement patterns of bald eagles in the Pacific Northwest. Raptor Research 13:79-88.

Sherrod, S. K., C. M. White, and F. S. L. Williamson. 1976. Biology of the bald eagle on Amchitka Island, Alaska. Living Bird 15:143-182.

Skagen, S. K., R. L. Knight, and G. H. Orians. 1991. Human disturbance of an avian scavenging guild. Ecological Applications 1:215-225.

Solomon, S., and T. Newlon. 1991. Living with Eagles: status report and recommendations. Northwest Renewable Resource Center. 48 pp.

Sorenson, K. 1995. Ventana Wilderness Sanctuary bald eagle restoration program. Ventana Wilderness Sanctuary, Research and Education Center, Monterey, CA.

Spofford, W. R. 1969. Problems of the Golden Eagle in North America. pp 345-347 in J. J. Hickey. Peregrine Falcon Populations: their biology and decline. University of Wisconsin Press, Madison, WI.

Sprunt, A., IV. 1969. Population trends of the bald eagle in North America. pp 347-351, *in* J. J. Hickey. Peregrine Falcon Populations: their biology and decline. University of Wisconsin Press, Madison, WI.

Sprunt, A., IV, W. B. Robertson, Jr., S. Postupalsky, R. J. Hensel, C. E. Knoder, F. J. Ligas. 1973. Comparative productivity of six bald eagle populations. Transactions of the North American Wildlife and Natural Resources Conference 38:96-106.

Stalmaster, M. V. 1981. Ecological energetics and foraging behavior of wintering bald eagles. Ph.D. Thesis, Utah State Univ., Logan. 157 pp.

Stalmaster, M. V. 1983. An energetics simulation model for managing wintering bald eagles. J. Wildlife Management 47:349-359.

Stalmaster, M. V. 1987. The Bald Eagle. Universe Books. New York. 227 pp.

Stalmaster, M. V., R. L. Knight, B. L. Holder, and R. J. Anderson. 1985. Bald Eagles. Chapter 13, *in* E. R. Brown (ed.). Management of Wildlife and Fish Habitats in Forests of Western Oregon and Washington. Part 1: chapter narratives. USDA Forest Service, PNW Region.

Stalmaster, M. V., and J. A. Gessaman. 1984. Ecological energetics and foraging behavior of overwintering bald eagles. Ecological Monographs 54:407-428.

Stalmaster, M. V., and J. R. Newman. 1978. Behavioral responses of wintering bald eagles to human activity. J. Wildlife Management 42:506-513.

Stalmaster, M. V., and J. R. Newman. 1979. Perch-site preferences of wintering bald eagles northwest Washington. J. Wildlife Management 43(1):1979.

Stalmaster, M. V. and J. L. Kaiser. 1997a. Winter ecology of bald eagles in the Nisqually River drainage, Washington. Northwest Science 71:214-223.

Stalmaster, M. V. and J. L. Kaiser. 1997b. Flushing responses of wintering bald eagles to military activity. J. of Wildlife Management 61:1307-1313.

Stalmaster, M. V. and J. L. Kaiser. 1998. Effects of recreational activity on wintering bald eagles. Wildlife Monograph 137.

Stalmaster, M. V. and R. G. Plettner. 1992. Diets and foraging effectiveness of bald eagles during extreme winter weather in Nebraska. J. of Wildlife Management 56:355-367.

Stefanek, P. R., W. W. Bowerman, IV, T. G. Grubb, and J. B. Holt Jr. 1992. Nestling red-tailed hawk in occupied bald eagle nest. J. Raptor Research 26:40-41.

Steidl, R. J., and R. G. Anthony. 1996. Responses of bald eagles to human activity during the summer in interior Alaska. Ecological Applications 6:482-491.

Steidl, R. J., and R. G. Anthony. 2000. Experimental effects of human activity on breeding eagles. Ecological Applications 10:258-268.

Steidl, R. J., K. D. Kozie, and R. G. Anthony. 1997. Reproductive success of bald eagles in interior Alaska. J. of Wildlife Management 61:1313-1321.

Stellini, J. 1987. Microclimate monitoring and protection policies of a deciduous bald eagle communal roost in Skagit County, Washington. Thesis, Evergreen State College, Olympia, WA.

Suckley, G. and J. G. Cooper. 1860. The natural history of Washington Territory and Oregon. Bailliere Bros., New York, NY. 399 pp.

Sweeney, S. J., K. E. Neiman, T. R. Strong, and V. L. Artman. 1992. Bald Eagle Monitoring, 1989-1991. [Summary Report for METRO West Point Secondary Treatment Facilities]. Parametrix, Inc. prepared for METRO, Seattle. 38 pp.

Swenson, J. E., K. L. Alt, and R. L. Eng. 1986. Ecology of bald eagles in the Greater Yellowstone Ecosystem. Wildlife Monograph 95.

Taylor, P. 1992. Bald eagles steal fish from river otters. Blue Jay 50(4):223-224.

Taylor, R. H. 1988. Washington State Midwinter Bald Eagle Survey Results for 1988. Washington Dept. of Fish and Wildlife, Olympia, WA. 60 pp.

Taylor, R. H. 1989. Washington State Midwinter Bald Eagle Survey Results for 1989. Washington Dept. of Fish and Wildlife, Olympia, WA. 31 pp.

Taylor, W. P., and W. T. Shaw. 1927. Mammals and birds of Mount Rainier National Park. U.S. Gov. Printing Office, Washington, D.C., 249 pp.

Therres, G. D., M. A. Byrd, D. S. Bradshaw. 1993. Effects of development on nesting bald eagles: case studies for Chesapeake Bay. Trans. North American Wildlife & Natural Resources Conf. 58:62-69.

Therres, G. D. and S. K. Chandler. 1993. Ospreys use bald eagle nests in Chesapeake Bay area. J. Raptor Research 27:217-218.

Thomas, C. M., 1997. Environmental contaminants and breeding biology of great blue herons in the Columbia River Basin. M.S. Thesis, Oregon State University, Corvallis, OR.

Thompson, P. 1998. Crows may cause abandonment and failure of urban Bald Eagle nests. WOSNews 57:1, 11.(Washington Ornithological Society, Seattle).

Thompson, S. P. 1989. Observations of bald eagles eating glaucous-winged gull eggs in western Washington. Northwestern Naturalist 70:13-14.

USFWS [Department of the Interior, Fish and Wildlife Service]. 1986. Pacific Bald Eagle Recovery Plan. U.S. Fish and Wildlife Service, Portland, OR. 163 pp.

USFWS [Department of the Interior, Fish and Wildlife Service]. 1978. Determination of certain Bald Eagle populations as Endangered or Threatened: Final rulemaking. Federal Register Vol. 43 No.31(14 February):6230-6233.

USFWS [Department of the Interior, Fish and Wildlife Service]. 1994. Proposed rule to reclassify the bald eagle from Endangered to Threatened in most of the lower 48 states. Federal Register Vol. 59 No.132 (12 July):35584-35594.

USFWS [Department of the Interior, Fish and Wildlife Service]. 1999. Proposed rule to remove the bald eagle in the lower 48 states from the list of endangered and threatened wildlife. Federal Register Vol. 64 No.128 (6 July):36454-36464.

Utzinger, D. R., P. Reed, C. E. Vandemoer, N. Paine-Donovan, L. Egtvedt, and W. D. Cole. 1993. Biological Evaluation - Evaluating the effects on listed and sensitive species from issuance of winter season special use permits on the Skagit Wild and Scenic River system. Unpubl. Rept., Mt Baker-Snoqualmie National Forest, Montlake Terrace, WA. 46 pp. + appendices.

Van Name, W. G. 1921. Threatened extinction of the bald eagle. Ecology 2:76-78.

Vermeer, K., and K. H. Morgan. 1989. Nesting population, nest sites, and prey remains of bald eagles in Barkley Sound, British Columbia. Northwestern Naturalist 70:21-26.

Ward, P. and A. Zahavi. 1973. The importance of certain assemblages of birds as “information centres” for food-finding. Ibis 115:517-534.

Warheit, K. I. 1998. Common Murre (*Uria aalge*). Management Recommendations for Priority Habitats and Species. Volume IV: Birds. Washington Dept. of Fish and Wildlife, Olympia, WA.

Waterbury, B. 2000. An analysis of Washington State management plans for the bald eagle. Washington Dept. of Fish and Wildlife, Olympia, WA. unpublished report. 16 pp.

Watson, J. W., M. Davison, and L. L. Leschner. 1993. Bald eagles rear red-tailed hawks. J. Raptor Research 27:126-127.

Watson, J. W., M. G. Garrett, and R. G. Anthony. 1991. Foraging ecology of bald eagles in the Columbia River estuary. J. Wildlife Management 55(3):492-499.

Watson, J. W., and B. Cunningham. 1996. Another occurrence of bald eagles rearing a red-tailed hawk. Washington Birds 5:51-52.

Watson, J. W., D. Mundy, J. S. Begley, and D. J. Pierce. 1995. Responses of nesting bald eagles to the harvest of geoduck clams. Final Report. Washington Dept. of Fish and Wildlife, Olympia, WA.

Watson, J. W., and D. J. Pierce. 1998a. Ecology of bald eagles in western Washington with an emphasis on the effects of human activity. Final Report. Washington Dept. of Fish and Wildlife, Olympia, WA.

Watson, J. W., and D. J. Pierce. 1998b. Migration, diets, and home ranges of bald eagles breeding along Hood Canal and at Indian Island, Washington. Final Report. Washington Dept. of Fish and Wildlife, Olympia, WA.

Watson, J. W., and D. J. Pierce. 2001. Skagit River Bald Eagles: movements, origins, and breeding population status. Final Report. Washington Dept. of Fish and Wildlife, Olympia, Washington. 80 pp.

Watson, J. W., D. J. Pierce, and B. Cunningham. 1999. An active bald eagle nest associated with unusually close human activity. Northwestern Naturalist 80:71-74.

Watt, J., B. Krausse, and T. M. Tinker. 1995. Bald eagles kleptoparasitizing sea otters at Amchitka Island, Alaska. Condor 97:588-590.

Wayland, M., and T. Bollinger. 1999. Lead exposure and poisoning in bald eagles and golden eagles in the Canadian prairie provinces. Environmental Pollution 104:341-350.

WDF et al. (Washington Dept. of Fisheries, Washington Dept. of Wildlife, and Western Washington Treaty Indian Tribes). 1993. 1992 Washington State Salmon and Steelhead Stock Inventory (SASSI). [summary report].Olympia, WA. 212 pp.

WDFW and ODFW (Washington Dept. of Fish and Wildlife and Oregon Dept. of Fish and Wildlife). 1999. Status Report: Columbia River Fish Runs and Fisheries, 1938-1998. 302 pp.

WDFW (Washington Dept. of Fish and Wildlife) and Western Washington Treaty Indian Tribes. 1994a. 1992 Washington State Salmon and Steelhead Stock Inventory. Appendix 1, Puget Sound Stocks, South Puget Sound Volume. Olympia, WA. 371 pp.

WDFW (Washington Dept. of Fish and Wildlife) and Western Washington Treaty Indian Tribes. 1994b. 1992 Washington State Salmon and Steelhead Stock Inventory. Appendix 1, Puget Sound Stocks, North Puget Sound Volume. Olympia, WA. 418 pp.

WDNR (Washington Dept. of Natural Resources). 1998. Our Changing Nature: Natural Resource Trends in Washington State. 75 pp.

WDOE (Washington Dept. of Ecology). 2000. Proposed Shoreline Master Program Guidelines, Rule Amendment (WAC 173-26, Part III and Part IV): Final Environmental Impact Statement. Publication 00-06-020. Shorelands and Environmental Assistance Program, Washington Dept. of Ecology, Olympia, WA. 144 pp.

Wells, P., J. G. Woods, G. Bridgewater, and H. Morrison. 1999. Wildlife mortalities on railways: monitoring methods and mitigation strategies. 11 pages *in*, G. L. Evink, P. Garrett, and D. Zeigler (eds.). Proceedings of the Third International Conference on Wildlife Ecology and Transportation (ICOWET III), 13-16 September, Missoula, MT. Florida Dept. of Transportation report FL-ER-73-99.

West, J. E. 1997. Protection and Restoration of Marine Life in the Inland Waters of Washington State. Puget Sound/Georgia Basin Environmental Report Series No. 6. Puget Sound Water Quality Action Team. 144 pp.

Wheeler, B. K., and W. S. Clark. 1995. A Photographic Guide to North American Raptors. Academic Press. San Diego, California. 198 pp.

White, C. M., R. J. Ritchie, B. A. Cooper. 1995. Density and productivity of bald eagles in Prince William Sound, Alaska, after the *Exxon Valdez* oil spill. pp 762- 776 *in* P. G. Wells, J. N. Butler, and J. S. Hughes (eds.). Exxon Valdez oil spill: fate and effects in Alaskan waters. American Society for Testing and Materials, Philadelphia, PA.

Willson, M. F., and K.C. Halupka. 1995. Anadromous fish as keystone species in vertebrate communities. Conservation Biology 9:489-497.

Wilson, U. W. 1991. Responses of three seabird species to El Niño events and other warm water episodes on the Washington coast, 1979-1990. Condor 93: 853-858.

Witmer, G., and T. A. O'Neil. 1990. Assessing cumulative impacts to wintering bald eagles in western Washington. pp 144-150 *in* Ecosystem Management: rare species and significant habitats. New York State Museum Bulletin 471.

Wood, B. 1979. Winter ecology of bald eagles at Grand Coulee Dam, Washington. Applied Research Bulletin No. 15. Washington Dept. of Game. 27 pp.

Wood, P. B., and M. W. Collopy. 1995. Population ecology of subadult southern bald eagles in Florida: post-fledging ecology, migration patterns, habitat use, and survival. Final Report. Nongame Wildlife Program, Florida Game and Fresh Water Fish Commission, Tallahassee.

Wydoski, R. S., and R. R. Whitney. 1979. Inland Fishes of Washington. University of Washington Press, Seattle. 220 pp.

Young, L. S. 1980. A quantitative evaluation of human disturbance impacts on breeding ecology of bald eagles in the San Juan Islands, Washington. Final Report. Presented to Washington Department of Game, Olympia, WA.

PERSONAL COMMUNICATIONS

Shelly Ament
Endangered Species Biologist
Washington Dept. of Fish and Wildlife
Montesano, Washington

Jim Ames
Pink/Chum/Sockeye Program Manager
Washington Dept. of Fish and Wildlife
Olympia, Washington

David Anderson
District Wildlife Biologist
Washington Dept. of Fish and Wildlife
Trout Lake, Washington

Karen Bedrossian
Wildlife Biologist
Snohomish Public Utility District
Everett, Washington

Pete Castle
Fish & Wildlife Biologist
Washington Dept. of Fish and Wildlife
LaConner, Washington

Tom Chisdock
Special Agent
U.S. Fish and Wildlife Service
Bellingham, Washington

Paul Fielder
Chelan County PUD
Wenatchee, Washington

Stephanie Garlichs, DVM
Oak Harbor, Washington

Monte Garrett
Pacific Power
Portland, Oregon

Frank Isaacs
Cooperative Wildlife Research Unit
Oregon State University
Corvallis, Oregon

Mary Mahaffy
U.S. Fish and Wildlife Service
Lacey, Washington

Steve Negri
Wildlife Biologist
Foster-Wheeler Environmental
Bellevue, Washington

Donald Norman
Norman Wildlife Consulting
Shoreline, Washington

Al Rammer
Conservation Education Program Specialist
Washington Dept. of Fish and Wildlife
Montesano, Washington

Peter Sharpe
Institute for Wildlife Studies
Avalon, California

Mark Stalmaster
Consulting Wildlife Biologist
Port Townsend, Washington

Mel Walters
GeoSciences
Redmond, Washington

Dennis Wiist
U.S. Fish and Wildlife Service,
National Eagle Repository
Denver, Colorado

Ulrich Wilson
U.S. Fish and Wildlife Service
Coastal Refuges Office
Sequim, Washington

Appendix A. Formulas for estimation of Carrying Capacity (K) and Moffat's Equilibrium.

Carrying Capacity - If a population is growing toward a steady ecological carrying capacity, and three or more years of estimates of population size (N) are available, then the carrying capacity (K) and maximum intrinsic growth rate (r_m) can be calculated by regression (Caughley 1977). This is based on Morisita (1965), who demonstrated that during logistic growth N_{t+1}-Nt/Nt is linear on N_{t+1} (where N = population size and t = time). The regression equation is in the form N_{t+1} - Nt/Nt = a-bN_{t+1}, where a = e^{rm} - 1 and b = a/K.

Moffat's Equilibrium - Equilibrium population values can be obtained from simple equations if one assumes annual constancy in vital rates, and therefore a stable age distribution (Hunt 1998). The total number or adults (A) at equilibrium can be calculated algebraically:

$$A = Cjs^v + Cjs^va + Cjs^va^2 + ... + Cjs^va^{w-1} = (Cjs^v(1-a^w))/(1-a)$$

where: C = the annual cohort fledging,
j = juvenile survival rate,
s = subadult survival rate,
v = number of years of subadulthood (after the juvenile year),
a = adult survival rate, and
w = maximum number of years of adulthood.

The number of nonadults at fledging time is:

$$Y = C(1+j(1+s+s^2+...s^{v-1}))$$

Appendix B. Bald eagles counted during the January Midwinter Bald Eagle Survey, 1982 - 1989 (Taylor 1989).

Drainage or Area	1982	1983	1984	1985	1986	1987	1988	1989
Cedar River	.	0	0	.	0	5	6	5
Chehalis River	9	7	21	18	17	20	22	21
Columbia R. (lower)	19	19	30	37	31	49	43	61
Columbia R. (middle)	148	91	154	193	148	123	161	114
Columbia R. (upper)	50	89	73	118	172	128	202	165
Cowlitz River	4	11	19	13	13	20	11	23
Dungeness River	13	8	7	4	4	8	5	4
Green River	2	1	6	5	4	4	7	1
Hamma Hamma River	10	6	23	15	12	17	32	16
Hoh River	5	7	3	4	2	5	16	6
Humptulips River	26	22	19	40	18	12	18	19
Kettle River	.	0	3	0	0	10	11	7
Klickitat River	7	4	13	13	11	14	6	11
Lewis River	13	27	14	5	14	14	10	24
Methow River	4	4	7	4	4	6	6	4
Okanogan River	2	13	6	4	3	10	16	13
Nisqually River	20	16	12	21	18	15	25	40
Nooksack River	80	185	194	219	88	157	227	333
Pacific Ocean coast	47	36	43	49	21	29	66	79
Pend Oreille River	15	13	11	5	15	25	8	14
Puget Sound (north)	396	222	411	365	292	345	384	472
Puget Sound (south)	63	54	81	110	97	128	139	170
Puyallup River	3	0	4	15	9	10	13	19
Queets River	.	.	.	.	1	0	3	0
Quillayute River	6	5	9	12	16	12	53	20
Quinault River	17	44	41	45	45	49	49	68
Skagit River	174	147	81	284	179	371	463	665
Skokomish River	5	4	0	1	7	0	17	45
Skykomish River	70	37	45	46	27	9	19	73
Snake River	1	5	7	9	16	19	12	13
Snohomish River	.	0	0	2	2	8	4	2
Snoqualmie River	1	3	2	4	1	5	4	8
Spokane River	20	24	25	18	9	12	36	15
Stillaguamish River	16	8	13	11	5	42	78	82
Strait of Juan de Fuca	17	7	53	39	21	20	50	80
Toutle River	.	0	0	5	6	2	17	4
Wenatchee River	6	1	7	3	2	2	4	2
White Salmon	3	1	3	3	1	6	3	7
Willapa River	3	1	3	2	4	1	12	11
Yakima River	5	3	31	32	18	27	36	39
Other areas	97	31	68	55	35	56	79	115
Statewide Total	**1377**	**1156**	**1542**	**1828**	**1388**	**1795**	**2373**	**2870**

Appendix C. Number of bald eagle management plans by county, September 2000.

County	No. of plans	Percent of total
Island	477	41.4
Kitsap	117	10.2
San Juan	105	9.1
Jefferson	89	7.7
Clallam	79	6.9
Mason	59	5.1
Skagit	43	3.7
Whatcom	37	3.2
Pierce	34	3.0
Thurston	22	1.9
Snohomish	16	1.4
King	10	1.7
Lewis	7	0.6
Clark	6	0.5
Pacific	6	0.5
Pend Oreille	6	0.5
Wahkiakum	6	0.5
Grays Harbor	6	0.5
Ferry	5	0.4
Cowlitz	4	0.3
Stevens	3	0.3
Benton	1	0.1
Grant	1	0.1
Klickitat	1	0.1
Skamania	1	0.1
Spokane	1	0.1
Total	**1,154**	**100.0**

Appendix D. Ownership of 822 bald eagle nest trees by county

County	No. Private	No. Public	Total	% Total
Clallam	51	66	117	14.23
San Juan	78	24	102	12.41
Island	61	11	72	8.76
Jefferson	30	37	67	8.15
Skagit	43	14	57	6.93
Kitsap	38	6	44	5.47
Whatcom	24	15	39	4.74
Grays Harbor	16	18	34	4.14
Snohomish	24	8	32	3.89
King	24	7	31	3.77
Pierce	19	11	30	3.65
Mason	17	6	23	2.80
Pacific	14	7	21	2.55
Ferry	1	17	18	2.19
Lewis	17	1	18	2.19
Thurston	14	4	18	2.19
Cowlitz	16	1	17	2.07
Pend Oreille	11	3	14	1.70
Wahkiakum	11	2	13	1.58
Clark	9	2	11	1.34
Lincoln	1	7	8	0.97
Okanogan	4	3	7	0.85
Douglas	5	1	6	0.73
Stevens	5	1	6	0.73
Spokane	5	0	5	0.61
Skamania	0	4	4	0.49
Grant	1	1	2	0.24
Klickitat	1	1	2	0.24
Benton	0	1	1	0.12
Chelan	0	1	1	0.12
Kittitas	0	1	1	0.12
Yakima	0	1	1	0.12
Total	540	282	822[a]	100
percent	65.7	34.3	100	

[a] Nest trees of territories active in at least 1 year since 1995; analysis based on ownership of 10 ft radius buffer on point data.

Appendix E. Ownership of land within 817 bald eagle territories by county

County	Total No.	Public			Private			
		100%	>70%	>50%	≥50%	≥70%	≥90%	100%
Clallam	118	46	58	64	54	49	41	37
San Juan	102	7	15	17	85	76	69	51
Island	70	2	8	9	61	59	56	51
Jefferson	66	24	33	34	32	28	26	22
Skagit	57	6	8	13	44	43	39	31
Kitsap	44	2	3	6	38	32	26	25
Whatcom	39	10	12	14	25	24	21	16
Grays Harbor	34	13	17	18	16	14	12	7
Snohomish	31	5	6	7	24	24	23	23
Pierce	31	6	10	11	20	20	17	16
King	30	1	3	7	23	22	20	17
Mason	21	3	3	3	18	16	14	14
Pacific	21	3	6	6	15	14	12	10
Ferry	18	14	15	16	2	1	0	0
Lewis	18	0	0	0	18	18	17	14
Thurston	18	0	1	3	14	14	14	12
Cowlitz	17	0	0	1	16	14	14	13
Pend Oreille	14	1	2	2	12	11	9	8
Wahkiakum	13	1	2	3	10	9	9	7
Clark	11	0	3	3	8	7	4	4
Lincoln	8	0	4	8	0	0	0	0
Okanogan	7	1	3	3	4	3	3	1
Douglas	6	0	0	0	5	2	0	0
Stevens	6	1	1	1	5	5	5	5
Spokane	5	0	1	1	4	4	4	4
Skamania	4	1	3	3	1	0	0	0
Grant	2	1	1	1	1	1	0	0
Klickitat	2	1	1	1	1	1	1	1
Benton	1	1	1	1	0	0	0	0
Chelan	1	1	1	1	0	0	0	0
Kittitas	1	0	0	0	1	0	0	0
Yakima	1	0	0	1	0	0	0	0
Total	817	152	182	219	557	510	456	389
Percent	100	18.6	22.3	26.8	68.2	62.4	55.8	47.6

[a] Territories active in at least 1 year since 1995; territories defined as ½ mi radius of nest for analysis.

Appendix F. County regulations and review of projects affecting bald eagle habitats and State Threatened, Sensitive, or PHS species[a].

County	No. nests private[b]	WA Threat[c]	WA Sens. or PHS[d]	WAC[e]	County review[f]	WDFW review[g]
Benton	0	yes	yes	no	yes	yes; usually
Chelan	0	yes	yes	no	yes	yes; usually
Clallam	51	yes	yes	yes	yes	yes; always
Clark	9	yes	yes	no	yes	yes; usually
Cowlitz	16	yes	yes	no	yes, SEPA only	no; -
Douglas	5	no	yes	no	yes	yes: usually
Ferry	1	yes	yes	no	not known	yes; usually
Grant	1	no	yes	no	yes	yes; usually
Gray's Harbor	16	no	no	no	yes	yes; usually
Island	61	yes	yes	yes	yes	yes; usually
Jefferson	30	no	yes	no	yes	yes; usually
King	24	yes	yes	no	yes	yes; usually
Kitsap	38	yes	yes	yes	yes	yes; usually
Kittitas	0	yes	yes	no	yes	yes; sometimes
Klickitat	1	no	no	no	yes	yes; usually
Lewis	17	yes	yes	yes	yes	yes; always
Lincoln	1	yes	yes	no	yes	yes; usually
Mason	17	yes	yes	no	yes	yes; always
Okanogan	4	yes	no	yes	yes	yes; almost always
Pacific	14	yes	yes	yes	yes	yes; always
Pend Oreille	11	no	yes	no	yes	yes; unkn., usually?
Pierce	19	yes	yes	no	yes	yes; always
San Juan	78	no	no	yes	yes	yes; always
Skagit	43	yes	yes	yes	yes	yes; always
Skamania	0	yes	yes	no	-[h]	-[h]
Snohomish	24	no	no	no	yes, use DFW standards	no; -
Spokane	5	no	yes	yes	yes	yes; usually
Stevens	5	yes	yes	no	yes	yes; usually
Thurston	14	no	yes	no	yes	yes; always
Whakiakum	11	yes	yes	no	yes	yes; always
Whatcom	24	yes	yes	yes	yes, uses DFW standards	no; -
Yakima	0	no[i]	no[i]	no	SEPA rev.only	no: -

[a] County information was compiled from phone interviews with county staff conducted in February 2001 and selective review of county ordinances; County staff responses did not always agree with existing ordinances.
[b] Number of bald eagle nests (817 nests used most recently) on private lands.
[c] Does the county require regulatory review of activities affecting State Threatened species by their critical area ordinance?
[d] Does the county require regulatory review for state Sensitive or PHS species by their critical area ordinance?
[e] Is the state Bald Eagle WAC referenced specifically in the critical area ordinance?
[f] Does the county conduct a review of activities potentially affecting critical wildlife habitats?
[g] Does the county seek WDFW review of activities affecting eagles or critical wildlife habitats? Frequency that county requires the project follow WDFW recommendations?
[h] According to Skamania County staff, no projects have affected threatened or sensitive wildlife species or habitats.
[i] In Yakima County, regulations only apply to species occurring in wetlands, not protected in other habitats.

Appendix G. Sample calculations of chum salmon escapement needs for a hypothetical river drainage population goal of 300 wintering bald eagles (*based on* Stalmaster 1981).

This is a simplified calculation of chum salmon escapement needed for a hypothetical winter population goal of 300 bald eagles for a river drainage.

Hypothetical population goal for the river: 300 bald eagles.
Average time spent on the river: 24-40 days (Watson and Pierce 2001). Therefore,
300 eagles X 24-40 = 7,200- 12,000 eagle-days.

Figure 19. Predicted carrying capacity based on chum salmon escapement assuming all other variables are constant (Stalmaster 1981).

Each chum salmon added to escapement results in an additional 0.657 eagle days of carrying capacity (Fig. 19; Stalmaster 1981). This is based on the following assumptions:
----average daily eagle food requirement is 486.3 g;
----chum carcasses take 2 weeks to decompose;
----5.9% of chum carcasses are lost to competing species;
----14% of carcasses become available to eagles (Hunt and Johnson 1981).

The needed escapement for 300 wintering eagles would be:

chum escapement X 0.657 = capacity goal, or
chum escapement X 0.657 = 7,200 - 12,000 eagle days =
chum escapement = 7,200/0.657 to 12,000/0.657 =
chum escapement needed = 10,958 - 18,265

Note: The model assumes chum salmon provide 100% of prey of wintering eagles. Separate regression statistics can be applied to include coho salmon as potential prey (Stalmaster 1981). Stalmaster (1981) reported that the most important variables were carcass availability and chum salmon escapement. Carcass availability was set at 14% based on 214 marked carcasses that were monitored in the Skagit River by Hunt and Johnson (1981). They assumed that carcasses stranded on bars and in shallow water would be available to eagles. Other variables included decomposition rate, coho escapement, competition with other species (coyotes, crows, gulls, and bears), and factors that affect energy expenditure. Energy demands are affected by distance to roost site, the quality of roost site, the frequency of avoidance flights resulting from human disturbance, and weather.

Appendix H. State Bald Eagle Protection Law and Rules: Revised Code of Washington 77.12.650 & 655 and Washington Administrative Codes 232-12-292.

RCW 77.12.650
Protection of bald eagles and their habitats -- Cooperation required.

The department shall cooperate with other local, state, and federal agencies and governments to protect bald eagles and their essential habitats through existing governmental programs, including but not limited to:

(1) The natural heritage program managed by the department of natural resources under chapter 79.70 RCW;

(2) The natural area preserve program managed by the department of natural resources under chapter 79.70 RCW;

(3) The shoreline management master programs adopted by local governments and approved by the department of ecology under chapter 90.58 RCW.

[1987 c 506 §§ 52; 1984 c 239 §§ 2.]

NOTES: Legislative findings and intent -- 1987 c 506: See note following RCW 77.04.020.

Legislative declaration -- 1984 c 239: "The legislature hereby declares that the protection of the bald eagle is consistent with a societal concern for the perpetuation of natural life cycles, the sensitivity and vulnerability of particular rare and distinguished species, and the quality of life of humans." [1984 c 239 §§ 1.]

RCW 77.12.655
Habitat buffer zones for bald eagles -- Rules.

The department, in accordance with chapter 34.05 RCW, shall adopt and enforce necessary rules defining the extent and boundaries of habitat buffer zones for bald eagles. Rules shall take into account the need for variation of the extent of the zone from case to case, and the need for protection of bald eagles. The rules shall also establish guidelines and priorities for purchase or trade and establishment of conservation easements and/or leases to protect such designated properties. The department shall also adopt rules to provide adequate notice to property owners of their options under RCW 77.12.650 and this section.

[2000 c 107 §§ 228; 1990 c 84 §§ 3; 1984 c 239 §§ 3.]

NOTES: Legislative declaration -- 1984 c 239: See note following RCW 77.12.650.

WAC 232-12-292 Bald eagle protection rules.

Purpose

1.1 The purpose of these rules is to protect the habitat and thereby increase and maintain the population of the bald eagle so that the species no longer is classified as threatened or endangered in Washington state. The "delisting" of the bald eagle for Washington state is a realistic goal which can best be accomplished by promoting cooperative efforts to manage for site-specific eagle habitat needs through a process which is sensitive to the site-specific landowner goals as well. The following rules are designed to promote such cooperative management.

Authority

2.1 These rules are promulgated pursuant to RCW 77.12.655.

Definitions

3.1 "Communal roost site" means all of the physical features surrounding trees used for night roosting that are important to the suitability of the roost for eagle use. These features include flight corridors, sources of disturbance, trees in which eagles spend the night, trees used for perching during arrival or departure and other trees or physical features, such as hills, ridges, or cliffs that provide wind protection.

3.2 "Cultural activities" means activities conducted to foster the growth of agricultural plants and animals.

3.3 "Delist" means to remove a species from the state special species list by action of the game commission or from the federal endangered species list by action of the secretary of the interior.

3.4 "Department" means department of game.

3.5 "Endangered" means a species which is seriously threatened with extirpation throughout all or a significant portion of its range within Washington.

3.6 "Government entities" means all agencies of federal, state and local governments.

3.7 "Landowner" means any individual, private, partnership, nonprofit, municipal, corporate, city, county, or state agency or entity which exercises control over a bald eagle habitat whether such control is based on legal or equitable title, or which manages or holds in trust land in Washington state.

3.8 "Nest tree" means any tree that contains a bald eagle nest or has contained a nest.

3.9 "Nest site" means all of the physical features surrounding bald eagle nests that are important to normal breeding behavior. These features include alternate and potential nest trees, perch trees, vegetative screening, foraging area, frequently used flight paths, and sources of disturbance.

3.10 "Perch tree" means a tree that is consistently used by eagles. It is often close to a nest or feeding site and is used for resting, hunting, consumption of prey, mating display and as a sentry post to defend the nest.

3.11 "Predacides" means chemicals used to kill or control problem wildlife.

3.12 "Region" means an ecological/geographic area that forms a unit with respect to eagles, e.g., Hood Canal, lower Columbia River, outer coast and south Puget Sound.

3.13 "Site management plan" means a legal agreement between the department and the landowner for management of a bald eagle nest or roost site.

3.14 "Threatened" means a species that could become endangered within Washington without active management or removal of threats.

Applicability and operation

4.1 The department of game shall make available to other governmental entities, interest groups, landowners and individuals information regarding the location and use pattern of eagle nests and communal roosts.

4.2 The department of game shall itself and through cooperative efforts (such as memoranda of understandings) work with other government agencies and organizations to improve the data base for nest and roost site activity and productivity. The department regularly shall confer with other governmental entities to improve the preliminary nest site management information and its accessibility and useability.

4.3 The department's goal shall be to identify, catalog and prioritize eagle nesting or roost sites. The department shall facilitate landowner notification that nesting or roost sites exist on their property and work with landowners to develop a nesting or roost site description.

4.4 When a proposed land-use activity involves land containing or adjacent to an eagle nest or communal roost, the permitting agency shall immediately notify the department of game of the permit application.

4.5 When the department determines that a proposed activity would adversely impact eagle habitat, a department representative shall meet on-site with the landowner and, where applicable, a representative of the permitting agency to discuss management options for the protection of eagle habitat. The purpose of these discussions shall be to reach agreement on a site management plan for bald eagle habitat protection.

4.6 It is recognized that normal on-going agricultural activities of land preparation, cultivating, planting, harvesting, other cultural activities, grazing and animal-rearing activities in existing facilities do not have significant adverse consequences for eagles and therefore do not require a site management plan. New building construction, conversion of lands from agriculture to other uses, application of predacides and aerial pesticide spraying, may, following a conference with the department of game, be subject to the site management planning process described in these rules.

4.7 Emergency situations, such as insect infestation of crops, requires immediate action on the site management plan or special permission to address the impending crisis by the department of game.

Site management plan for bald eagle habitat protection

5.1 The purpose of the site management plan is to provide for the protection of specific bald eagle habitat in such a way as to recognize the special characteristics of the site and the landowner's property rights, goals and pertinent options. To this end, every land owner shall have fair access to the process including available incentives and benefits. Any relevant factor shall be considered, including, but not limited to, the following:

5.1.1 The status of the eagle population in the region.

5.1.2 The useful life of the nest or roost trees and condition of the surrounding forest; the topography; accessibility and visibility; and existing and alternative flight paths, perch trees, snags and potential alternative nest and roost trees.

5.1.3 Eagle behavior and historical use patterns, available food sources, and vulnerability to disturbance.

5.1.4 The surrounding land-use conditions, including degree of development and human use.

5.1.5 Land ownership, landowner ability to manage, and flexibility of available landowner options.

5.1.6 Appropriate and acceptable incentive mechanisms such as conservation easements, transfer or purchase of development rights, leases, mutual covenants, or land trade or purchase.

5.1.7 Published recommendations for eagle habitat protection of other government entities such as the U.S. Fish and Wildlife Service.

5.2 The site management plan shall provide for

5.2.1 Tailoring the timing, duration or physical extent of activities to minimize disturbance to the existing eagle habitat and, where appropriate, identifying and taking steps to encourage and create alternative eagle habitat; and

5.2.2 Establishing a periodic review of the plan to monitor whether:

a) The plan requires amendment in response to changing eagle and landowner circumstances

b) The terms of the plan comply with applicable laws and regulations,

c) c)The parties to the plan are complying with its terms.

5.3 The site management plan may also provide for implementing landowner incentive and compensation mechanisms through which the existing eagle habitat can be maintained or enhanced.

Guidelines for acquisition of bald eagle habitat

6.1 Real property interests may be acquired and agreements entered into which could enhance protection of bald eagle habitat. These include fee simple acquisition, land trades, conservation easements, transfer or purchase of development rights, leases, and mutual covenants. Acquisition shall be dependent upon having a willing seller and a willing buyer. Whatever interest or method of protection is preferable will depend on the particular use and ownership characteristics of a site. In discussing conservation objectives with private or public landowners, the department shall explore with the landowner the variety of protection methods which may be appropriate and available.

6.2 The following criteria and priorities shall be considered by the department when it is contemplating acquiring an interest in a bald eagle habitat.

6.2.1 Site considerations:

a) Relative ecological quality, as compared to similar habitats

b) Ecological viability -- the ability of the habitat and eagle use to persist over time

c) Defensibility -- the existence of site conditions adequate to protect the eagle habitat from unnatural encroachments

d) Manageability -- the ability to manage the site to maintain suitable eagle habitat

e) Proximity to food source

f) Proximity to other protected eagle habitat

g) Proximity to department land or other public land

h) Eagle population density and history of eagle use in the area

i) The natural diversity of native species, plant communities, aquatic types, and geologic features on the site.

6.2.2 Other considerations

a) Ownership

b) Degree of threat

c) Availability of funding

d) Existence of willing donor or seller and prior agency interest

e) Cost

In general, priority shall be given to the most threatened high quality eagle habitats with associated natural values which require the least management.

Resolution of site management plan disputes

7.1 The department, the landowner and the permitting agency shall work to develop a mutually agreeable site management plan within 30 days of the original notice to the department of game. This plan shall become a part of the application for a permit.

7.2 Should agreement not be reached, the landowner may refer the site management plan to the bald eagle oversight committee (paragraph 8). The committee shall have 30 days from the date contacted to bring about agreement among the department, the landowner, and the permitting agency. The committee may use conciliation, mediation and factfinding, or any other method they deem appropriate to bring about a mutually acceptable resolution of the issues.

7.3 If the landowner chooses not to use the services of the bald eagle oversight committee or if resolution is not reached, the department of game shall within 15 days provide a site management plan to the landowner and permitting agency.

7.4 The landowner may initiate a formal appeal of the department of game's decision. Formal appeal procedures appear in WAC 232-12-197.

Bald eagle oversight committee

8.1 The director of the department of game shall appoint a five-member bald eagle oversight committee with two members representing landowner interests, two members representing wildlife interests and one nonvoting member from the department of game. Members are appointed for three year terms, with the initial terms for one, two or three years so that committee appointments will be staggered over time. The committee shall meet at least quarterly, and as needed, to accomplish the following:

- 8.1.1 Monitor the progress of cooperative bald eagle management processes under these regulations and make recommendations to the department and other interested parties to improve the effectiveness of these processes.
- 8.1.2 Undertake resolution of site management plan disputes under paragraph 7.2 above.
- 8.1.3 Coordinate joint efforts on Washington bald eagle protection.

8.2 The members of the committee shall not receive compensation but shall be reimbursed under RCW 43.03.050 and 43.03.060 for travel expenses incurred while attending official meetings of the committee.

Automatic review processes

9.1 The bald eagle oversight committee will report to the department of game annually regarding its activities under paragraph 8.1. The department of game will conduct an initial review of the bald eagle regulatory process after 3 years which will include a public hearing, and then every five years thereafter.

Penalties

10.1 Failure to comply with the processes set forth in these rules or with the provisions of a site management plan constitutes a misdemeanor as set forth in RCW 77.21.010.

[Statutory Authority: RCW 77.12.655. 86-21-010 (Order 283), §§ 232-12-292, filed 10/3/86.]

Appendix I. Washington Administrative Code 232-12-297, 232-12-011 and 232-12-014.

WAC 232-12-011 Wildlife classified as protected shall not be hunted or fished.

Protected wildlife are designated into three subcategories: Threatened, sensitive, and other.
(1) Threatened species are any wildlife species native to the state of Washington that are likely to become endangered within the foreseeable future throughout a significant portion of their range within the state without cooperative management or removal of threats. Protected wildlife designated as threatened include:

Common Name	Scientific Name
western gray squirrel	*Sciurus griseus*
Steller (northern) sea lion	*Eumetopias jubatus*
North American lynx	*Lynx canadensis*
Aleutian Canada goose	*Branta canadensis leucopareia*
bald eagle	*Haliaeetus leucocephalus*
ferruginous hawk	*Buteo regalis*
marbled murrelet	*Brachyramphus marmoratus*
green sea turtle	*Chelonia mydas*
loggerhead sea turtle	*Caretta caretta*
sage grouse	*Centrocercus urophasianus*
sharp-tailed grouse	*Phasianus columbianus*

(2) Sensitive species are any wildlife species native to the state of Washington that are vulnerable or declining and are likely to become endangered or threatened in a significant portion of their range within the state without cooperative management or removal of threats. Protected wildlife designated as sensitive include:

Common Name	Scientific Name
Gray whale	*Eschrichtius robustus*
Common Loon	*Gavia immer*
Larch Mountain salamander	*Plethodon larselli*
Pygmy whitefish	*Prosopium coulteri*
Margined sculpin	*Cottus marginatus*

(3) Other protected wildlife include:

Common Name	Scientific Name
cony or pika	*Ochotona princeps*
least chipmunk	*Tamius minimus*
yellow-pine chipmunk	*Tamius amoenus*
Townsend’s chipmunk	*Tamius townsendii*
red-tailed chipmunk	*Tamius ruficaudus*
hoary marmot	*Marmota caligata*
Olympic marmot	*Marmota olympus*
Cascade golden-mantled ground squirrel	*Spermophilus saturatus*
golden-mantled ground squirrel	*Spermophilus lateralis*
Washington ground squirrel	*Spermophilus washingtoni*
red squirrel	*Tamiasciurus hudsonicus*

Douglas squirrel	*Tamiasciurus douglasii*
northern flying squirrel	*Glaucomys sabrinus*
wolverine	*Gulo gulo*
painted turtle	*Chrysemys picta*
California mountain kingsnake	*Lampropeltis zonata;*

All birds not classified as game birds, predatory birds or endangered species, or designated as threatened species or sensitive species; all bats, except when found in or immediately adjacent to a dwelling or other occupied building; all wildlife within Titlow Beach Marine Preserve Area and the conservation areas defined in chapter 220-16 WAC; mammals of the order *Cetacea*, including whales, porpoises, and mammals of the order *Pinnipedia* not otherwise classified as endangered species, or designated as threatened species or sensitive species. This section shall not apply to hair seals and sea lions which are threatening to damage or are damaging commercial fishing gear being utilized in a lawful manner or when said mammals are damaging or threatening to damage commercial fish being lawfully taken with commercial gear.

[Statutory Authority: RCW 77.12.047, 00-17-106 (Order 00-149), § 232-12-011, filed 8/16/00, effective 9/16/00. Statutory Authority: RCW 77.12.040, 77.12.010, 77.12.020. 00-10-001 (Order 00-47), § 232-12-011, filed 4/19/00, effective 5/20/00. Statutory Authority: RCW 77.12.040, 77.12.010, 77.12.020, 77.12.770, 77.12.780. 00-04-017 (Order 00-05), § 232-12-011, filed 1/24/00, effective 2/24/00. Statutory Authority: RCW 77.12.020. 98-23-013 (Order 98-232), § 232-12-011, filed 11/6/98, effective 12/7/98. Statutory Authority: RCW 77.12.040. 98-10-021 (Order 98-71), § 232-12-011, filed 4/22/98, effective 5/23/98. Statutory Authority: RCW 77.12.040 and 75.08.080. 98-06-031, § 232-12-011, filed 2/26/98, effective 5/1/98. Statutory Authority: RCW 77.12.020. 97-18-019 (Order 97-167), § 232-12-011, filed 8/25/97, effective 9/25/97. Statutory Authority: RCW 77.12.040, 77.12.020, 77.12.030 and 77.32.220. 97-12-048, § 232-12-011, filed 6/2/97, effective 7/3/97. Statutory Authority: RCW 77.12.020. 93-21-027 (Order 615), § 232-12-011, filed 10/14/93, effective 11/14/93; 90-11-065 (Order 441), § 232-12-011, filed 5/15/90, effective 6/15/90. Statutory Authority: RCW 77.12.040. 89-11-061 (Order 392), § 232-12-011, filed 5/18/89; 82-19-026 (Order 192), § 232-12-011, filed 9/9/82; 81-22-002 (Order 174), § 232-12-011, filed 10/22/81; 81-12-029 (Order 165), § 232-12-011, filed 6/1/81.]

WAC 232-12-014 Wildlife classified as endangered species. Endangered species include:

Common Name	Scientific Name
pygmy rabbit	*Brachylagus idahoensis*
fisher	*Martes pennanti*
gray wolf	*Canis lupus*
grizzly bear	*Ursus arctos*
sea otter	*Enhydra lutris*
sei whale	*Balaenoptera borealis*
fin whale	*Balaenoptera physalus*
blue whale	*Balaenoptera musculus*
humpback whale	*Megaptera novaeangliae*
black right whale	*Balaena glacialis*
sperm whale	*Physeter macrocephalus*
Columbian white-tailed deer	*Odocoileus virginianus leucurus*
woodland caribou	*Rangifer tarandus caribou*
American white pelican	*Pelecanus erythrorhynchos*
brown pelican	*Pelecanus occidentalis*
peregrine falcon	*Falco peregrinus*
sandhill crane	*Grus canadensis*
snowy plover	*Charadrius alexandrinus*
upland sandpiper	*Bartramia longicauda*
spotted owl	*Strix occidentalis*

western pond turtle	*Clemmys marmorata*
leatherback sea turtle	*Dermochelys coriacea*
Oregon spotted frog	*Rana pretiosa*
Northern leopard frog	*Rana pipiens*
Oregon silverspot butterfly	*Speyeria zerene hippolyta*
Mardon skipper	*Polites mardon*

[Statutory Authority: RCW 77.12.040, 77.12.010, 77.12.020, 77.12.770, 77.12.780. 00-04-017 (Order 00-05), § 232-12-014, filed 1/24/00, effective 2/24/00. Statutory Authority: RCW 77.12.020. 98-23-013 (Order 98-232), § 232-12-014, filed 11/6/98, effective 12/7/98; 97-18-019 (Order 97-167), § 232-12-014, filed 8/25/97, effective 9/25/97; 93-21-026 (Order 616), § 232-12-014, filed 10/14/93, effective 11/14/93. Statutory Authority: RCW 77.12.020(6). 88-05-032 (Order 305), § 232-12-014, filed 2/12/88. Statutory Authority: RCW 77.12.040. 82-19-026 (Order 192), § 232-12-014, filed 9/9/82; 81-22-002 (Order 174), § 232-12-014, filed 10/22/81; 81-12-029 (Order 165), § 232-12-014, filed 6/1/81.]

WAC 232-12-297 Endangered, threatened, and sensitive wildlife species classification.

PURPOSE

1.1 The purpose of this rule is to identify and classify native wildlife species that have need of protection and/or management to ensure their survival as free-ranging populations in Washington and to define the process by which listing, management, recovery, and delisting of a species can be achieved. These rules are established to ensure that consistent procedures and criteria are followed when classifying wildlife as endangered, or the protected wildlife subcategories threatened or sensitive.

DEFINITIONS

For purposes of this rule, the following definitions apply:

2.1 "Classify" and all derivatives means to list or delist wildlife species to or from endangered, or to or from the protected wildlife subcategories threatened or sensitive.

2.2 "List" and all derivatives means to change the classification status of a wildlife species to endangered, threatened, or sensitive.

2.3 "Delist" and its derivatives means to change the classification of endangered, threatened, or sensitive species to a classification other than endangered, threatened, or sensitive.

2.4 "Endangered" means any wildlife species native to the state of Washington that is seriously threatened with extinction throughout all or a significant portion of its range within the state.

2.5 "Threatened" means any wildlife species native to the state of Washington that is likely to become an endangered species within the forseeable future throughout a significant portion of its range within the state without cooperative management or removal of threats.

2.6 "Sensitive" means any wildlife species native to the state of Washington that is vulnerable or declining and is likely to become endangered or threatened in a significant portion of its range within the state without cooperative management or removal of threats.

2.7 "Species" means any group of animals classified as a species or subspecies as commonly accepted by the scientific community.

2.8 "Native" means any wildlife species naturally occurring in Washington for purposes of breeding, resting, or foraging, excluding introduced species not found historically in this state.

2.9 "Significant portion of its range" means that portion of a species' range likely to be essential to the long term survival of the population in Washington.

LISTING CRITERIA

3.1 The commission shall list a wildlife species as endangered, threatened, or sensitive solely on the basis of the biological status of the species being considered, based on the preponderance of scientific data available, except as noted in section 3.4.

3.2 If a species is listed as endangered or threatened under the federal Endangered Species Act, the agency will recommend to the commission that it be listed as endangered or threatened as specified in section 9.1. If listed, the agency will proceed with development of a recovery plan pursuant to section 11.1.

3.3 Species may be listed as endangered, threatened, or sensitive only when populations are in danger of failing, declining, or are vulnerable, due to factors including but not restricted to limited numbers, disease, predation, exploitation, or habitat loss or change, pursuant to section 7.1.

3.4 Where a species of the class Insecta, based on substantial evidence, is determined to present an unreasonable risk to public health, the commission may make the determination that the species need not be listed as endangered, threatened, or sensitive.

DELISTING CRITERIA

4.1 The commission shall delist a wildlife species from endangered, threatened, or sensitive solely on the basis of the biological status of the species being considered, based on the preponderance of scientific data available.

4.2 A species may be delisted from endangered, threatened, or sensitive only when populations are no longer in danger of failing, declining, are no longer vulnerable, pursuant to section 3.3, or meet recovery plan goals, and when it no longer meets the definitions in sections 2.4, 2.5, or 2.6.

INITIATION OF LISTING PROCESS

5.1 Any one of the following events may initiate the listing process.

5.1.1 The agency determines that a species population may be in danger of failing, declining, or vulnerable, pursuant to section 3.3.

5.1.2 A petition is received at the agency from an interested person. The petition should be addressed to the director. It should set forth specific evidence and scientific data which shows that the species may be failing, declining, or vulnerable, pursuant to section 3.3. Within 60 days, the agency shall either deny the petition, stating the reasons, or initiate the classification process.

5.1.3 An emergency, as defined by the Administrative Procedure Act, chapter 34.05 RCW. The listing of any species previously classified under emergency rule shall be governed by the provisions of this section.

5.1.4 The commission requests the agency review a species of concern.

5.2 Upon initiation of the listing process the agency shall publish a public notice in the Washington Register, and notify those parties who have expressed their interest to the department, announcing the initiation of the classification process and calling for scientific information relevant to the species status report under consideration pursuant to section 7.1.

INITIATION OF DELISTING PROCESS

6.1 Any one of the following events may initiate the delisting process:

6.1.1 The agency determines that a species population may no longer be in danger of failing, declining, or vulnerable, pursuant to section 3.3.

6.1.2 The agency receives a petition from an interested person. The petition should be addressed to the director. It should set forth specific evidence and scientific data which shows that the species may no longer be failing, declining, or vulnerable, pursuant to section 3.3. Within 60 days, the agency shall either deny the petition, stating the reasons, or initiate the delisting process.

6.1.3 The commission requests the agency review a species of concern.

6.2 Upon initiation of the delisting process the agency shall publish a public notice in the Washington Register, and notify those parties who have expressed their interest to the department, announcing the initiation of the delisting process and calling for scientific information relevant to the species status report under consideration pursuant to section 7.1.

SPECIES STATUS REVIEW AND AGENCY RECOMMENDATIONS

7.1 Except in an emergency under 5.1.3 above, prior to making a classification recommendation to the commission, the agency shall prepare a preliminary species status report. The report will include a review of information relevant to the species' status in Washington and address factors affecting its status, including those given under section 3.3. The status report shall be reviewed by the public and scientific community. The status report will include, but not be limited to an analysis of:

7.1.1 Historic, current, and future species population trends.

7.1.2 Natural history, including ecological relationships (e.g., food habits, home range, habitat selection patterns).

7.1.3 Historic and current habitat trends.

7.1.4 Population demographics (e.g., survival and mortality rates, reproductive success) and their relationship to long term sustainability.

7.1.5 Historic and current species management activities.

7.2 Except in an emergency under 5.1.3 above, the agency shall prepare recommendations for species classification, based upon scientific data contained in the status report. Documents shall be prepared to determine the environmental consequences of adopting the recommendations pursuant to requirements of the State Environmental Policy Act (SEPA).

7.3 For the purpose of delisting, the status report will include a review of recovery plan goals.

PUBLIC REVIEW

8.1 Except in an emergency under 5.1.3 above, prior to making a recommendation to the commission, the agency shall provide an opportunity for interested parties to submit new scientific data relevant to the status report, classification recommendation, and any SEPA findings.

8.1.1 The agency shall allow at least 90 days for public comment.

8.1.2 The agency will hold at least one Eastern Washington and one Western Washington public meeting during the public review period.

FINAL RECOMMENDATIONS AND COMMISSION ACTION

9.1 After the close of the public comment period, the agency shall complete a final status report and classification recommendation. SEPA documents will be prepared, as necessary, for the final agency recommendation for classification. The classification recommendation will be presented to the commission for action. The final species status report, agency classification recommendation, and SEPA documents will be made available to the public at least 30 days prior to the commission meeting.

9.2 Notice of the proposed commission action will be published at least 30 days prior to the commission meeting.

PERIODIC SPECIES STATUS REVIEW

10.1 The agency shall conduct a review of each endangered, threatened, or sensitive wildlife species at least every five years after the date of its listing. This review shall include an update of the species status report to determine whether the status of the species warrants its current listing status or deserves reclassification.

10.1.1 The agency shall notify any parties who have expressed their interest to the department of the periodic status review. This notice shall occur at least one year prior to end of the five year period required by section 10.1.

10.2 The status of all delisted species shall be reviewed at least once, five years following the date of delisting.

10.3 The department shall evaluate the necessity of changing the classification of the species being reviewed. The agency shall report its findings to the commission at a commission meeting. The agency shall notify the public of its findings at least 30 days prior to presenting the findings to the commission.

10.3.1 If the agency determines that new information suggests that classification of a species should be changed from its present state, the agency shall initiate classification procedures provided for in these rules starting with section 5.1.

10.3.2 If the agency determines that conditions have not changed significantly and that the classification of the species should remain unchanged, the agency shall recommend to the commission that the species being reviewed shall retain its present classification status.

10.4 Nothing in these rules shall be construed to automatically delist a species without formal commission action.

RECOVERY AND MANAGEMENT OF LISTED SPECIES

11.1 The agency shall write a recovery plan for species listed as endangered or threatened. The agency will write a management plan for species listed as sensitive. Recovery and management plans shall address the listing criteria described in sections 3.1 and 3.3, and shall include, but are not limited to:

11.1.1 Target population objectives.

11.1.2 Criteria for reclassification.

11.1.3 An implementation plan for reaching population objectives which will promote cooperative management and be sensitive to landowner needs and property rights. The plan will specify resources needed from and impacts to the department, other agencies (including federal, state, and local), tribes, landowners, and other interest groups. The plan shall consider various approaches to meeting recovery objectives including, but not limited to regulation, mitigation, acquisition, incentive, and compensation mechanisms.

11.1.4 Public education needs.

11.1.5 A species monitoring plan, which requires periodic review to allow the incorporation of new information into the status report.

11.2 Preparation of recovery and management plans will be initiated by the agency within one year after the date of listing.

11.2.1 Recovery and management plans for species listed prior to 1990 or during the five years following the adoption of these rules shall be completed within five years after the date of listing or adoption of these rules, whichever comes later. Development of recovery plans for endangered species will receive higher priority than threatened or sensitive species.

11.2.2 Recovery and management plans for species listed after five years following the adoption of these rules shall be completed within three years after the date of listing.

11.2.3 The agency will publish a notice in the Washington Register and notify any parties who have expressed interest to the department of the initiation of recovery plan development.

11.2.4 If the deadlines defined in sections 11.2.1 and 11.2.2 are not met the department shall notify the public and report the reasons for missing the deadline and the strategy for completing the plan at a commission meeting. The intent of this section is to recognize current department personnel resources are limiting and that development of recovery plans for some of the species may require significant involvement by interests outside of the department, and therefore take longer to complete.

11.3 The agency shall provide an opportunity for interested public to comment on the recovery plan and any SEPA documents.

CLASSIFICATION PROCEDURES REVIEW

12.1 The agency and an ad hoc public group with members representing a broad spectrum of interests, shall meet as needed to accomplish the following:

12.1.1 Monitor the progress of the development of recovery and management plans and status reviews, highlight problems, and make recommendations to the department and other interested parties to improve the effectiveness of these processes.

12.1.2 Review these classification procedures six years after the adoption of these rules and report its findings to the commission.

AUTHORITY

13.1 The commission has the authority to classify wildlife as endangered under RCW 77.12.020. Species classified as endangered are listed under WAC 232-12-014, as amended.

13.2 Threatened and sensitive species shall be classified as subcategories of protected wildlife. The commission has the authority to classify wildlife as protected under RCW 77.12.020. Species classified as protected are listed under WAC 232-12-011, as amended. [Statutory Authority: RCW 77.12.020. 90-11-066 (Order 442), § 232-12-297, filed 5/15/90, effective 6/15/90.]