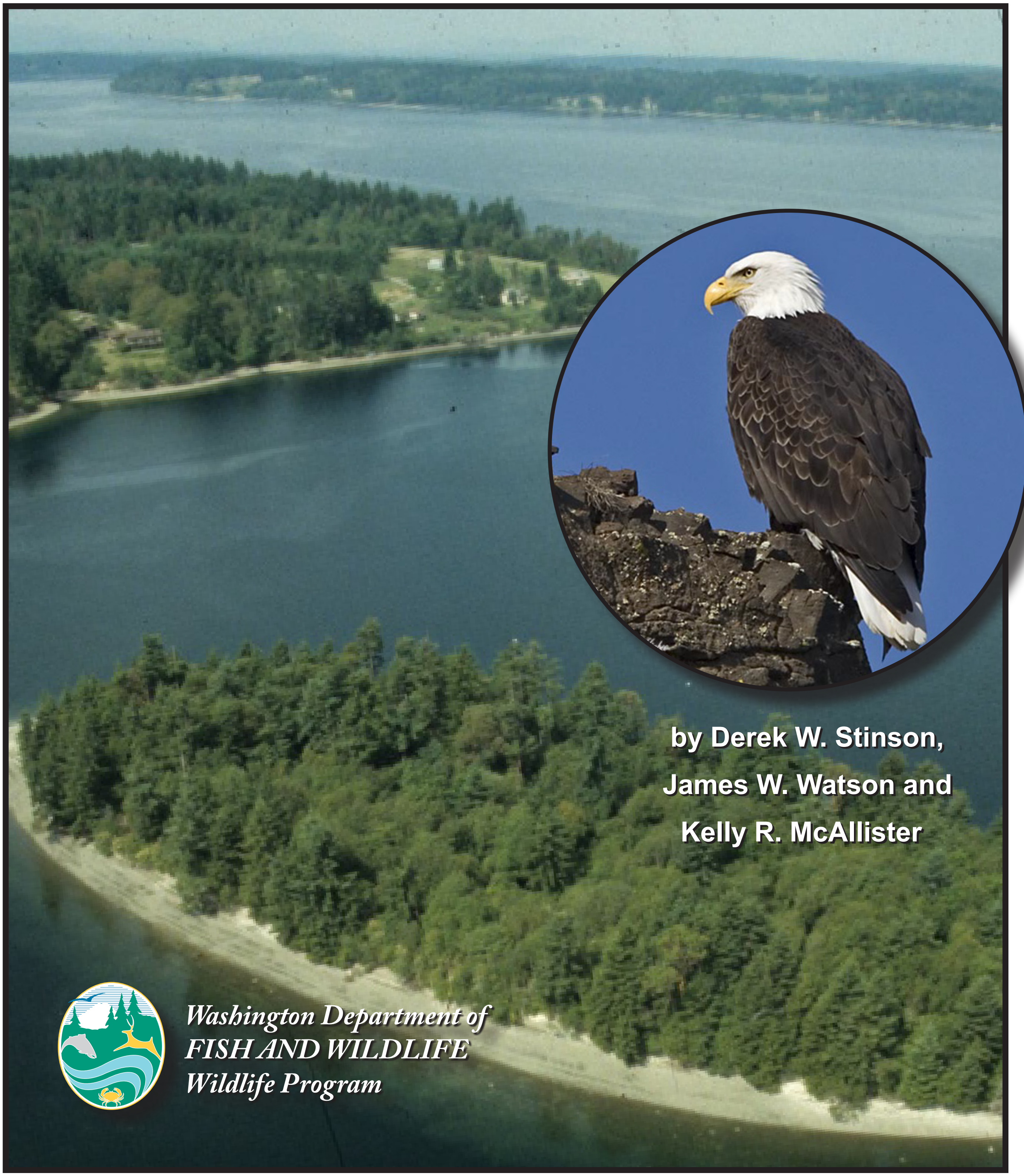
STATE OF WASHINGTON October 2007

# Status Report for the Bald Eagle



by Derek W. Stinson,
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Washington Department of
FISH AND WILDLIFE
Wildlife Program

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 D). 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 D). 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 may hold public meetings to take comments and answer questions. At the close of the comment period, the Department completes the final status report and listing recommendation for presentation to the Washington Fish and Wildlife Commission. The final report and recommendations are then released 30 days prior to the Commission presentation for public review.

The 2001 Status Report for the Bald eagle was reviewed by researchers and state, provincial, and federal agencies, and was then subject to a 90-day public comment period from 1 July – 30 September 2001. This report is an update of the 2001 report. It was reviewed by bald eagle specialists in Washington Department of Fish and Wildlife and external experts, and will be subject to a 30-day public review. The Department will present this status review and a recommendation to down-list the bald eagle to the Fish and Wildlife Commission at the 8 December meeting in Port Angeles. Send written comments on this report or the recommendation to down-list the bald eagle to Sensitive by 30 November via e-mail to: WILDTHING@dfw.wa.gov or by mail to:

Endangered Species Section Manager
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600 Capitol Way North, Olympia, WA 98501-1091

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*Cover photos by Joe Higbee (eagle) and Jim Watson (background aerial of Eagle Island and Otso Point of Anderson Island, Pierce County)*
*Title page illustration by Michelle LaGory*

# WASHINGTON STATE STATUS REPORT FOR THE BALD EAGLE


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Washington Department of Fish and Wildlife
Wildlife Program
600 Capitol Way N
Olympia, Washington

October 2007

# TABLE OF CONTENTS

## LIST OF TABLES

# LIST OF FIGURES

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Joe Higbee graciously allowed us to use the eagle photo on the cover. Terry Grubb, Grainger Hunt, Mark Stalmaster, Frank Isaacs, Gerry Hayes, Shelly Ament, Eric Cummins, Joe Buchanan, Elizabeth Rodrick, Michelle Tirhi and Howard Ferguson reviewed the updates to the report. Peter Dunwiddie, Dave Clouse, Gretchen Blatz, Tom Owens, and Jay Shepard provided updated data for some of the tables and graphs.

Many individuals contributed to the 2001 status report. 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.

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Acronyms used in the text:

| | |
|---|---|
| DDT | dichlorodiphenyltricloroethane, an organochlorine pesticide. |
| ESA | U.S. Endangered Species Act of 1973 |
| FFR | Forest & Fish rules (Forest Practice regulations specific to protection of stream organisms) |
| 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 8,800 based on presumed habitat condition. Persecution, the cutting of forests, commercial exploitation of salmon runs, and finally the use of DDT reduced the state's population to only 104 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, may have 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 25 years, the population of nesting bald eagles grew about 9% per year as eagles reoccupied habitat. In 2005, there were 840 occupied nests, and there are some indications that the population may have 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 near saturation around Puget Sound and other marine coasts, the total late spring/early summer population is expected to 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 6,000 eagles.

The number of bald eagles detected during winter surveys in eastern Washington doubled between 1975 and 1984. Comprehensive, statewide surveys of wintering eagles from 1982-89 counted 1,000-3,000 eagles in the state. The increasing trends in those surveys and in resident breeding birds predicted 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 assumed that winter carrying capacity limits have not been reached. Statewide winter counts have not been conducted since 1989, 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.

In the lowlands around Puget Sound, bald eagles nest in small patches of residual large trees and second growth forest. 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 2,900 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 removed the bald eagle from the federal list of threatened and endangered species in 2007. Bald eagles and their nests are still 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 30 years, most nests are on private lands and only about 10% of eagle nests are on lands dedicated to conservation. 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 continues to diminish, and the needs of eagles and desires of humans are often in conflict. Without protections of nesting and roosting habitat, the bald eagle could again decline and require re-listing as threatened or endangered in the state.

Although problems still persist, the dramatic increase in bald eagles in Washington suggests that they no longer fit the definition of a threatened species. For these reasons we recommend that the bald eagle be down-listed to sensitive in the State of Washington.

# INTRODUCTION

The bald eagle population in Washington has made a dramatic recovery in recent decades since its' listing under the federal Endangered Species Act and the banning of the pesticide DDT. Only about 104 pairs nested in Washington in 1980; the most recent survey counted over 800 pairs. Recent estimates for the lower 48 states total nearly 10,000 nesting pairs. The USFWS initially proposed de-listing the bald eagle under the ESA in 1999, but de-listing was delayed while protections under federal laws were clarified and a long-term monitoring plan was developed (USFWS 2007c,d). The species was finally removed from the Endangered Species Act in August 2007. The increase in abundance and distribution of bald eagles in Washington suggest that the species should be considered for downlisting. However, because bald eagles are affected by shoreline development, fisheries, and forest management there is a continued need to conserve nesting habitat and foraging opportunities. This report summarizes the natural history, past and present population status, and management of bald eagles in Washington. It is a revision and update of the 2001 state status report (Stinson et al. 2001).

# 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 dark brown body and wing feathers. The eyes, beak, and cere (fleshy area at the base of the beak) of adults are yellow, but in juveniles the eyes are dark brown and the beak and cere also start off very dark, almost black, becoming yellow with age. Juveniles and subadults lack the white head and tail and display various patterns of dark brown, light brown, whitish gray, and white on the body and wing feathers. 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). Young bald eagles can be difficult to distinguish from golden eagles (*Aquila chrysaetos*), but the white of juvenile golden eagles occurs in discrete patches on the wings and at the base of the tail and adults have no white (Stalmaster 1987). White in the wing pit is indicative of a young bald eagle. The bald eagle also has a heavier bill and in flight its head protrudes further forward of the wing (Stalmaster 1987, Buehler 2001).

# GEOGRAPHICAL 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

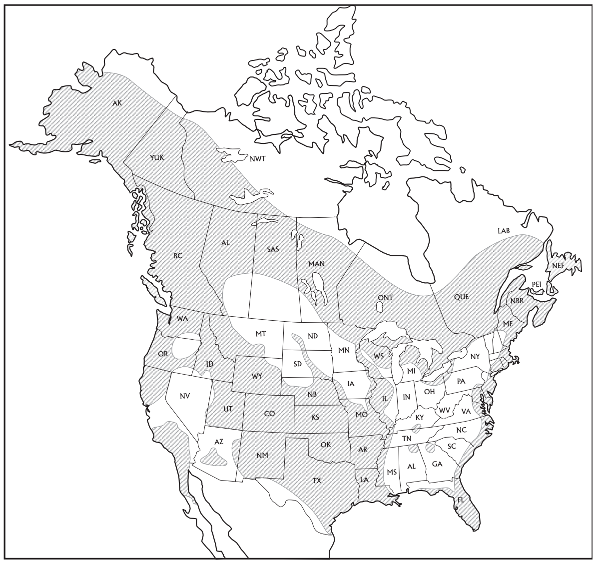

Figure 1. The range of the bald eagle (based on Johnsgard 1990).

highest along marine and Great Lakes shorelines, particularly of Canada, Alaska, and Florida (Fig. 1). 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.

Washington

Bald eagles can be found in all the forested parts of Washington throughout the year, but they are much 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 away from large rivers in the Columbia Basin and Palouse regions where large trees are absent.

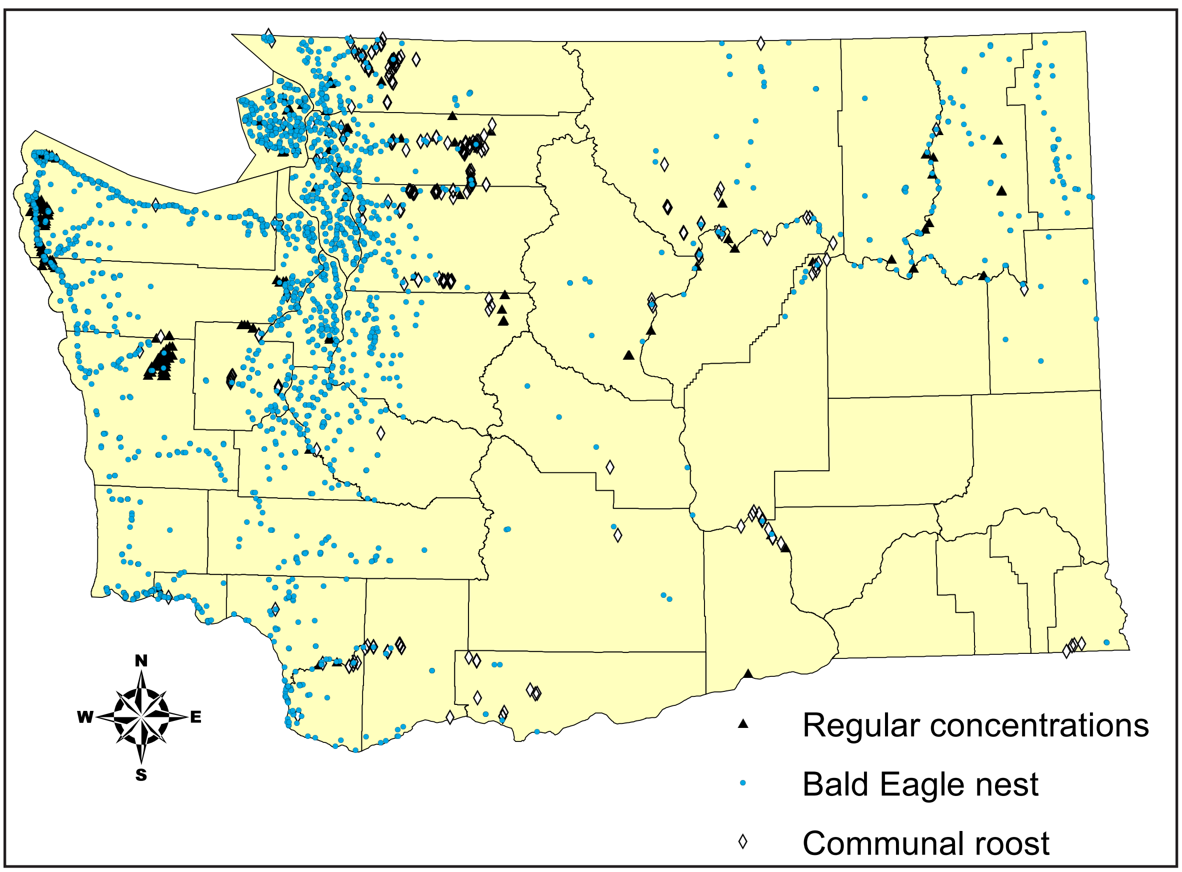


Figure 2. Distribution of known nests, roosts, and regular concentrations of bald eagles in Washington, 2007.

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. 2). Wintering eagles are found in some areas where birds are rarely or never seen during the breeding season. The reservoirs and major tributaries of the Columbia River in eastern Washington 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.

# NATURAL HISTORY

## General Behaviors

*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 friendly, but competitive and feeding opportunities depend on an individual's 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. These "kettles" may consist of up 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 280 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 are 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).

## 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).

*Mating behavior and territoriality*. Adult bald eagles go through a series of courtship behaviors that establish 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 2006), or at other times of the year (S. Ament, pers. comm.).

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 some of the injured birds that require rehabilitation and fights sometimes have fatal outcomes.

*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 1,050 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. In western Washington most eagles begin to incubate their eggs by the third week in March, and young hatch by late April (Watson 2006); however, the start of nesting period for individual pairs can vary considerably year to year (S. Ament, pers. comm.). 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. 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. 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 2006), but occasionally not until mid-August (S. Ament, pers.comm.).

Longevity, Survival, and Mortality

The longevity record for bald eagles in the wild is >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 (*Procyon lotor*), wolverines (*Gulo gulo*), gulls, red-tailed hawks (*Buteo jamaicensis*), ravens (*Corvus corax*), crows (*Corvus* spp.), 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, Millsap et al. 2004). 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 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. Many carcasses are sent directly to the U.S. Fish and Wildlife Service's Eagle Repository in Denver, Colorado, 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, Wisconsin. A report based on 1,429 carcasses received between 1963 and 1984 indicated that gunshot (23%), trauma (21%), poisoning (11%), and electrocution (9%) 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 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 carcasses are probably not found before they are eaten by scavengers, and eagles killed by human-related causes (roads, powerlines) are 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 40 years have generally found relatively high rates of juvenile survival. 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 suggested that a population with moderate nest success and 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 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 survival for eagles that breed in Washington is higher than for the migratory population that winters here. 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.

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

| 1 | 2-4 | 5+ | Annual population growth rate | Years | Location | Source |
|---|---|---|---|---|---|---|
| 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 |
| 81[a] | 87-88[b] | - | increasing | 1997-2001 | Florida | Millsap et al. 2004 |
| 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%[c] | 1993-99 | Washington | Watson, unpubl. data |
| | | 68-95 | stable-increasing[d] | 1996-99 | Washington | Watson and Pierce 2001 |

[a]Surival from 8 weeks to 1 year.
[b]Survival from age 1- 3 years.
[c]Nesting population study of 2 telemetered juvenile, 3 subadult, and 21 adult eagles (8 telemetered).
[d]Wintering population study of 22 telemetered adults; minimum estimate, assumes all stationary signals indicated fatalities.

## 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 foods 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). Bald eagles are capable predators and regularly kill prey using various 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 eggs, nestlings, or fledglings 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, sometimes an eagle pair alternating attacks, causing the duck to dive repeatedly until it is so exhausted that it is easily plucked from the water (Beebe 1974, S. Ament, pers. comm.); Joe Buchanan (pers. comm.) has observed this technique used to take buffleheads (*Bucephala albeola*) and western grebes (*Aechmophorus occidentalis*). Mammals, including rabbits, raccoons, 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; Galusha and Hayward 2002, Watson 2002, D. Norman, pers. comm.). Bald eagles also feed on the carcasses of whales, seals (probably *Phoca vitulina*), sea lions (*Zalophus californianus*, *Eumatopias jubatus*), sea otters (*Enhydra lutris*), and other marine mammals that wash up on marine shores (S. Ament, pers. comm.). Thus, bald eagles are also effective scavengers, willing, at times, to feed on well-decayed flesh or garbage. In winter, spawned salmon on riverbanks and bars become the most important food for much of the wintering population. They will often steal (pirate or kleptoparasitize) prey from ospreys (*Pandion haliaeetus*) and gulls, and have even been observed stealing marine invertebrates from sea otters (Watt et al. 1995), and fish from river otters (*Lontra canadensis*)(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).

Diet studies usually use either direct observations of foraging eagles, or the collection of 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). Feeding experiments with captive eagles indicate that soft-boned fishes also tend to be underrepresented in prey remains (Hunt et al. 2002). Fish can be over-represented by direct observations (Knight et al. 1990). Of 1,198 items collected in 68 nesting territories in the San Juans, Olympic Peninsula, and Puget Sound, 53% were birds, 34% fish, 9% mammals, and 4% invertebrates (Knight et al. 1990). Recent direct observations of nesting eagles in western Washington found they captured 78% fish, 19% birds, and 3% mammals (Watson 2002). Invertebrates were not observed to be captured, but were found in prey remains (molluscs 6% and crustaceans 1%).

A collection of 269 prey items under 33 nest trees in four aquatic habitats in western Washington was 72% birds, 16% fish, 6% mollusks and crustaceans, and 6% mammal (Watson 2002). Birds were among the most common prey remains in the two prey collection studies. These included at least 15 species of duck, (especially mallards [Anas platyrhychos], American widgeon [Anas americana], scoters [Melanitta spp.], green-winged teal [Anas crecca], mergansers [Mergus spp.]), gulls (especially glaucous-winged, Larus glaucescens), snow goose (Chen caerulescens), loons (Gavia spp), western grebe, common murre (Uria aalge), great blue heron (Ardea herodias), and pelagic cormorant (Phalacrocorax pelagicus) (Knight et al. 1990, Watson 2002). Red-tailed hawks, ring-necked pheasants (*Phasianus colchicus*), grouse (*Dendrogapus fuliginosus* or *Bonasa umbellus*), mink (*Mustela vison*), muskrat, and domestic dog (*Canis familiaris*) occurred in prey remains less frequently (1- 4 territories; Watson 2002). Fish that occurred several times in western Washington studies included flounder (family Pleuronectidae), ling-cod (*Ophiodon elongatus*), plainfin midshipman (*Porichthys notatus*), dogfish shark (*Squalus acanthias*), sculpin (family Cottidae), rockfish (*Sebastes* spp.), walleye pollock (*Theragra chalcogramma*), Pacific hake (*Merluccius productus*), Pacific cod (*Gadus macrocephalus*), cabezon (*Scorpaenichthys marmoratus*), red Irish lord (*Hemilepidotus hemilepidotus*), salmon (unidentified salmonids), striped bass (*Morone saxatilis*), 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). Bald eagles also are known to prey on adult and post-fledging juvenile great blue herons (Forbes 1987). 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 collection of prey remains from a nest on Sequim Bay was comprised almost entirely of gull (*Larus* spp.) feathers (S. Ament, pers. comm). 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).

Watson (2002) reported that generally, eagles at coastal nests preyed more on birds, and eagles nesting near lakes and rivers fed more on fish. Watson (2002) examined prey class, foraging mode and success in bay, river, marine, and lake habitats (Table 2). Eagles successfully captured prey in 62% of attempts. Most of 998 capture attempts were of live prey (73%), with lower frequencies of scavenging (15%), and piracy of prey caught by

Table 2. Capture mode, success, and prey type for 53 bald eagle pairs in four habitat types in western Washington, 1986-1997 (Watson 2002).

| | Habitat | | | | | | |
|---|---|---|---|---|---|---|---|
| Capture mode and prey type | Bay[a] | River | Marine | Lake | All | $X^2$ | P |
| % Capture success (n)[b] | 60 (679) | 88 (110) | 59 (334) | 62 (60) | 62 (1183) | 34.76 | 0.001 |
| % Prey class[c] | | | | | | 52.13 | 0.001 |
| Fish | 77 | 58 | 84 | 84 | 78 | | |
| Birds | 22 | 24 | 13 | 16 | 19 | | |
| Mammals | 1 | 18 | 3 | 0 | 3 | | |
| % Capture type[d] | | | | | | 39.48 | 0.001 |
| Live | 70 | 97 | 74 | 94 | 73 | | |
| Scavenge | 19 | 3 | 10 | 0 | 15 | | |
| Pirate | 11 | 0 | 16 | 6 | 12 | | |

[a]Bays were habitats with extensive tidal flats.
[b]Number of successful captures / total attempts.
[c]Number of prey in class / total prey classified; Total prey classified in respective habitats = 531, 45, 288, and 62.
[d]Number of captures per capture type / total captures; Totoal types classified by habitat = 647, 30, 258, and 63.

other species (12%). Eagles nesting along rivers were more successful at capturing prey than those nesting in other habitats, and those nesting on lakes and rivers captured live prey almost exclusively (Watson 2002). Piracy, which was more common in bay and marine habitat, often involved stealing prey from gulls (*Larus* spp.). Eagles nesting on Washington rivers preyed much more frequently on mammals than in other habitats (Watson 2002). Hunt et al. (2002) and Grubb (1995) noted that mammals seem to fill a dietary gap during periods of high water turbidity for eagle pairs on rivers in Arizona.

A study of nesting birds at Lake Roosevelt (Columbia River) in north-central 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 (*Percaflavescens*), 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. 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).

## Home Range, Migration, and Dispersal

*Home range.* Watson (2002) analyzed the breeding season home range that contains the foraging and nesting habitat of 53 bald eagle pairs grouped by bay, river, marine, and lake habitat types (Table 3). Home ranges averaged 4.9 km$^2$ (3 mi$^2$), and ranged from about 2-7 km$^2$, (1.24-4.34 mi$^2$) with mean home range sizes progressively larger from

Table 3. Mean home range area and length of shoreline for 53 bald eagle pairs in four habitat types in western Washington, 1986-1997 (Watson 2002).

| | Habitat | | | | | | |
|---|---|---|---|---|---|---|---|
| Area measured | Bay[a] | River | Marine | Lake | All | $X^2$ | P |
| Home range[b] ($km^2$ ±SE) | 6.4 ±0.9 | 5.0 ±1.8 | 3.3 ±0.4 | 2.1 ± 0.4 | 4.9 ±0.5 | 12.35 | 0.006 |
| Core area ($km^2$ ±SE) | 1.7 ±0.2 | 0.9 ±0.4 | 0.8 ±0.1 | 0.4 ±0.1 | 1.2 ±0.1 | 8.75 | 0.033 |
| Home range shoreline (km ±SE) | 4.3 ±0.4 | 2.6 ±0.6 | 3.4 ±0.4 | 2.1 ±0.5 | 3.7 ±0.3 | 8.05 | 0.045 |
| Core area shoreline(km ±SE) | 1.9 ±0.3 | 0.8 ±0.3 | 1.5 ±0.2 | 0.6 ±0.2 | 1.6 ±0.2 | 6.88 | 0.076 |

[a]Bays were habitats with extensive tidal flats.
[b]95% harmonic mean contours.

lakes, to marine shorelines, rivers, and the largest on bays. Ranges and core areas were smallest on lakes, having the least shoreline and fewest perches. The home ranges of a pair averaged about 13.7 $km^2$ (8.5 $mi^2$) in the Columbia River estuary (Garrett et al. 1993).

Where shorelines are irregular, home ranges contain an average of 4 km (2.5 mi) of shoreline. Where shorelines are relatively straight, home ranges encompass about 3 km (1.86 mi) of shoreline, and the nest is often centrally located with a core area of most frequent use extending 600 m of shoreline on both sides of the nest (Watson 2002). 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 density, presumably reflecting high quality habitat, occupied nests of adjacent nesting pairs may be spaced every few miles. Clallam County, Washington averages about 2.8 mi (4.8 km) of shoreline per active nest. Hodges (1982) reported active nests were an average of 1.25-2.5 mi (2 – 4 km) apart along the Seymour Canal of southeast Alaska. Hunt et al.(2002) reported that the home range sizes for 4 pairs in Arizona included 17-29 river km.

Winter ranges are considerably larger and more variable. Winter ranges for 15 eagles (24 winters) captured on the Skagit River averaged 28,094 $km^2$ (17,450 $mi^2$), and ranged from 89- 113,365 $mi^2$ (143 –182,518 $km^2$ (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.

*Migration.* Many populations of bald eagles are migratory, moving south in the autumn and north in spring, particularly those birds that breed in the northern regions of Canada and Alaska. Where winters are more moderate, some eagles, including many that breed in Washington and California, move north in late summer to take advantage of seasonally available foods. Juvenile bald eagles are often more nomadic and may travel long distances in somewhat random directions. Bald eagles migrate during late morning and afternoon (10:15-17:45) when thermals provide soaring opportunities (Buehler 2000, Harmata 2002). They usually soar up on a thermal, then glide down to catch another thermal; they sometimes circle constantly while moving in the desired direction (Buehler 2000). Members of a pair migrate independently. Spring migration appears to coincide with incoming low pressure systems, cyclonic air flows, and southerly winds (Harmata 2002). Prominent physiographic features, celestial cues and weather seem to all play a role in bald eagle migration (Harmata 2002). Sun-azimuth orientation seem to be important in migration, because bald eagles do not migrate on days of total overcast (Gerrard and Gerrard 1982, Harmata 2002). They also did not migrate when winds exceeded 35 km/h before 9:00 AM (Harmata 2002). Harmata (2002) reported flight speeds averaged 50 km/h and ranged from 22-144 km/h, and eagles were typically 1,500-3,050 m above ground level; McClelland et al. (1996) reported that 4 birds in Montana migrated at 200 – 600 m above ground level. Bald eagles may lose >25% of their body weight during migration, which is not unusual for eagles, and raptors in general (Harmata 2002).

Washington's breeding adults are on their territories until late summer when many migrate north to coastal British Columbia and southeast Alaska for several weeks to take advantage of food supplies associated with late summer and early fall salmon runs (Servheen and English 1979, 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 may be vital for breeding adults to be sufficiently healthy to reproduce successfully the following spring (Hansen and Hodges 1985). They return to territories in Washington by January to secure their territories and commence nesting again. A few pairs are reported to remain on their territories year-round, probably where food is locally abundant (S. Ament. pers. comm.). 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, Linthicum et al. 2007).

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 western 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). In addition to eagles that concentrate to feed on spawned salmon in western Washington, a few hundred wintering eagles are dispersed along rivers in eastern Washington and feed on waterfowl, upland birds, fish, and carrion (Fielder and Starkey 1987). 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 3). 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 southeastern 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 (Fig. 3; Appendix A). 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, 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 direct distance moved averaged 74 km/day and ranged from 7-239 km/day (Watson and Pierce 2001). The straight-line distance traveled between their winter range and breeding territory averaged 700 miles (1,126 km) and ranged from 142 to 1,747 mi (228- 2,810 km). 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


Figure 3. Bald eagle migration corridors in the Pacific Northwest (based on Watson and Pierce 2001, Grubb et al. 1994, McClelland et al. 1994, and Sorenson 1995; excludes data on movements from Montana in McClelland et al. 1994, and from California in Linthicum et al. 2007).

coast, and they speculated that these birds may be looking for spawning salmon runs including some that are now extinct.

Linthicum et al. (2007) tracked, via satellite, four bald eagle nestlings from California and 16 wintering eagles captured in California. All the eagles, including those of Canadian origin and those fledged in California, spent time during the summer in Canada and winters in California. Three California fledglings departed natal areas in July or August and traveled to coastal areas of British Columbia. They initiated their return to California as early as October and as late as December. After spending 4-7 months in California, they departed in June or July for the same summer areas in Canada. One female fledgling made a loop migration northward along the Cascades to the Canadian Rockies and then to Great Slave Lake in the southern Northwest Territories; its southward route followed the eastern Rockies through Montana and on to California. Birds of Canadian origin (n=11; 6 ad, 5 imm.) generally arrived in California in December or January and left in late February and March, returning to an area encompassing northeast Alberta, northwest Saskatchewan, and the Great Slave Lake region of the Northwest Territories. These birds made a loop with the northward route further west than the southward route, and shared flyways and habitats with some birds of California origin. One 2-year old male made additional movements while in Canada to within 100 km of the Beaufort Sea; its movements for the year were estimated to total 35,000 km (Linthicum et al. 2007).

Harmata (2002) tracked the spring migration of bald eagles that wintered in the San Luis Valley of Colorado (n = 15) using conventional radio transmitters. Daily movements averaged 180 km and ranged from 144-435 km (n = 10). Three birds followed a relatively narrow migration corridor north through Colorado, Wyoming, and Montana; all four eagles located on the summer range nested in an area of southeastern Saskatchewan and northwestern Manitoba, and migrated an average distance of 2,019 km (Harmata 2002).

*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, Linthicum et al. 2007). 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. Eagles that originated in Canada exhibited fidelity to the wintering locations where they were first captured in California (Linthicum et al. 2007). 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 hatched 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). Juveniles that fledged in California showed fidelity to their natal region (Linthicum et al. 2007). 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).

## Ecological Relationships

As predators and kleptoparasites, bald eagles interact with many other animals, and the increase in bald eagle numbers in Washington has presumably led to an increase in these interactions. 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, gulls, and common murres. 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.).

*Great blue herons*. Bald eagle incursions and predation at great blue heron nesting colonies in the region have received increasing attention in recent years (Forbes 1987, Norman et al. 1989, Vennesland and Butler 2004). Adult herons often leave the nest when threatened by eagles, leaving the eggs or chicks vulnerable to predation. Bald eagles also sometimes create disturbances, giving crows and ravens the opportunity to prey on heron eggs and chicks while adults are off the nests (Moul 1990). Vennesland and Butler (2004) identified disturbance by humans and bald eagles as the two factors negatively related to heron nesting productivity in southwestern British Columbia. Nesting failure was common and widespread; eagle predation events sometimes led to total nesting failure, particularly of small colonies, and there have been similar observations in Washington (S. Ament, pers. comm.). Eagles predated heron eggs, nestlings, or fledged young during 9.8% of 239 incursions, and eagles were responsible for 7 of 14 colony failures, and likely involved in the remaining 7 (Vennesland and Butler 2004). One event involved the failure of 399 nests at a 400 nest colony. In 2004, 34 of 60 (56.7%) surveyed colonies experienced total failure and were subsequently abandoned primarily due to eagle incursions and predation (McClaren 2004). Nesting productivity of great blue herons in coastal British Columbia declined significantly from 1987-2004, although there has been no large decline apparent in the heron population (Gebauer and Moul 2001, Vennesland 2003, McClaren 2004). Relative stability in the heron population may relate to the longevity of great blue herons (at least 24.5 years; Klimkiewicz 2007), or recruitment from other regions (Vennesland 2003).

Great blue herons and bald eagles coexisted prior to the decline in eagle numbers during the 20th century, and presumably great blue herons will adapt to the eagle's increased abundance. The historical population level of herons is unknown, but they may have been less abundant in the region prior to the decline of eagles than in recent decades (McClaren 2004). Data from 2002-2004 suggest that large heron colonies in and around the Strait of Georgia, BC may be breaking up and dispersing to smaller colonies (McClaren 2004). It is not known if large colony break-up is a response to eagle predation, or related to habitat availability, but small colonies have not been as productive as large colonies (McClaren 2004, Vennesland and Butler 2004). Factors that may complicate the interactions between eagles and herons today are: the fragmentation of forest that has isolated heron nesting colonies in small woodlots that may be more vulnerable to predation; loss of shoreline habitat may concentrate nesting eagles and herons into less habitat and closer proximity; a greater abundance of crows facilitated by human-related food sources; widespread and frequent disturbance by human activities; and contaminants in food sources.

## HABITAT REQUIREMENTS

### Nesting Habitat

Breeding bald eagles need large trees near open water with a relatively low level of 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 (Fig. 4). 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 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 4; Anthony

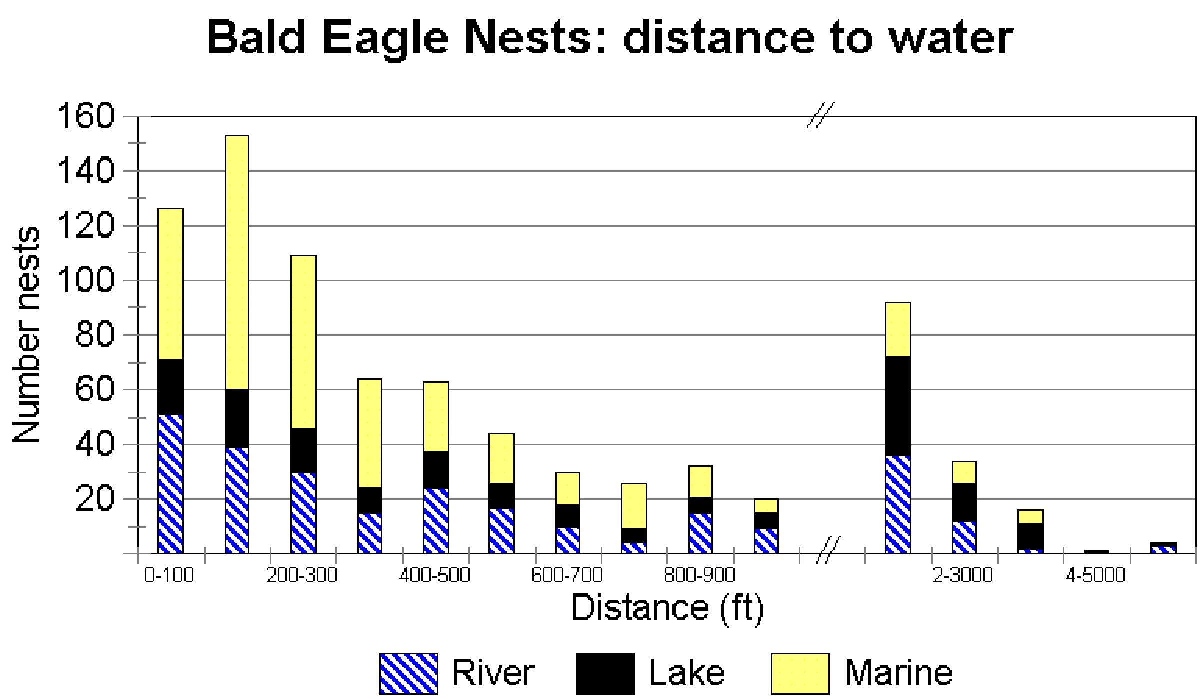


Figure 4. Distance to open water for 817 bald eagle nests grouped by nearest shore type (note change in scale at x axis break).

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 trees are most often old-growth Douglas-fir (*Pseudotsuga menziesii*) and Sitka spruce (*Picea sitchensis*) near the coast (Grubb 1976), with more frequent use 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 the more abundant red alder (*Alnus rubra*). 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 a larger percentage of forest cover, more large trees with stout horizontal limbs, and trees that were closer to the water, than segments of 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 bald eagles allows them to nest successfully in a variety of habitats. Coastal

Table 4. Characteristics of 218 bald eagle nest trees and surrounding forest stands in two forest types in Washington (Anthony et al. 1982).

| Forest type | Nest tree: Mean dbh (range)(in) | Nest tree: Mean height (range) (ft) | Nest Stand: Mean dbh (in) | Nest Stand: Mean height (ft) | Nest Stand: 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.

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). Thompson et al. (2005) reported that unvegetated tidal mudflats, isolated from intensive human activity provided the highest quality foraging habitat on the Hudson River in New York. 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).

Capture success, primary prey class, and foraging mode differed between bay, river, marine, and lake habitats in western Washington (Watson 2002). Eagles nesting along rivers were more successful at capturing prey than those nesting in other habitats, suggesting that rivers should have dense nesting populations. However, bald eagles only began re-colonizing inland rivers in Washington relatively recently (Watson 2002). The lower density of eagle territories and slower re-colonization of rivers may relate to density and vulnerability of prey. The high consumption of live prey and fish by pairs nesting on lakes compared to rivers may in part be due to annual stocking of lakes with hatchery rainbow trout and regular summer die-offs of yellow perch and brown bullheads.

Food is 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, Green 2005). 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). Harmata (2002) reported that during diurnal migration, bald eagles roosted in any habitat type as long as there was a tree of adequate size and security from human disturbance. 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, and 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

Table 5. Characteristics of roost trees and roost stands in three forest types in Washington (Anthony et al. 1982).

| Forest type<br>Roost | Roost Tree<br>Mean height (ft) | Mean dbh (in) | Roost stand<br>Mean (range) tree ht. (ft) | Mean (range) 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) |

(Table 5). 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). 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).

# 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 still may have been 70,000 in 1980, with most of these in Alaska and British Columbia (Gerrard 1983, Buehler 2000). From the time of white settlement, 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. Nesting sites were lost to shore development, and eagles (both bald and golden) seem to have been shot at every opportunity. John James 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, or 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 Native Americans 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 in 1963 (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).

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 1,237% from 791 in 1974 to about 9,789 in 2007 (USFWS 2007c). The bald eagle population doubled every 7-8 years during the preceeding 30 years (Fig. 5). Ten of the contiguous states (WA, OR, MN, WI, MI, FL, ME, MD, VA, MT) now have populations

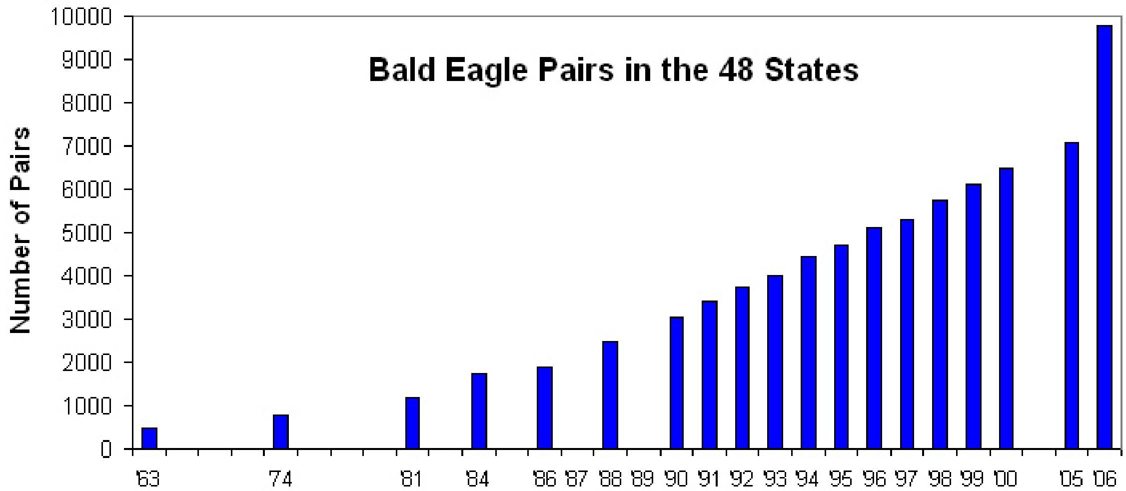


Figure 5. Estimated number of breeding pairs of bald eagles in the 48 contiguous states, 1963-2006 (source: U.S. Fish and Wildlife Service).

exceeding 300 pairs (Fig. 6). Most populations have reached regional recovery goals, but are still well below pre-Euro-American settlement levels (Buehler 2000). In 1999, the USFWS originally proposed to de-list the bald eagle from protection under the federal Endangered Species Act (USFWS 1999). From 1999-2006, the USFWS developed management guidelines, defined "disturb" as used in the Bald and Golden Eagle Protection Act, and continued development of a post de-listing monitoring plan. The bald eagle was removed from protection under the federal Endangered Species Act on 8 August 2007 (USFWS 2007c).

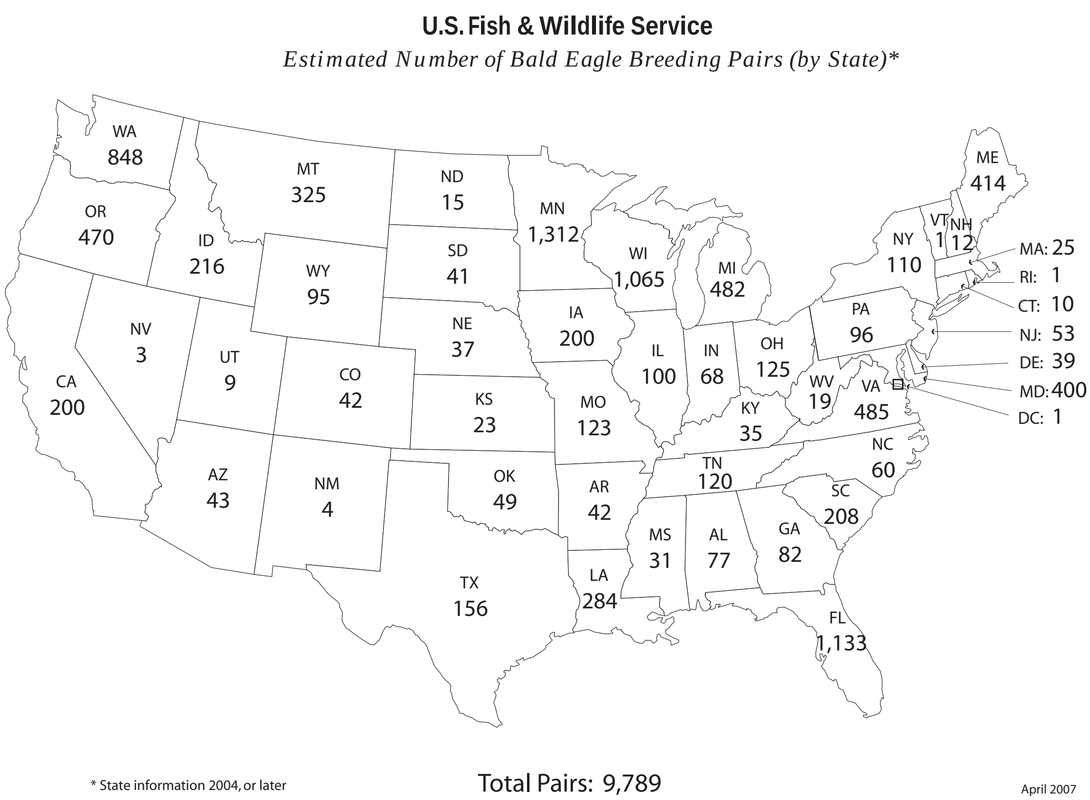


Figure 6. Most recent (2004 or later) estimate of the number of bald eagle pairs in the 48 contiguous states (source: U.S. Fish and Wildlife Service).

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). In 1825, David Douglas shot two, one to eat, and the other to impress the natives with his shooting prowess (Douglas 1914). J. K. Townsend indicated that the species was "chiefest" among the year-round residents of the lower Columbia River region (Jobanek and Marshall 1992). 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 Juan Islands. 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 (0.36 active nests/mi), then the 2,880 mi of Washington marine coasts would have supported 1,037 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 1,242 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 1,328 historical SBLs for Washington. Annual survival rates have been reported from Alaska of 0.88 for adults, 0.95 for subadults, 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 (Bowman et al. 1995), Moffat's equilibrium model, as described by Hunt (1998), would yield an equilibrium population of 5,344 adults and 3,455 subadults and juveniles, for a total of 8,799. 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 of 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 our historical population would have included about 5,344 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 8,800 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.

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), persecution, widespread loss of suitable nesting habitat from logging, housing developments, and recreation (USFWS 1978). Shooting was cited as an important mortality factor accounting for 40-50% of birds picked up by field personnel.

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 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, and conducted again in 2001 and 2005 (Watson et al. 2002; Fig. 7). 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 6).

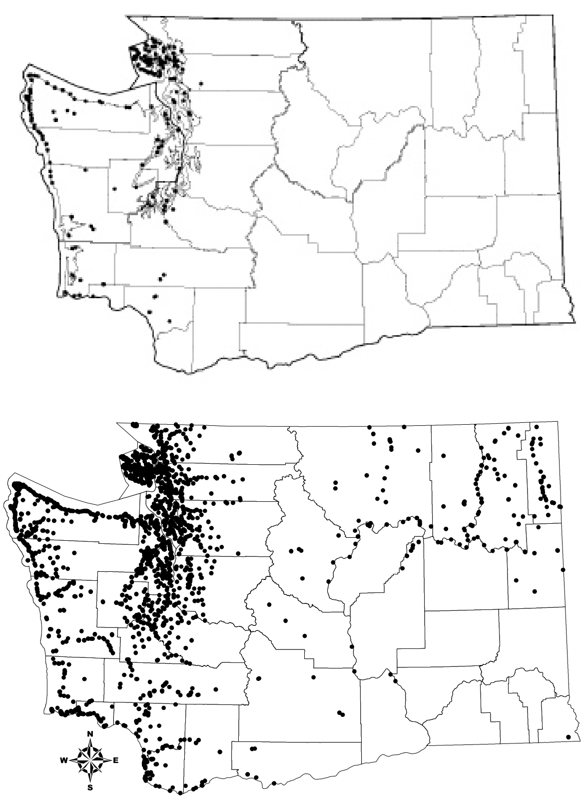

Figure 7. Distribution of bald eagle nests 1980 (top), and 2005 (bottom) in Washington.

Washington: Present

The last statewide surveys conducted in 2005 at 1,125 known territories recorded 840 occupied nests. Nest records, surveys, and additional surveys of habitat resulted in an estimated total of 1,939 nests in Washington (E. Cummins, pers. comm.); many pairs have >1 nest in their territory and this estimate includes all alternate nests. From 1981-2005 the nesting population in Washington had increased 707% (Fig. 8; $P < 0.001$). In 2001, 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 each year from 1980-98 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). This resulted in an estimated carrying capacity of about ≈733 breeding territories (Stinson et al. 2001). However, the breeding population exceeded that number by 2005. The true carrying capacity is unknown, but a recent decline in nest occupancy rate suggests that nesting habitat in parts of western Washington is approaching saturation. For example, the number of active nests along shorelines in San Juan County, long a stronghold of the population, declined from 73 in 1998, to 54 in 2005. Also, the appearance of nests in developed areas may be related to increased competition for more optimal nesting sites. In contrast, some subpopulations in Washington may still be increasing. For example, the number of territories has continued to increase along rivers of the western Olympic Peninsula (S. Ament, pers. comm.), and on Lake

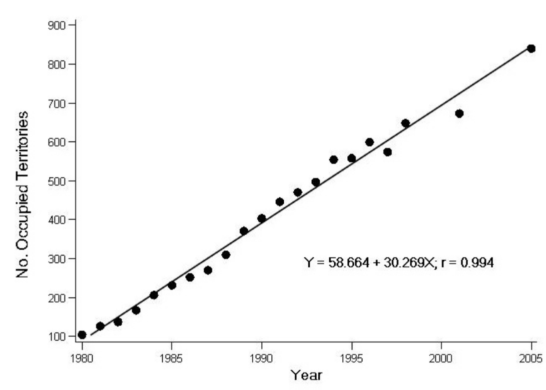


Figure 8. Growth in the number of occupied bald eagle nests in Washington, 1980-2005.

Roosevelt (2 in 1988 to 24 in 2000; Murphy 2000) and other eastern Washington rivers.

*Nesting density*. Nest density in Washington in recent years approaches the averages for southern and northern British Columbia (Table 7). 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 Alaska. Statewide there are about 5,090 mi of forested shoreline (salt and fresh), and 790 nests were active in 2005 (though not all are on shorelines, probably all are associated with shoreline foraging areas), for a density of about 1 active nest/6.4 mi of forested shoreline, or 0.155 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. The trend in occupancy in Washington from 1980-2005

Table 6. Number and productivity of nesting bald eagles in Washington,1980-2005[a].

| Year | No. territories surveyed | No.(%) Occupied[b] territories | Occupied territories successful (%) | Estimated no. of young produced[c] | No. nests with known outcome | Mean no. young/ occupied territory [c] |
|---|---|---|---|---|---|---|
| 1980 | 153 | 104 (68) | 64 | 94 | 90 | 0.90 |
| 1981 | 164 | 126 (77) | 56 | 95 | 110 | 0.75 |
| 1982 | 188 | 137 (73) | 56 | 102 | 117 | 0.75 |
| 1983 | 230 | 167 (73) | 59 | 145 | 149 | 0.87 |
| 1984 | 252 | 206 (83) | 67 | 195 | 188 | 0.95 |
| 1985 | 287 | 231 (81) | 64 | 226 | 192 | 0.98 |
| 1986 | 300 | 252 (85) | 73 | 279 | 218 | 1.11 |
| 1987 | 329 | 270 (84) | 65 | 264 | 245 | 0.98 |
| 1988 | 360 | 310 (87) | 66 | 303 | 279 | 0.98 |
| 1989 | 424 | 371 (88) | 63 | 367 | 331 | 0.99 |
| 1990 | 471 | 403 (86) | 70 | 431 | 355 | 1.07 |
| 1991 | 520 | 446 (86) | 63 | 433 | 401 | 0.97 |
| 1992 | 558 | 470 (85) | 69 | 466 | 425 | 0.99 |
| 1993 | 586 | 497 (85) | 62 | 465 | 142[d] | 0.94 |
| 1994 | 639 | 554 (87) | 70 | 565 | 236[d] | 1.02 |
| 1995 | 667 | 558 (86) | 63 | 509 | 254[d] | 0.91 |
| 1996 | 711 | 599 (86) | 65 | 564 | 233[d] | 0.94 |
| 1997 | 710 | 574 (83) | 66 | 565 | 201[d] | 0.98 |
| 1998 | 804 | 648 (81) | 75 | 713 | 297[d] | 1.10 |
| [e] | | | | | | |
| 2001 | 905 | 673 (79) | 78 | 761 | 207[d] | 1.13 |
| [e] | | | | | | |
| 2005 | 1125 | 840 (78) | 72 | 925 | 113[d] | 1.10 |

[a]Data varies slightly from that reported in Stinson et al. 2001 due to improvements in the analysis program.
[b]Occupied territories had two adults present, young or eggs in the nest, or an adult in incubation posture.
[c]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.
[d]During these years, only a sample of nests were revisited by a second aerial 'productivity' flight to determine outcome.
[e]Nest activity and productivity surveys in 1999, 2000, 2002-2004 were conducted only in select portions of the state.

Table 7. 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) | 0.15[b] |
| Clallam County | 0.36[b] |
| Clallam, Jefferson and San Juan Counties (combined) | 0.30[b] |
| British Columbia | |
| S. of Cape Caution (Hodges et al. 1984) | 0.130 |
| Gulf Islands (Vermeer and Morgan 1989) | 0.19 |
| Queen Charlotte Isl. (Harris 1978) | 0.31 - 0.47[d] |
| several lakes (Hodges et al. 1984) | 0.03 - 0.06 |
| Seymour Canal, Alaska (Hodges 1982) | 0.50 |

[a]Active nests are usually defined as nests showing evidence of actual breeding by a pair of eagles, such as the presence of eggs, young, or an adult in breeding posture.
[b]Density of active nests in 2005.
[c]Nests within 3,000 feet of shorelines.
[d]This survey was conducted by boat; the remaining studies used aircraft.

was curvilinear. From 1980-98 nesting occupancy exhibited an increasing linear trend (Fig. 9; P = 0.005), but seemed to level off and remain relatively stable around 84-87% from 1988-96 (Table 6). A recent change in occupancy rate suggests that nesting habitat may be reaching carrying capacity. 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).

*Productivity rate.* Productivity rate is defined as the number of eagles produced per occupied nest.

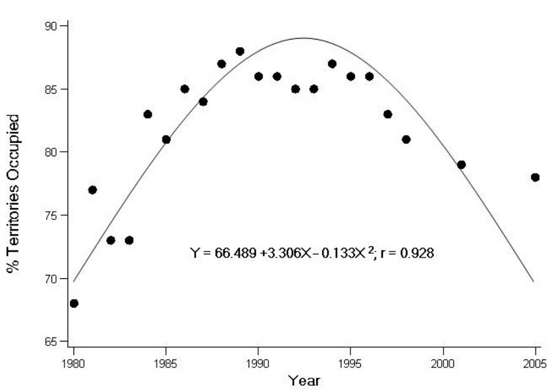


Figure 9. Trend in bald eagle territory occupancy in Washington, 1980-2005 (P=0.00001).

Nesting bald eagles most often lay 2 eggs (range 1 to 3), but only one or neither 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 8). 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. 10; P = 0.0015).

However, for the years 1990-05 only, there was no significant trend in productivity for Washington

Table 8. Productivity and nest success of bald eagle populations that were increasing, stable, or 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.

eagles (P = 0.0947), 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 per 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.

*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 can be affected by human disturbance, or the health of nesting adults, which can be affected by environmental factors such as contaminants. 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 8; 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%, and an increasing trend (Fig. 11; P = 0.0306). However, from 1984-05, no significant trend was evident (P = 0.0772), nest success having stabilized between 63% and 74% annually.

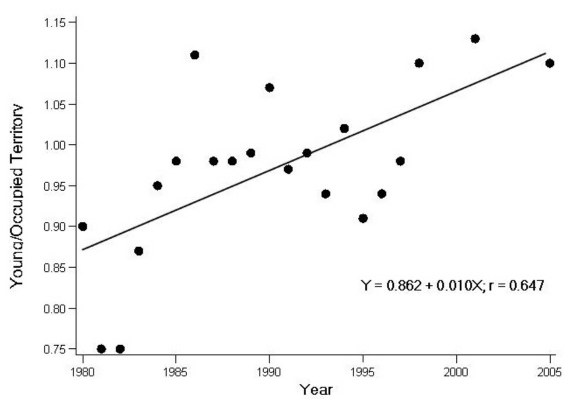


Figure 10. Trend in bald eagle nest productivity in Washington, 1980 - 1998.

*Lower Columbia River and Hood Canal.* In spite of the high productivity and overall health of the nesting population of Washington's bald eagles, two regional populations, the lower Columbia River

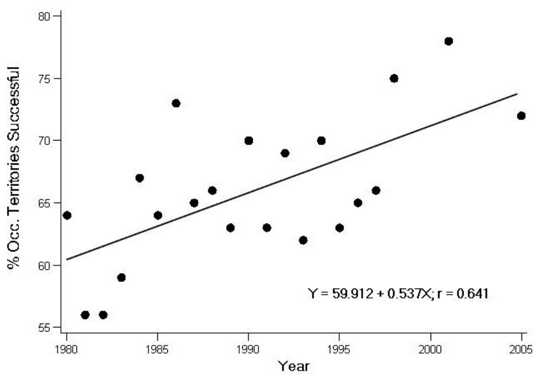


Figure 11. Trend in bald eagle nest success in Washington, 1980-2005.

and Hood Canal, have exhibited low reproductive success similar to those in decreasing populations (Table 8). 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 (Watson et al. 2002).

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 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. 12). 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. Fielder and Starkey (1987) reported that the number of eagles wintering on eastern Washington rivers doubled between 1975 and 1984. Winter surveys that 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, though the Skagit numbers do not seem to have increased since the early 1990s, and we have no Whatcom data after 2000 (Fig.13). Peak winter detections on the Nisqually River also increased from 12-40 birds during 1982-89 to >200 birds since 2001 (2002-2006: 239, 204, 278, 195, and 242; Taylor 1989, Stalmaster and Kaiser 1997a, M. Stalmaster, pers. comm., Dave Clouse, pers.

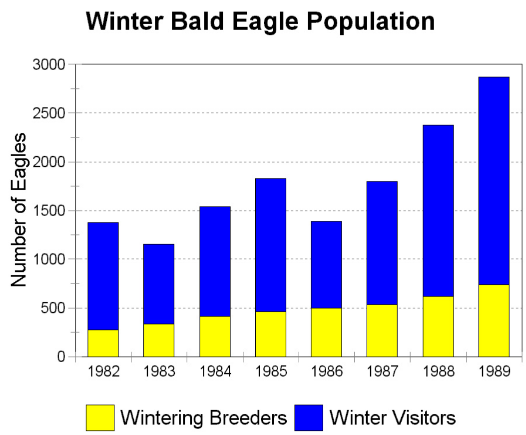


Figure 12. Number of bald eagles wintering in Washington, 1982-89 (based on mid-winter counts and number of known breeders).

comm.). Christmas Bird Count data from British Columbia also suggested 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. 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 have been 3,193 individuals, and the total winter population around 4,500 if Washington breeders were included. The validity of this population estimate is unknown since the actual carrying capacity of eagle wintering habitat in Washington, and whether the increase in migrants has continued, is unknown. The size and trends of migrant, wintering bald eagles in 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, waterfowl) 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. Stinson et al. (2001) predicted a carrying capacity of 733 territories; that estimate was evidently low, however, as the eagle population

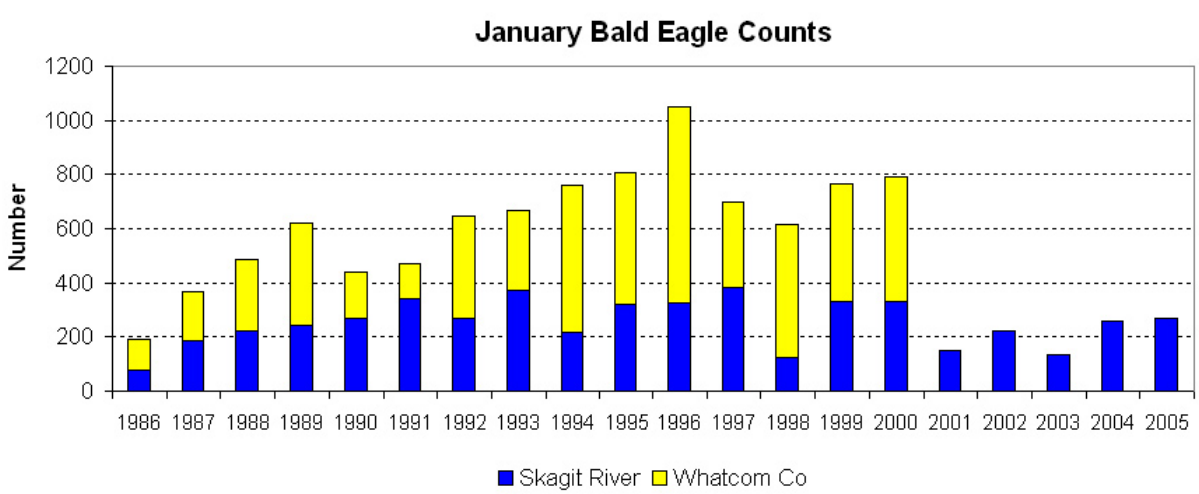


Figure 13. Bald eagles counted in Whatcom County and on the Skagit River in January, 1986-2005 (*high water precluded boat counts on the Nooksack (Whatcom) in 1991, 1993, 1997; 1996 Skagit count incomplete; source TNC, NPS, and Sylvia Thorpe; Skagit Counts are for Rockport to Newhalem; no data from the Nooksack and Whatcom County past 2000).

reached 840 pairs in 2005. Although nesting habitat may limit the number of breeding pairs, the total population of eagles is expected to continue to increase because the pool of non-breeders (floaters) typically increases as raptor populations reach carrying capacity (Newton 1979). The total peak eagle population can be predicted based on Moffat's Equilibrium (Hunt 1998, Hunt and Law 2000; Appendix B). If Washington provides 900 serviceable breeding locations, the total population might be around 6,000 birds.

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. 14) are based on known numbers in 1980 and 2005, 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 serviceable breeding locations would result in a 20% decline in the total eagle population. 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.

## 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

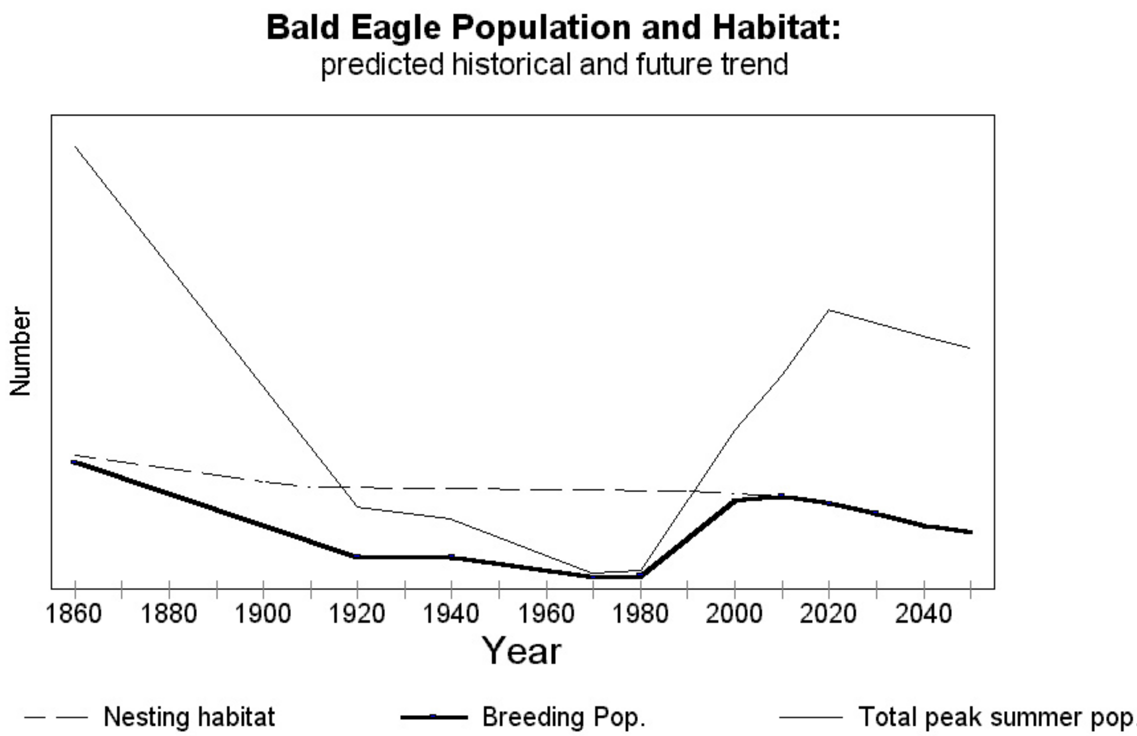


Figure 14. Hypothesized trends in the peak early summer bald eagle population and nesting habitat in Washington, 1860-2050.

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, and 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, would rapidly cover the mud and sandflats of Willapa Bay, eliminating the stop-over foraging habitat for >100,000 migrating shorebirds without ongoing control programs (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. 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.

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. 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 ring-necked pheasants were introduced into eastern Washington providing new prey sources that may mitigate somewhat for declines in other prey. 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 food source (Knight et al. 1990), although many of these have reduced stocks. Hunter crippled waterfowl and other game are probably more available to the eagles, although often containing toxic lead pellets.

*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 was 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 little old (>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 continue to be lost. Outside of national forests (that are primarily above the lowlands) these late mature and old 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.

Booth (1991) estimated that prior to logging, about 62% of western Washington and Oregon forests were 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 Sitka 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 have 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. 15). In 2000, 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 $\geq$90% private (Table 9). 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

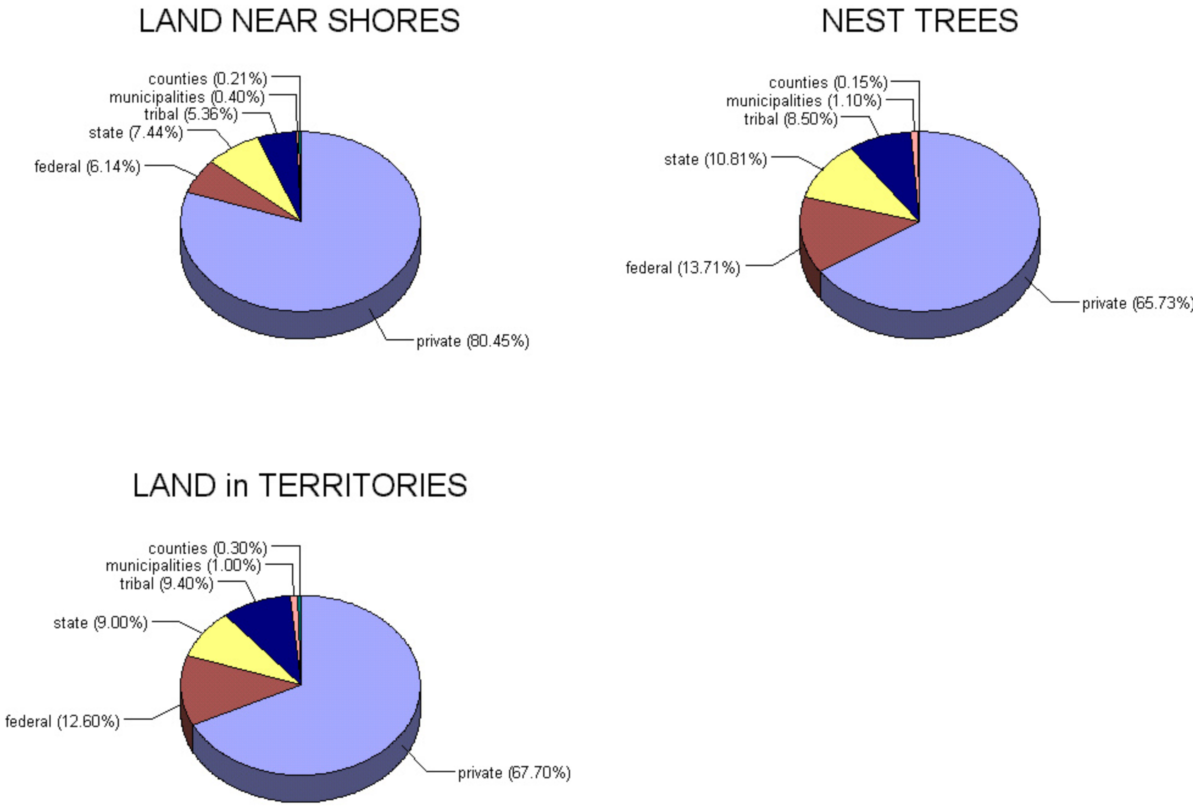


Figure 15. Percent ownership of lands within ½ mi of marine shores, most recently used nest trees, and aggregate land in territories, for 817 bald eagle territories (1/2 mi radius around nest) in Washington, 2000.

development are likely to become 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. 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 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. 15). The types of land uses that affect bald eagles on public lands are somewhat different from those

Table 9. Number and percent of bald eagle nest territories in percent ownership categories.

| | | Public lands | | | Private lands | | | |
|---|---|---|---|---|---|---|---|---|
| | n | 100% | >70% | >50% | ≥50% | ≥70% | ≥90% | 100% |
| No. territories[ab] | 817 | 152 | 182 | 219 | 557 | 510 | 456 | 389 |
| Percentb | 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.

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 10). Tribal governments control 9.4% of the public lands within territories.

In addition to private lands, state, county, and municipal lands are subject to the provisions of the bald eagle protection rules, and management must consider providing for large trees for nesting and minimizing disturbances to nesting eagles. These non-federal public lands support about 100 nests and about 10.2% of lands within 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 no longer listed under the Endangered Species Act, agencies must comply with protections under the Bald and Golden Eagle Protection Act, and will likely abide by management guidelines provided by the USFWS. 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,

Table 10. Ownership or jurisdiction of nest trees and aggregate lands in bald eagle territories (1/2 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 | 67.80% | 192,153 | 65.7% | 540 |
| Tribal governments | 9.40% | 26,719 | 8.5% | 70 |
| Washington Dept. Natural Resources | 5.10% | 14,436 | 4.7% | 39 |
| National Park Service[a] | 4.60% | 12,989 | 5.1% | 42 |
| Washington State Parks and Rec. | 2.70% | 7,686 | 4.7% | 39 |
| Bureau of Reclamation | 2.40% | 6,845 | 2.2% | 18 |
| U.S. Dept. of Defense | 2.20% | 6,313 | 2.7% | 22 |
| U. S. Forest Service | 1.70% | 4,713 | 1.6% | 13 |
| U. S. Fish and Wildlife Service[a] | 1.30% | 3,670 | 1.7% | 14 |
| Cities | 1.00% | 2,670 | 1.1% | 9 |
| Washington Dept. Fish & Wildlife[a] | 0.80% | 2,137 | 1.0% | 8 |
| Bureau of Land Management | 0.30% | 863 | 0.4% | 3 |
| Counties | 0.30% | 715 | 0.1% | 1 |
| U. S. Dept. of Energy | 0.20% | 500 | 0.1% | 1 |
| Washington universities | 0.20% | 467 | 0.4% | 3 |
| Washington Dept. of Corrections | 0.10% | 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.

such as the lower Snohomish River basin (Witmer and O'Neil 1990). Statewide, we have location information for 280 known or suspected communal roost sites. Many of these sites have no data on the number of eagles present, but in 2000, 33 have had 15 birds or more eagles present. Of these 33 largest roosts, 17 (>50%) were entirely on private land, 7 were entirely on public land, and 9 had 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. The pattern of ownership indicates that without the nesting habitat that exists on private lands, the breeding population of bald eagles in Washington could decline substantially if nesting sites were not protected by state and federal laws.

Future

Trends in the human population suggest that available nesting habitat and the quality of foraging habitat in many bald eagle territories is likely to 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 allocated to houses and businesses doubled in the central Puget Sound region, and a rapid growth rate continues in the Puget Sound. Urbanization and the increase in impervious surfaces takes its toll on bald eagle habitat suitability by degrading water quality, decreasing prey abundance and diversity, and decreasing perching opportunities, and increased disturbance. 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 resulting increase in chronic disturbance that the birds may be slow, or unable to adapt to, there may be a steady removal of trees along 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 ways 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. Land trusts and conservation easements may be important in protection shoreline forest, and the recent increase in attention to improving the water quality of Puget Sound and Hood Canal may slow the degradation of foraging areas.

There are also ecosystem health concerns that bear upon bald eagle habitat suitability in the future. Prey must be relatively abundant and available to the eagles as a prerequisite for successful annual nesting. 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 that 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. 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, although riparian buffers often contain deciduous trees that are unsuitable to nesting (S. Ament, pers. comm.).

# CONSERVATION STATUS

## 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 11). The bald eagle was removed from protection under the ESA in 2007 (USFWS 2007c). The bald eagle is still 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). Protections were clarified in June 2007 when the term "disturb" was defined (USFWS 2007a). 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 currently 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 E). 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).

## Management Activities in Washington

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, Makah, and Colville Indian tribes, are also committed to protecting the bald eagles under their jurisdiction.

## 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, and were conducted

Table 11. 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. |
| 2001 | Washington Bald Eagle Status Report; habitat protection rules revised. |
| 2005 | Statewide surveys find 840 occupied nests in Washington |
| 2007 | 8 August, USFWS removes bald eagles from listing under the Endangered Species Act on. |

in 2001 and 2005. 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 federal de-listing of the species. The draft post-delisting monitoring plan will involve nest surveys conducted at 5-year intervals for a period of 20 years. The scheme is statistically designed to detect a 25% or greater change in occupied nests between 5-year surveys (Millar 2007).

*Mid-winter Bald Eagle Surveys.* Winter counts of bald eagles began in 1962 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, 8x12 mi in area. The standardized Mid-winter Survey was conducted each winter from 1982-89. 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 The Nature Conservancy, National Park Service, U.S. Forest Service, Department of Defense and many volunteers for discrete areas 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 E). 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 because most territories have multiple landowners, these plans are not a comprehensive territory management plan (Appendix C).

Development of bald eagle plans by WDFW biologists began in earnest in 1987. Since 1986, over 2,900 bald eagle plans have been developed between WDFW and various landowner entities for activities on private, state, and municipal lands in Washington. These plans represent agreements for discrete bald eagle occurrences (nest territories or roosts) throughout the state. The number of bald eagle plans developed per year (Figure 16) shows a steady rise from 9 plans in 1987 to 334 in 2006. When analyzed by Waterbury (2000), 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.

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, boating infrastructure, and other development (Table 12). 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 unchanged. The remaining land use activity types each accounted for <2% of total bald eagle plans. The number of bald eagle

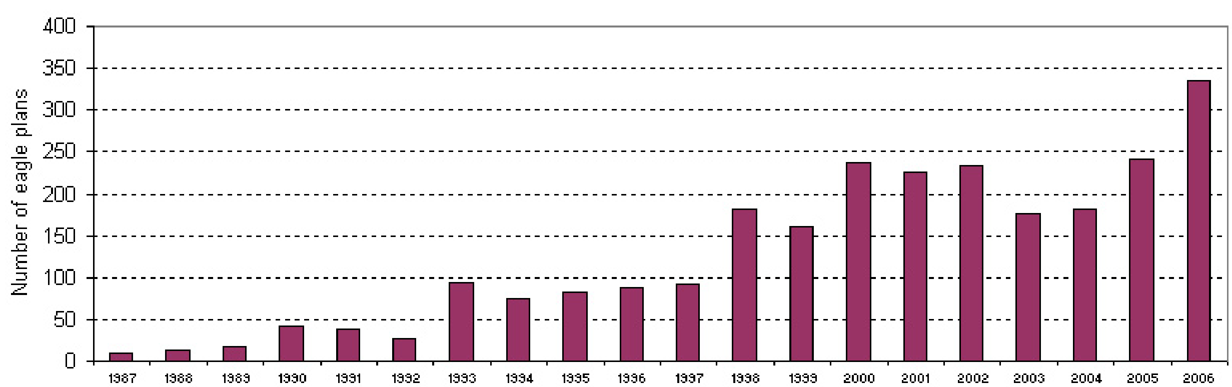


Figure 16. Number of bald eagle management plans signed annually in Washington, 1987 - 2006.

Table 12. 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 |
| Boating infrastructure | 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.

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. Most plans involving >25 ac are for forest practices (Figure 17).

*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. 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).

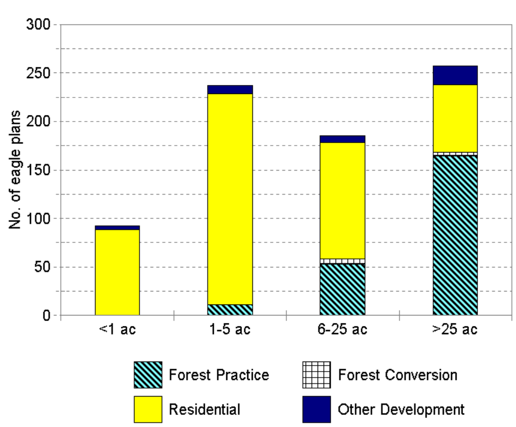


Figure 17. Number of bald eagle management plans for 4 activity types by area category.

*Standard short plans.* In response to escalating development within the Puget Sound region, WDFW and county governments developed the standard short plan, an abbreviated plan tailored for single family and small multi-residential development (Appendix C). These plans specify habitat protections for properties falling between 400- 800 feet from a bald eagle nest or roost, or within 250 ft of a shoreline if within ½ mile of a nest. 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 or by WDFW biologists when landowners seek grading, septic, and/or building permits. Standard short plans account for an increasing proportion of eagle plans and comprise the vast majority of plans signed each year. The development of standard short 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 conditions based on landowner objectives and site specific factors (Appendix D). The conditions negotiated in bald eagle plans then become the key components of a legally-binding contract between WDFW and landowners. In bald eagle plans prescribing habitat protection measures, four general types of vegetation management strategies are 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. Plans generally contained restrictions on activity during the most sensitive nesting period (timing restrictions), but these were no longer imposed after 2001. Since that time, timing recommendations are sometimes included in plans.

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 those amended plans, 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.

## 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, lifetime productivity, 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, Watson 2002); the effects of habitat change and human disturbance (Knight et al. 1991, McGarigal et al. 1991, Stalmaster and Kaiser 1997b,1998, Parson 1994, Schirato and Parson 2006, 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 habitat and wetland that protected habitat for bald eagles were acquired through state grants from the Washington Wildlife & Recreation Program.

### 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, but 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 cannot be readily quantified. Farmers and ranchers sometimes purposely leave carrion in their fields to provide food for eagles. A few landowners have even had nest platforms erected on their property to encourage eagles to nest there.

*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. 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, Northwest Raptor Center (Sequim), West Sound Wildlife Shelter (Bainbridge Island), and other licensed rehabilitators have cared for numerous injured bald eagles and released them, or provided them to educational institutions when the injuries were crippling and release was not feasible. 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. In 2000, the island had 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) still hampered eagle reproduction. The population was maintained by intensive manipulation of chicks and eggs, including artificial incubation of the abnormally fragile eggs, fostering of chicks for many years, and the release of 16 additional eagles through hacking (Institute for Wildlife Studies: www.iws.org). Finally in 2006, a chick hatched normally and fledged on Santa Cruz Island, the first successful fledging on the northern Channel Islands since 1949. Two nests hatched eggs unaided on Santa Catalina in 2007, the first since 1945.

*EagleCams*. 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 small video 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 http://wdfw.wa.gov/wildwatch/eaglecam/index.html . In 2007, 4 eagle nests were equipped with cameras. The EagleCam website recieves around ½ million 'hits' each nesting season and has provided an incredible opportunity to inform and educate the public about eagles and their conservation. The program is a great success and the concept has been applied to several other species, and copied by many other agencies and organizations.

## FACTORS AFFECTING CONTINUED EXISTENCE

### Adequacy of Existing Regulatory Mechanisms

*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 (later updated to include golden eagles). 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 (ESA) in 1978 as a Threatened species was significant in terms of increased awareness of the eagle's decline and the identification and subsequent protection of important nesting, roosting, and wintering habitat. Protection of the bald eagle under the ESA was very successful in part because it was an important factor in addressing several threats, including DDT, compound 1080, lead shot in waterfowl, electrocution hazards, habitat loss, shooting, and the black market in eagle parts. 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 was removed from protection under the ESA in 2007. Eagles, their nests, and eggs are still protected under the Bald and Golden Eagle Protection Act, the Migratory Bird Treaty Act, and the Lacey Act. Protections under the Bald and Golden Eagle Protection Act were clarified in 2007 by defining the term "disturb" (USFWS 2007a):

> Disturb means to agitate or bother a bald or golden eagle to a degree that causes, or is likely to cause, based on the best scientific information available, (1) injury to an eagle, (2) a decrease in its productivity, by substantially interfering with normal breeding, feeding, or sheltering behavior, or (3) nest abandonment, by substantially interfering with normal breeding, feeding, or sheltering behavior.

USFWS (2007b) proposed new permit regulations to allow incidental take under the Bald and Golden Eagle Protection Act similar to incidental take under Sections 7 and 10 of the ESA. The proposed revisions would provide for incidental take through otherwise lawful activity by holders of permits.

*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 2006). Schirato and Parson (2006) 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. 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.

*Forest and Fish.* The "Forest and Fish" Forest Practices rules (FFR) intended to protect habitat of salmonids and certain stream amphibians in the State Forest Practice code (WAC 222) will provide some 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 eagle nests (85%) are >100 ft from water, so many will be beyond the linear riparian buffers required by Forest and Fish rules. 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. In addition to protecting some nests and roosting habitat, the protection of salmonid populations, particularly chum and coho will provide benefit to the bald eagle. The FFR rules are complex and the 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 (RCW 90.58). 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. Shorelines converted to non-forestry uses are regulated by counties and cities under Shoreline Master Programs required by the Shoreline Management Act (RCW 90.58). Local jurisdiction's shoreline Master Programs vary and may include partial exemptions for existing small residential lots, and small lots drastically reduce the options and opportunities for protecting eagle nests in bald eagle management plans. Shoreline Master Programs are required to provide for "no net loss of ecological function" (WAC 173-26-186 § 8) Washington Department of Ecology predicted that "over time, the rate of habitat degradation on shorelines should slow..."(WDOE 2000).

*County ordinances*. Bald eagles nest in at least 33 counties in Washington. County ordinances vary widely in the degree of recognition and environmental review required for eagle nest and roost sites. County permitting agencies are often the first point of contact for people clearing or developing land, and counties can and often do greatly facilitate eagle protection by informing landowners of the need for a bald eagle plan, and processing a short plan, or providing contact information for WDFW. 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. Most counties use 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 including bald eagle nests and roosts identified as priorities for management and preservation. Counties with geographic information system (GIS) capabilities are able to download a bald eagle map from WDFW. At least 10 counties have ordinances that refer specifically to protections under the state bald eagle rules (WAC 232-12-292).

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. 1997). Of 441 Washington stocks assessed in 2002, 163 were rated healthy, 110 were depressed, 21 critical, and 9 extinct; 138 stocks were of unknown status or not rated (http://wdfw.wa.gov/fish/sasi/2002_summary_tables.pdf ). Fortunately many of the large and medium spawning populations are rated healthy (Table 13).

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 2002). Summer runs typically do not spawn until August or September.

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 >90% in the marine derived nitrogen and phosphorous once delivered annually to ecosystems in Washington, Oregon, Idaho, and California (Gresh et al. 2000). Although not all river systems have dramatically reduced salmon runs, this change in nutrient availability may have profound effects on the productivity of some ecosystems. The possible impacts to various prey populations and ultimately bald eagles is unknown. Gresh et al. (2000) recommended the development of "ecological escapement" goals as an alternative to harvest-minded conventional approach.

*Chum and pinks*. Salmonids, inluding chum, pink, coho salmon, and steelhead, are an important fall and winter food for bald eagles. Of these, chum

Table 13. Summary of condition ratings for salmon and steelhead stocks in three regions in Washington, 2002 (http://wdfw.wa.gov/fish/sasi/2002_summary_tables.pdf ).

| | Stock condition | | | | |
|---|---|---|---|---|---|
| Region | Healthy | Depressed | Critical | Extinct | Unknown/not rated |
| Puget Sound | 38% | 24% | 6% | 4% | 28% |
| Coast | 53% | 11% | <1% | 0% | 35% |
| Columbia River | 17% | 42% | 7% | 1% | 33% |
| Total | 37% | 25% | 5% | 2% | 31% |

salmon are the most important due to their spawning time and the concentration of carcasses. Wild chum salmon make up the majority of wild salmon in the region, and are distributed throughout streams of Puget Sound, Hood Canal, and the Strait of Juan de Fuca. Chum salmon are the most abundant salmon species in the Puget Sound region and have increased substantially in recent years as a result of a favorable climate pattern and successful fishery management (Fig. 18). A recent NMFS coast-wide review concluded that Puget Sound chum are "at or near historic levels," (Johnson et al. 1997), with escapements averaging >600,000 spawners for 1998-2005 in the Puget Sound region (K. Adicks, pers. comm.). During 1998-2005, wild and hatchery runs combined averaged 2 million fish/year. Pink salmon are also "close to historic levels" in the Puget Sound region, with escapements averaging >2 million/year for 1999-2005 (K. Adicks, pers. comm.). The Skagit, Snohomish, Stillaguamish, and Nooksack River systems have traditionally had the largest runs, but in recent years the Green and Puyallup have had larger runs than the Nooksack and Stillaguamish (K. Adicks, pers.comm.). 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 eagles 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

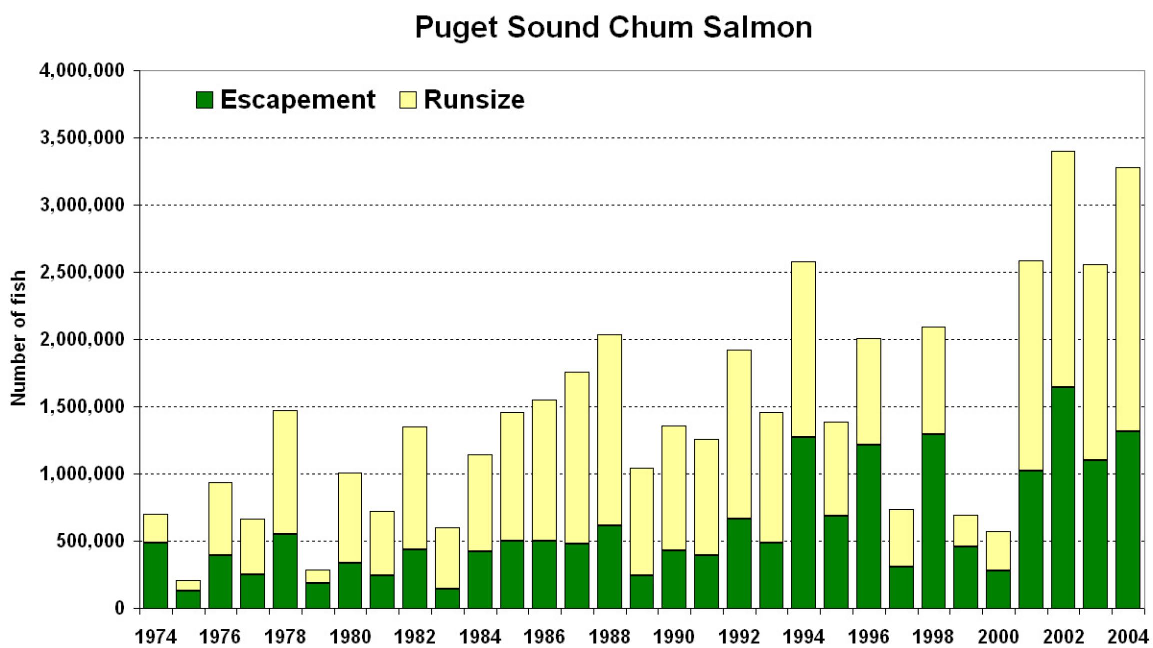


Figure 18. Run size and escapement of Puget Sound chum salmon, 1974-2004.

salmon runs are healthy, some coho runs are not: only 47 of 94 are rated as healthy, 9 are depressed, 2 are critical, and 36 are unknown. Depressed stocks include the lower Columbia, Lewis, and Cowlitz 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.); the stock is now rated as depressed, and was listed as federally Threatened 11 June 2007 (NMFS 2007). 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. Chum salmon are abundant, coho stocks on the Skagit were rated as depressed due to a sharp decline in spawning escapement, but were upgraded to healthy in 2002. Spawning and rearing habitat quality has generally deteriorated over the years and approximately 25-35% of potential fresh water coho production has been lost due to impacts of flood control, logging, agriculture, hydropower, urbanization, 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 17 % of stocks were rated healthy (Table 13). 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 1/2 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; this activity has since expanded to other watersheds with the help of volunteer organizations. 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 D). 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 on the Skagit are exploited by eagles (Watson and Pierce 2001), and the carrying capacity may not be reached when feeding conditions are favorable further north (Hunt et al. 1992c).

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 evaluated for listing under the federal Endangered Species Act in 1999-2000. The National Marine Fisheries Service 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). Of Puget Sound herring stocks, 9 (50%) are considered healthy or moderately healthy, while 6 (33%) are depressed, and 3 (16%) are critical (Stick 2005).

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 declines in native fishes and nesting sites 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. Hunt et al. (2002) reported that reproductive success of bald eagles on river sections affected by dams was nearly identical to that on free-flowing river sections of rivers in Arizona. Water development projects including >1,000 dams (those holding ≥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, 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 30 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: -95%; red-necked, *Podiceps grisegena*: -89%; horned, *P. auritus*: -82%); loons (common: -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 (*Histrionicus histrionicus*: +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). 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 lack of recovery may result from a change in ocean conditions or a combination of El Niños, gillnet mortality, oil spills, 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, and perhaps a dozen pairs nested on both Protection and Smith islands in 2007, although there were 41 bald eagles on Smith Island (S. Pearson, pers. comm.). The cause for this long-term decline has not been determined.

*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 harvest pressures, shellfish are impacted by past and chronic contamination of sediments.

Disturbance and Habitat

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 and lynx, most bald eagle habitat is on private lands, and private lands near shore are highly valued for residential development.

*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 2004, 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 reported nest failure caused by disturbance, while others did not find 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, some 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).

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

1) 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 (Grubb and King 1991, Grubb et al. 2002, Watson 2004). The distance to disturbance is the single most important element of any potential disturbance. Watson (2004) found that the most important factor was the vertical height of the nest, followed by the horizontal distance to the human activity. 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) Bald eagles vary in their sensitivity to disturbance, but generally when given a choice, eagles nest away from human disturbance. In Washington for example, the lower density of nesting eagles along heavily urbanized areas of Puget Sound relative to the San Juan Islands 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 1920, 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 1,640 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, 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 et al. (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) 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. 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 > 1,312 ft (400 m). In Oregon, Anthony and Isaacs (1989) recommended against clearcut logging, road building, hiking trails, and boat launches <1,312 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 1,690 ft (500 m), and for flight response was 656 ft (200 m); variation in response demonstrated the need for specificity in management. Grub et al. (2002) concluded that the current level of recreational watercraft in Voyageurs National Park, Minnesota did not appear to be having a negative impact on nesting eagles. Their model indicated that distance and duration of disturbance was the most important factor, and they suggested excluding watercraft from within 100 m of nest trees, and a no-stopping zone between 100-400 m.

4) Disturbance reduces the time eagles spend incubating, and incubation time affects nesting success. 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) In the Puget Sound area, pedestrian activity is the most frequent cause of disruption of eagle nesting activity. 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 curtailment of pedestrian activities within 394 ft (120 m) of nests and high screening cover would be most effective in reducing eagle disturbance (Watson 2004). 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) Maintaining high levels of nest screening and tall nest trees reduces visible and audible disturbance to nesting eagles and heavy vegetative screening dramatically reduced eagle response to human activity (Therres et al. 1992, Watson 2004). 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).

In addition to the issues of active disturbance and habitat alteration discussed below, passive displacement often goes unnoticed, but may 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 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). 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) indicated an increasing trend in wintering bald eagle numbers on the Skagit River between 1982 and 1993.

Becker (2002) reported that construction of a large industrial facility at the Hanford nuclear site on the Columbia River 460 m from a small roost did not appear to affect use of the roost or behavior of the birds. 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.

Acclimation to human environments opens up more habitat to nesting and foraging, but can place eagles in hazardous situations. Fledgling eagles from suburban nests in Florida experienced considerably higher mortality, primarily from human-related factors (Millsap et al. 2004). Suburban fledglings did not regard dangerous situations with the same degree of caution exhibited by rural fledglings and this sometimes resulted in mortality (e.g., powerlines, landfills, vehicles).

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). In 2000, a nationwide study of 143 lakes by the Environmental Protection Agency found high levels of DDT in lake trout from Lake Chelan (Seattle Times, 18 Oct 2002). Residual DDT and PCBs continue to accumulate and concentrate during the lifetime of individuals as they 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). Elliott et al. (2007) report that among 16 osprey eggs collected from throughout Washington, Oregon and British Columbia, eggs from the lower Columbia had the highest levels of DDE. 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, Bowerman et al. 2002).

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).

Mercury from both naturally occurring sources in the earth's crust, and derived from air pollution from coal-fired power plants accumulates in aquatic organisms. Mercury is the most frequent cause of public health advisories about eating fish (USFWS 2007c). Consumption of prey containing mercury is known to affect growth, development, behavior, and reproduction in birds. Elevated levels of mercury have been detected in bald eagles in the Pacific Northwest, Montana, the Great Lakes region, New England, and Florida (DeSorbo and Evers 2005, USFWS 2007c). The U. S. Fish and Wildlife Service concluded that mercury and other contaminants do not seem to be having a significant impact on the bald eagle in the 48 contiguous states (USFWS 2007c). However, the regional or local effects of mercury and other contaminants on eagle reproduction may be masked by recruitment of new breeders from outside the area.

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). Millsap et al. (2004) noted that three eagles died at landfills in Florida, and they believed the likely cause was barbiturate poisoning from scavenging euthanized pets, which had also been reported in South Carolina. National Wildlife Health Lab records include 50 cases of bald eagle poisoning by barbiturates (Millsap et al. 2004).

*Avian Vacuolar Myelinopathy*. The deaths of bald eagles from a neurological disorder at lakes in several southeastern states have been attributed to a toxin that has yet to be identified (Buehler 2000; Ornithological Newsletter 142:2-3 [June 2001]). 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]). Between 1994 and 2003, 99 eagles died, and the cause of AVM is still unknown. So far, AVM has only been observed in the southeastern states, but it indicates that the era of mysterious bird deaths due to chemical contaminants is not past. Despite these mortalities, eagle populations in the southeastern states have increased, and it is not perceived as a significant threat to the species (USFWS 2007c).

*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 to poisoning from spent lead pellets. A total of 1,323 dead trumpeter and tundra swans (*Cygnus buccinator, C. columbianus*) were picked up in Whatcom County, Washington and the Sumas Prairie area of British Columbia from 2001-2006 (WDFW/Canadian Wildlife Service/USFWS 2006). Although swan carcasses are collected relatively quickly for analysis and to prevent secondary poisoning of scavengers, an additional unknown number of carcasses were likely scavenged, or the swans depredated while experiencing sublethal effects. An interagency working group is investigating the source of lead and potential solutions to the problem. Sampling of lakes and soils in foraging and roosting sites suggests that sources of the lead may include residual pre-ban deposits, continued illegal use of lead shot by a small percentage of waterfowl hunters, and deposits in fields from upland game hunting (Cullinan 2006).

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). Lead poisoning from bullets in scavenged ungulate carcasses is apparently preventing recovery of reintroduced populations of California condors in California and Arizona (Snyder and Snyder 2000, Cade 2007). Spent bullets in deer carcasses and lead pellets in injured upland birds are implicated in lead poisoning of golden eagles in Washington (Watson and Davies 2006). Another potential source of lead exposure for eagles includes sinkers ingested by fish.

*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 from unaffected areas 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 carcasses 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 prosecuted two cases involving the smuggling of parts of 130 eagles which were killed on Vancouver Island, British Columbia (T. Chisdock, pers. comm.). In another case, 14 eagle carcasses with feet and tails cut off were found in North Vancouver in 2005 (Seattle Times, 4 February 2005). 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.

*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. Millsap et al. (2004) noted electrocutions are still apparently a significant source of mortality for suburban-reared fledglings in Florida.

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.). In 2007, at least 1 eagle was electrocuted in Clallam Count, and 2 in Jefferson County (S. Ament, 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 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 15 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 have developed procedures in recent years 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 retrofitted >20 sites with protective equipment in Skagit, Whatcom, and Island counties and were evaluating at least 60 additional sites for possible retrofits (M. Walters, pers. comm.).

*Wind power turbines.* Wind energy projects are increasing in number and distribution in Washington, and bird collisions with turbine blades are known to be a significant source of mortality at some locations in other states (Thelander 2004). Although bird mortalities at some sites with newer generation turbines have been extremely low (Johnson et al. 2002), wind turbines located near water or along migratory corridors could pose a significant hazard to bald eagles and other raptors. Although the situation at Altamont Pass in California is rather unique, a study there determined that 40% of golden eagle mortalities resulted from turbine blade strikes (Hunt 2000). Sites for proposed wind energy projects must be carefully evaluated for the potential for significant mortality of migrating or resident raptors, including bald and golden eagles (Anderson et al. 1999).

*Vehicle and train collisions*. Bald eagles are occasionally killed or injured 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

The bald eagle population has increased dramatically in the past 30 years. Although the bald eagle has been removed from the list of Threatened species under the federal Endangered Species Act, it remains protected by provisions of the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act. In addition a 20-year post de-listing monitoring scheme will be administered through the USFWS designed to detect a 25% population change between 5-year survey intervals (Millar 2007).

Although the bald eagle population has recovered substantially, the human population of Washington is expected to increase by 2 million to 7.7 million by 2020, and may double to 11 million by 2050 (WDNR 1998). In addition to nesting and roosting habitat issues, climate changes and recent seasonal die-offs of fish and marine invertebrates in parts of Hood Canal caused by a decline in water quality suggest that the future still holds uncertainty for any species that depends on food from our marine, estuarine, and river ecosystems.

On marine, lake, and river shorelines the needs of eagles often conflict with the desires of humans. Shorelines afford the water views so desirable for residential development so forest near shorelines is often cleared. State bald eagle protection rules, the Shoreline Management Act, Forest and Fish rules, zoning restrictions, and some concerned landowners all may moderate the rate of forest clearing. 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) applies to the bald eagle if it is listed as state Endangered, Threatened, or Sensitive. 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). The prospects for the eagle population would be uncertain without these habitat protections in place. Also, without the habitat protection rule and planning process that WDFW has administered since 1986s, activities of Washington landowners might come in conflict with the Bald and Golden Eagle Protection Act.

While the bald eagle population is likely to remain below the historic numbers of the early 19th century, the number of nesting pairs in Washington is about eight times the number present when the use of DDT was banned. The security of nesting and roosting habitat is an important factor affecting the future viability of the species, and only about 10% occurs on lands devoted to conservation (Stinson et al. 2001). Assuming that no new environmental contaminant crisis or other factor causes widespread mortality or reproductive failure in the future, and if current levels of habitat protection continue, then the bald eagle population may stabilize around 6,000 birds.

For these reasons the Department recommends that the bald eagle be down-listed to Sensitive in the State of Washington.

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Coastal Refuges Office
Sequim, Washington

[a]Information received during preparation of the 2001 report, and several individuals have since moved to other locations or positions.

Appendix A. Seasonal movements and breeding locations of bald eagles that winter in Washington

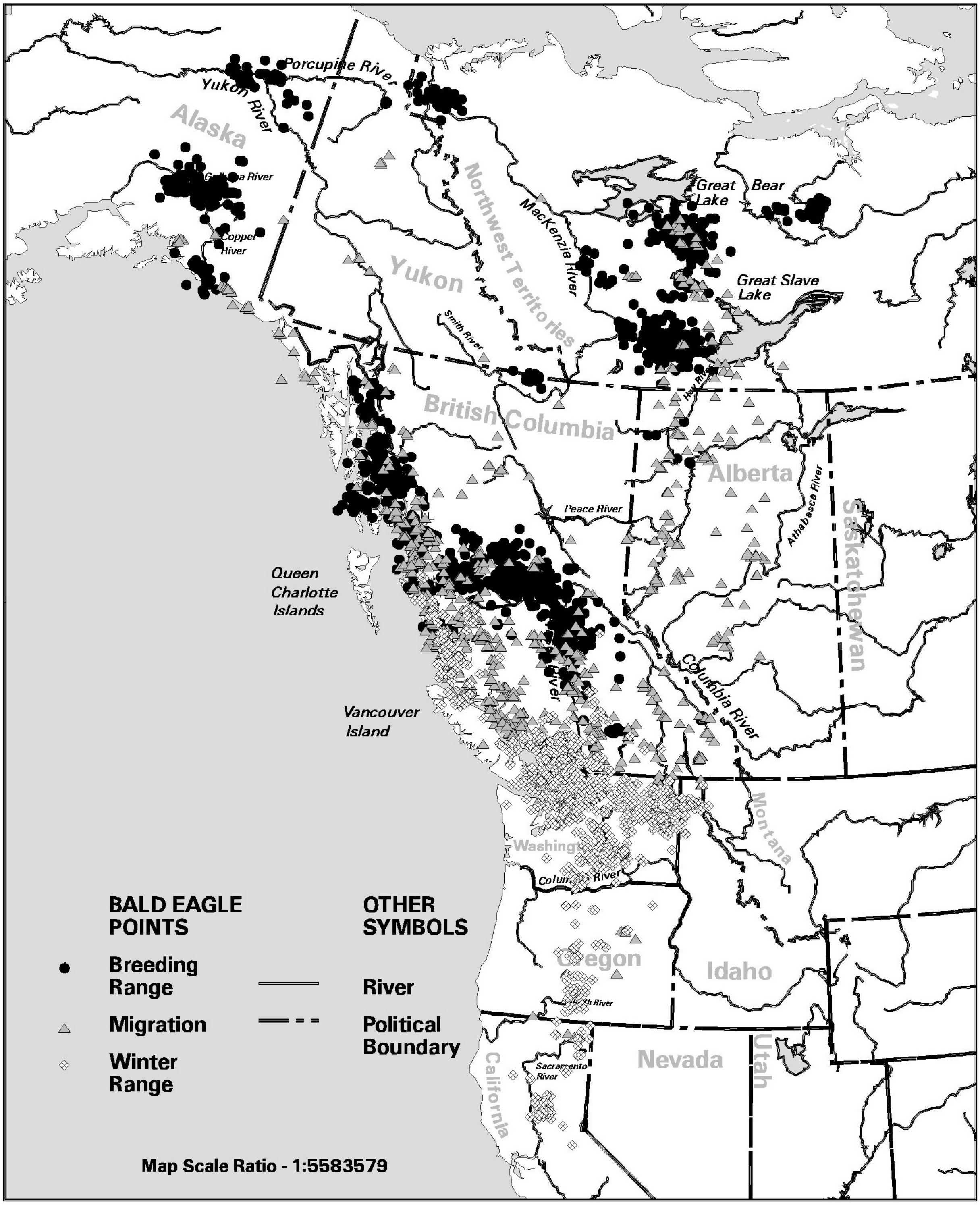


Figure 19. Satellite locations during 1996-2000 (n= 8,061) on the winter range, in migration, and on breeding areas for 26 bald eagles captured on the Skagit River, Washington (from Watson and Pierce 2001).

## Appendix B. Formulas for estimation of Moffat's equilibrium population

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:

$$A = Cjsv + Cjsva + Cjsva2 + ... + Cjsva\ w-1 = (Cjsv(1-aw))/(1-a)$$

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:

$$Y = C(1+j(1+s+s2+...s\ v-1))$$

## Appendix C. Bald Eagle protection in Washington

Prepared by Julie Stofel, November 2005; revised in July 2007 by Elizabeth Rodrick, and Gretchen Blatz, WDFW

Bald eagles are protected by both state and federal law. This document covers Washington state law, which addresses bald eagle habitat protection. Federal law, which addresses both nest tree protection and protection from harassment, is discussed in the Harm or Harassment of Eagles section, below. In July 2007, the bald eagle was removed from protection under the federal Endangered Species Act. However, two other federal laws still provide protection for the bald eagle, the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act. These laws primarily address nest tree protection and protection from harassment. Federal laws and regulations come into play when a federal permit is required (such as a dock permit from the Army Corps of Engineers), or when a federal crime, such as harm to an individual eagle or nest, is suspected. The federal delisting is expected to be followed by state downlisting. However, bald eagles will remain protected under other state and federal laws.

Bald eagle habitat protection in Washington State is authorized by the Bald Eagle Protection Law of 1984, RCW 77.12.655. This law requires the establishment and enforcement of rules for buffer zones around bald eagle habitat. The law states that the rules shall take into account the need for variation of the extent of the zone from case to case. A group of stakeholders developed the Bald Eagle Protection Rule, WAC 232-12-292, and it was adopted by the Washington State Wildlife Commission in 1986. The primary focus of the Bald Eagle Protection Rule is to protect habitat via site management plans.

### Bald Eagle Management Plans

A Bald Eagle Management Plan (BEMP) is a habitat protection agreement between Washington State Department of Fish and Wildlife (WDFW) and the landowner ensuring minimal impact on bald eagles and reasonable land use for the owner.

Prior to most property improvement or other land use, a permit application must be submitted to the appropriate agency. Washington Dept. of Natural Resources (DNR) reviews all proposed timber and mining proposals, and county permitting departments handle clearing, storm water and shoreline, septic and building permits, etc. If you are not sure about the need for a permit, it is best to ask beforehand. Delays and penalties can be costly. If the activity is near an eagle nest or roost (discussed below), the permitting agency works with WDFW and the landowner to develop a Bald Eagle Management Plan (see WAC 232-12-292, section 4.4). This plan will not prevent the landowner from reasonable use of the property, but it will ensure that development will have the least impact possible on the eagles and their habitat. There are no specific requirements established by the enabling language of the rule, but to ensure consistency across landowners, WDFW has established basic guidelines. . WDFW has described the scientific basis for bald eagle site management in the Priority Habitat & Species Management Recommendations for the Bald Eagle. Management Guidelines are used by WDFW biologists in developing bald eagle management plans and ensure that fair and even treatment is extended to all landowners. The bald eagle management plan guidelines have changed significantly since the bald eagle management planning process was begun in 1986. These changes reflect the increasing population of eagles, the apparent increasing tolerance of eagles in urbanizing areas, and WDFW's interest in accommodating landowner goals and reducing landowner burdens while minimizing impacts on critical eagle habitat. The guidelines discussed below were updated in 2001.

*Please be aware that activity on federal land, or involving a permit from a federal agency such as the Army Corps of Engineers, requires approval from the U.S. Fish & Wildlife Service. Contact your federal permit reviewer for guidance.*

#### The Standard Bald Eagle Management Plan

For activities that are within 800 ft of an eagle nest, but not within 400 ft of the eagle nest, and for activities that are within 250 ft of the shoreline or its adjacent bank and within ½ mile of an eagle nest, but not within 400 ft of an eagle nest, the following basic conditions are applied. See diagram below.

1. Retain all known perch trees and all conifers greater than or equal to 24 inches diameter at breast height (24" dbh, measured at 4 ½ ft above the ground).

2. Retain all cottonwoods greater than or equal to 20" dbh, in counties where cottonwood nests occur.

3. Retain at least 50% of pre-clearing or pre-construction conifer stand with diameter distributions representative of the original stand (>6 feet tall).

4. Windowing and low limbing of trees is acceptable provided no more than 30% of the live crown is removed. Topping of trees is not allowed.

*The conditions listed above are part of what is called the "Standard Short Plan". It is pre-approved by WDFW for activities that do not require a DNR permit (forest practice application). It is available from the county or city permit desk for parcels and activities that meet the distance definitions. No site visit by WDFW is necessary in these cases. There is no cost to the Bald Eagle Management Plan.*

**The Site-Specific Bald Eagle Management Plan**

For activities that are within 400 ft of an eagle nest, a site-specific plan is required. Any landowner who feels that the conditions of the Standard Short Plan cannot be met may request a site-specific plan. A site-specific plan is also required for any forest practice activity that is within ½ mile of an eagle nest (but see "No Conditions Plan", below). A site-specific plan is also required for any activity within ¼ mile of a bald eagle communal roost. There is no cost to the site-specific plan, but it is more time consuming to obtain. Typically, a site-specific plan can be obtained in 2-6 weeks, depending on the complexity. Landowners may hire a qualified consultant to prepare a bald eagle management plan for WDFW approval. While this is not necessary in most cases, it can help save time by ensuring that all the necessary documents are complete. To request a site-specific bald eagle management plan, provide the following information to the WDFW bald eagle biologist for your area:

1. Landowner name, mailing address, telephone number, and email address

2. Requestor's name, mailing address, telephone number, and email address (if different from above)

3. County in which the activity will occur

4. Parcel number

5. Site address of parcel (if available)

6. Parcel map (available from county) or Forest Practice Base Map (available from DNR) showing the parcel/activity area and the Township, Range, Section, and Quarter Section

7. A site map showing the activity:
   a. Forest Practice Activities: the timber harvest boundary and buffer boundaries must be marked, with the location of the eagle nest shown.
   b. Subdivisions and short plats: include the plat map and show the location of the eagle nest, and the location of currently forested areas.
   c. Building Permits (and related permits, like clearing and grading and septic): show the location of the eagle nest, and the locations of conifer trees greater than or equal to 24" dbh that will be affected by the activity. Also show the locations of conifer trees greater than or equal to 24" dbh that will be protected and retained. Show the proposed locations of house, driveway, garage, septic, and any other clearing activity

   Note: For site-specific information, contact the WDFW bald eagle biologist for your area.

Once the biologist has received the above information, you may be contacted to arrange a site visit. A site visit may be required for activities within 400 ft of a nest site.

**The "No Conditions" Bald Eagle Management Plan**

Forest Practice Rules (WAC 222-16-080 6e) require a bald eagle management plan for activities within ½ mile of and eagle nests or ¼ mile of an eagle roost. In many cases, however, WDFW does not require conditions, because the activity is not within 250 ft of the shoreline and is not within 800 ft of the nest or roost. In these cases, WDFW provides the landowner with a plan that explains why no conditions are needed.

**The Communal Roost Bald Eagle Management Plan**

Bald eagle communal night roosts are important winter habitat. Eagles use night roosts as protection from inclement weather and temperature extremes. Night roosts may also serve important social functions. Winter night roosts are generally associated with large, salmon-bearing rivers, although there are some associated with coastal foraging areas. Night roosts are usually on forested slopes, up to 5 miles from the feeding areas. The combination of topography and trees provides the microclimate that is important to roosting eagles. For the purpose of inclusion in the WDFW database of protected sites, a roost is defined as a tree or a group of trees in which at least 3 eagles roost for at least 2 nights and during more than one year. The definition refers to at least 3 eagles to differentiate the communal roost from a perch used by a territorial pair of eagles. Site-specific Bald Eagle Management Plans are required for activities within ¼ mile of communal night roosts. Activities within ¼ mile of eagle roosts are restricted in the winter, generally from Nov 1 to Feb 15, although this may be modified (shortened) for roosts with known activity periods that do not extend through the entire winter season. Leave tree buffers are also required, although the buffer distance varies with the conditions of the site. Timber harvest within communal night roost stands is not permitted.

## How Do I Find Out What Kind of Plan I Need?

Your county planning or permit desk can tell you whether you need a bald eagle management plan and if you are eligible to use the Standard Plan. The Department of Natural Resources will direct you to the WDFW bald eagle biologist for your area. In all cases, you can request a site-specific bald eagle plan from the WDFW bald eagle biologist for your area.

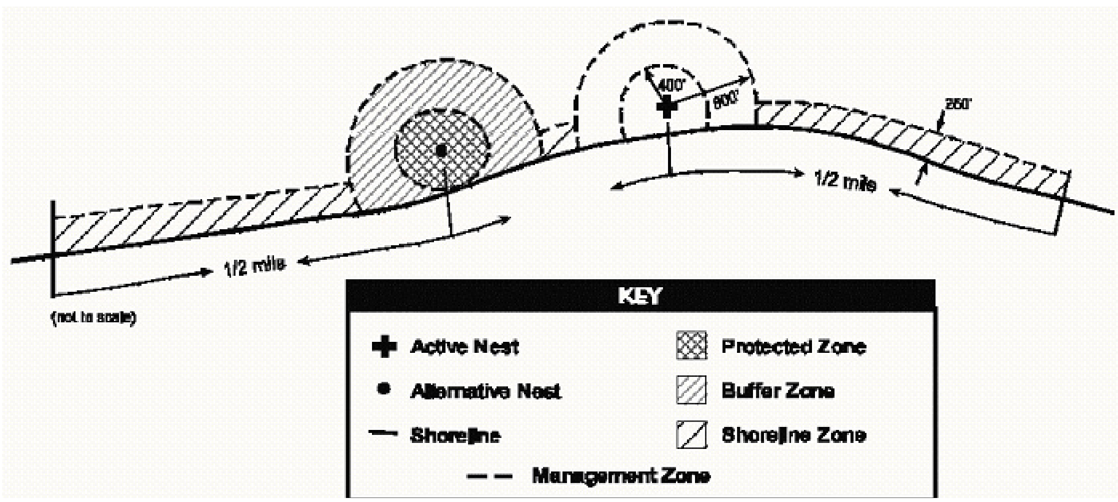


Figure 20. Management zones for bald eagle nests.

<u>Management Plan Zones</u> are defined by distance from a bald eagle active nest tree:

- Within 400' (Requires a Site-Specific BEMP from WDFW)
- From 400' to 800' (Eligible for a Standard 1-Page WDFW BEMP)
- Shoreline Zone: within 250 ft of shoreline if also within ½ mile of a nest. (Eligible for a Standard 1-Page WDFW BEMP)

## How Long Are Eagle Management Plans Good For?

Each year bald eagles return to the same area, known as a breeding territory. In many cases, there are several nests per territory, only one of which will be occupied at a given time. Territories are generally occupied year after year, although it is not unusual for a territory to be unoccupied for one or several years at a time. Sometimes, nests that have not been used for many years are reoccupied by a new pair of eagles that take over part of another pair's territory. The most extreme example known from Washington was a nest that was unoccupied for 12 years before a new pair moved in to take over the north part of the resident pair's territory. Examples such as these demonstrate why it is important to maintain large trees capable of supporting nests, in order to provide for the recovery of the species as a whole. Nest structures may blow or fall out of a tree, or even be dismantled by energetic chicks, but as long as the tree is capable of supporting a new nest, the tree is protected as a nest site. Individual nest sites within a territory are removed from the list of protected sites only if the tree falls naturally or break in such a way as to prevent new nest construction.

A Bald Eagle Management Plan constitutes an agreement by the landowner to protect the eagle habitat on their property. The plan remains in effect indefinitely. However, a change of ownership or a request for a new activity may lead to a new bald eagle plan. If a landowner believes that the site is no longer capable of supporting bald eagles, the landowner can also request a review by WDFW to determine if the bald eagle plan is no longer needed. This is determined by reviewing the history of the site, as well as the physical state of the habitat. In general, WDFW uses a guideline of 5 consecutive years of absence throughout the whole territory (not just at a single nest site) to determine whether a territory is truly “not active”.

As of 1998, WDFW no longer conducts annual nest surveys. The last complete statewide survey was conducted in 2005. Sampling surveys will be conducted at 5-year intervals for the next 20 years to comply with federal monitoring requirements under the Endangered Species Act, but annual surveys are no longer conducted. Therefore, documenting absence for a period of 5 years will become the responsibility of the landowner making the request.

## Timing of Logging or Construction

The Bald Eagle Management Plan is focused on maintaining habitat (nest trees, perch trees, and associated screening trees). As of December 2001, WDFW recommends but does not require that construction or logging activities take place during the least sensitive times periods for eagles, July 15 – January 31.

Eagles are most sensitive to disturbance Feb 1 - April 15. They are establishing territories and beginning incubation at this time. The chicks typically hatch in mid to late April. Once the chicks have hatched, the adults are less likely to abandon as a result of disturbance. The chicks are able to keep themselves warm and feed themselves by late April to early May, so are more easily able to survive periods when the adult is off the nest due to temporary disturbance. The young typically fledge (leave the nest) in mid July. At that time, just before fledging, they are vulnerable and can be frightened off the nest before they are able to fly. When conducting activities that are noisy or that involve people within 400 feet of a nest tree, landowners should take the following approximate schedule into account as much as possible: Feb 1 - May 1, more sensitive; May 1-July 1, less sensitive; July 1-July 15, more sensitive; July 15 - Jan 31, least sensitive.

## Harm or Harassment of Eagles

Harm and harassment of eagles is prohibited by law. The relevant State law is RCW 77.15.130 (regarding harm of protected wildlife). The relevant Federal laws are: USC Title 16 Chapter 5A Subchapter II Section 668 Bald and Golden Eagle Protection Act, which primarily addresses physical possession of live or dead birds or nests or eggs, and the Migratory Bird Treaty Act (USC Title 16 Chapter 7 Subchapter II Section 703). If harm or harassment of eagles is suspected, please call Washington State Patrol and ask to have a wildlife enforcement officer dispatched. In addition, failure to comply with the Bald Eagle Habitat Protection Rule (WAC 232-12-292) may constitute harm to eagles under RCW 77.15.130 (b).

## What About Other Species?

Red-tailed hawks and ospreys are two other species that build large nests in trees. Ospreys also commonly nest on cell phone towers, power poles, and on marine structures like “dolphins” (a group of pilings used for mooring). Great blue herons build medium-sized stick nests in trees, often in groups or colonies. Crows build medium sized stick nests, but they do not nest in colonies like herons. All birds, (except game birds and the following species which are considered nuisance species: crows, magpies, starlings, and English sparrows), are protected by state law (WAC 232-12-011). Nests and eggs of protected species are protected from harm under RCW 77.15.130. Contact your local WDFW biologist to determine whether a nest is active, the species at the nest, and the best methods by which to ensure habitat protection while initiating development near such a nest. Generally, human activity can coexist with nesting wildlife. In rare cases, such as osprey nesting on equipment, the nest may be incompatible with safety or operation of the equipment. In those cases, arrangements can be made with WDFW to determine the best time and method of removal.

## Web Links

Federal Endangered Species Act
www.fws.gov/endangered/policies/index.html

RCW 77.12.655 - Habitat buffer zones for bald eagles -- Rules.
www.leg.wa.gov/RCW/index.cfm?section=77.12.655&fuseaction=section

WAC 232-12-292 - Bald eagle protection rules.
www.leg.wa.gov/wac/index.cfm?fuseaction=Section&Section=232-12-292

WDFW: PHS Management Recommendations for the Bald Eagle
wdfw.wa.gov/hab/phs/vol4/baldeagle.pdf

WAC 222-16-080 Forest Practices requiring Bald Eagle Management
www.leg.wa.gov/wac/index.cfm?fuseaction=Section&Section=222-16-080

RCW 77.15.130 Protected fish or wildlife - Unlawful taking - Penalty.
www.leg.wa.gov/RCW/index.cfm?section=77.15.130&fuseaction=section

USC Title 16 Chapter 5A Subchapter II Section 668
**(Federal Bald and Golden Eagle Protection Rule)**
www4.law.cornell.edu/uscode/html/uscode16/usc_sup_01_16_10_5A_20_II.html

USC Title 16 Chapter 35 Section 1538
**(Endangered Species Act definition for "take")**
uscode.house.gov/download/pls/16C62.txt

USC Title 16 Chapter 7 Subchapter II
**(U.S. Migratory Bird Treaty Act)**
www4.law.cornell.edu/uscode/html/uscode16/usc_sup_01_16_10_7_20_II.html

### Additional Information

Washington State Department of Fish and Wildlife (WDFW homepage)
wdfw.wa.gov/

U. S. Fish & Wildlife Service (USFWS) Endangered Species Information
www.fws.gov/endangered/wildlife.html

USFWS Species Profile for the Bald Eagle
ecos.fws.gov/species_profile/servlet/gov.doi.species_profile.servlets.SpeciesProfile?spcode=B008

## Appendix D. 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.

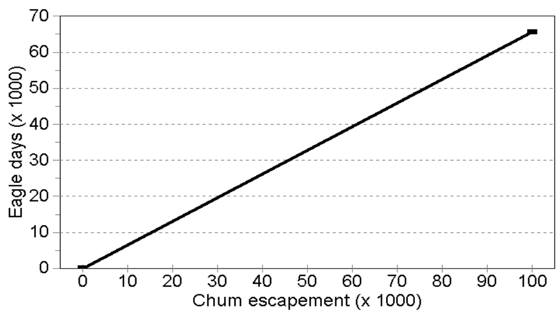


Figure 21. Predicted carrying capacity based on chum salmon escapement assuming all other variables are constant (Stalmaster 1981).

Hypothetical population goal for the river is 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.

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.

**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 maintain the population of the bald eagle so that the species is not classified as threatened, endangered or sensitive in Washington state. This can best be accomplished by promoting cooperative efforts to manage for eagle habitat needs through a process which is sensitive to the 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 "Department" means department of fish and wildlife.

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

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

3.6 "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.

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

3.8 "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. This site is also referred to as the territory defended by a breeding pair of eagles.

3.9 "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.

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

3.11 "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.

3.12 "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.

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. This plan may be a list of conditions on a permit or a more detailed, site-specific plan.

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 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 shall itself and through cooperative efforts (such as memoranda of understandings pursuant to chapter 39.34 RCW) work with other government agencies and organizations to improve the data base for nest and communal roost site activity and productivity and to protect eagle habitats through site management plans.

4.3 The department's goal shall be to identify, catalog and prioritize eagle nest or communal roost sites. The department shall notify permitting agencies of nesting or roost site locations.

4.4 When a landowner applies for a permit for a land-use activity that involves land containing or adjacent to an eagle nest or communal roost site, the permitting agency shall notify the department.

If the department determines that the proposed activity would adversely impact eagle habitat, a site management plan shall be required. The department, a permitting agency, or wildlife biologist may work with the landowner to develop a plan. The department has final approval authority on all plans.

4.5 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, be subject to the site management planning process described in these rules.

4.6 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.

**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 may 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 communal 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 communal 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 may 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) 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.

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 and the landowner shall attempt to develop a mutually agreeable site management plan within 30 days of the original notice to the department.

7.2 Should agreement not be reached, the landowner may request an informal settlement conference with the department.

7.3 If the landowner chooses not to use the informal settlement conference process or if resolution is not reached, the department shall within 15 days provide a site management plan to the landowner.

7.4 Upon issuance of a final site management plan, the landowner may initiate a formal appeal of the department's decision. The appeal shall be conducted according to the Administrative Procedure Act, chapter 34.05 RCW and the model rules of procedure, chapter 10-08 WAC.

A request for an appeal shall be in writing and shall be received by the department during office hours within thirty days of the issuance of the final site management plan. Requests for appeal shall be mailed to Department of Fish and Wildlife, 600 Capitol Way N., Olympia, Washington 98501-1091, or hand delivered to 1111 Washington Street S.E., Wildlife Program, Fifth floor. If there is no timely request for an appeal, the site management plan shall be unappealable.

The written request for an appeal shall be plainly labeled as "request for formal appeal" and shall contain the following:

(a) The name, address, and phone number of the person requesting the appeal;
(b) The specific site management plan that the person contests;
(c) The date of the issuance of the site management plan;
(d) Specific relief requested; and
(e) The attorney's name, address, and phone number, if the person is represented by legal counsel.

The appeal may be conducted by the director, the director's designee, or by an administrative law judge (ALJ) appointed by the office of administrative hearings. If conducted by an ALJ, the ALJ shall issue an initial order pursuant to RCW 34.05.461. The director or the director's designee shall review the initial order and enter a final order as provided by RCW 34.05.464.

**Penalties**

8.1 Failure of a landowner to comply with the processes set forth in these rules or with the provisions of a site management plan approved by the department constitutes a misdemeanor as set forth in RCW 77.15.130.

[Statutory Authority: RCW 77.12.047, 77.12.655, 77.12.020. 02-02-062 (Order 01-283), § 232-12-292, filed 12/28/01, effective 1/28/02. Statutory Authority: RCW 77.12.655. 86-21-010 (Order 283), § 232-12-292, filed 10/3/86.]

## Appendix F. Washington Administrative Code 232-12-297. 232-12-014, and 232-12-297.

### 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 | *Eumatopias jubatus* |
| North American lynx | *Lynx canadensis* |
| bald eagle | *Haliaeetus leucocephalus* |
| ferruginous hawk | *Buteo regalis* |
| marbled murrlet | *Brachyramphus marmoratus* |
| green sea turtle | *Chelonia mydas* |
| loggerhead sea turtle | *Caretta caretta* |
| sage grouse | *Centrocercus urophasianus* |
| sharp-tailed grouse | *Phasianus columbianus* |
| Mazama pocket gopher | *Thomomys mazama* |

(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 gibbosus* |
| common loon | *Gavia immer* |
| peregrine falcon | *Falco peregrinus* |
| Larch Mountain salamander | *Plethodon larselli* |
| pygmy whitefish | *Prosopium coulteri* |
| margined sculpin | *Cottus marginatus* |
| Olympic mudminnow | *Novumbra hubbsi* |

(3) Other protected wildlife include:

| Common name | Scientific name |
|---|---|
| cony or pika | *Ochotona princeps* |
| least chipmunk | *Tamias minimus* |
| yellow-pine chipmunk | *Tamias amoenus* |
| Townsend's chipmunk | *Tamias townsendii* |
| red-tailed chipmunk | *Tamias 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; 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, 77.12.655, 77.12.020. 06-04-066 (Order 06-09), § 232-12-011, filed 1/30/06, effective 3/2/06; 04-11-036 (Order 04-98), § 232-12-014, filed 5/12/04, effective 6/12/04. Statutory Authority: RCW 77.12.047, 77.12.655, 77.12.020. 02-11-069 (Order 02-98), § 232-12-011, filed 5/10/02, effective 6/10/02. Statutory Authority: RCW 77.12.047. 02-08-048 (Order 02-53), § 232-12-011, filed 3/29/02, effective 5/1/02; 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, 77.12.770. 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 | *Marted pennanti* |
| gray wolf | *Canis lupus* |
| grizzly bear | *Ursus arctos* |
| sea otter | *Enhydra lutris* |
| killer whale | *Orcinus orca* |
| sei whale | *Balaenoptera borealis* |
| fin whale | *Balaenoptera physalus* |
| blue whale | *Balaenoptera musculus* |
| humpback whale | *Megaptera novaeangliae* |
| black right whale | *Balaena glacialis* |
| sperm whale | *Physeter macrocephulus* |
| Columbian white-tailed deer | *Odocoileus virginianus leucurus* |
| woodland caribou | *Rangifera tarandus caribou* |
| American white pelican | *Pelecanus erythrorynchos* |
| brown pelican | *Pelecanus occidentalis* |
| 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* |
| mardon skipper | *Polites mardon* |
| Oregon silverspot butterfly | *Speyeria zerene hippolyta* |
| Oregonj spotted frog | *Rana pretiosa* |
| northern leopard frog | *Rana pipiens* |
| Taylor's checkerspot | *Euphydryas editha taylori* |
| Streaked horned lark | *Eremophila alpestris strigata* |

[Statutory Authority: RCW 77.12.047, 77.12.655, 77.12.020. 06-04-066 (Order 06-09), § 232-12-014, filed 1/30/06, effective 3/2/06. Statutory Authority: RCW 77.12.047, 77.12.655, 77.12.020. 02-11-069 (Order 02-98), § 232-12-014, filed 5/10/02, effective 6/10/02. 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.]

## Washington Administrative Code 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 foreseeable 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.

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 5 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 interested parties 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 77.12.047, 77.12.655, 77.12.020. 02-02-062 (Order 01-283), § 232-12-297, filed 12/28/01, effective 1/28/02. Statutory Authority: RCW 77.12.040. 98-05-041 (Order 98-17), § 232-12-297, filed 2/11/98, effective 3/14/98. Statutory Authority: RCW 77.12.020. 90-11-066 (Order 442), § 232-12-297, filed 5/15/90, effective 6/15/90.]

## WASHINGTON STATE STATUS REPORTS AND RECOVERY PLANS

**Status Reports**

| | | |
|---|---|---|
| 2005 | Mazama Pocket Gopher, Streaked Horned Lark, Taylor's Checkerspot | √ |
| 2005 | Aleutian Canada Goose | √ |
| 2004 | Killer Whale | √ |
| 2002 | Peregrine Falcon | √ |
| 2001 | Bald Eagle | √ |
| 2000 | Common Loon | √ |
| 1999 | Northern Leopard Frog | √ |
| 1999 | Olympic Mudminnow | √ |
| 1999 | Mardon Skipper | √ |
| 1999 | Lynx Update | |
| 1998 | Fisher | √ |
| 1998 | Margined Sculpin | √ |
| 1998 | Pygmy Whitefish | √ |
| 1998 | Sharp-tailed Grouse | √ |
| 1998 | Sage-grouse | √ |
| 1997 | Aleutian Canada Goose | √ |
| 1997 | Gray Whale | √ |
| 1997 | Olive Ridley Sea Turtle | √ |
| 1997 | Oregon Spotted Frog | √ |
| 1993 | Larch Mountain Salamander | |
| 1993 | Lynx | |
| 1993 | Marbled Murrelet | |
| 1993 | Oregon Silverspot Butterfly | |
| 1993 | Pygmy Rabbit | |
| 1993 | Steller Sea Lion | |
| 1993 | Western Gray Squirrel | |
| 1993 | Western Pond Turtle | |

**Recovery Plans**

| | | |
|---|---|---|
| 2006 | Fisher | √ |
| 2004 | Greater Sage-Grouse | √ |
| 2003 | Pygmy Rabbit: Addendum | √ |
| 2002 | Sandhill Crane | √ |
| 2004 | Sea Otter | √ |
| 2001 | Pygmy Rabbit: Addendum | √ |
| 2001 | Lynx | √ |
| 1999 | Western Pond Turtle | √ |
| 1996 | Ferruginous Hawk | √ |
| 1995 | Pygmy Rabbit | √ |
| 1995 | Upland Sandpiper | |
| 1995 | Snowy Plover | |

√: These reports are available in pdf format on the Department of Fish and Wildlife's web site: http://wdfw.wa.gov/wlm/diversty/soc/concern.htm.

To request a printed copy of reports, send an e-mail to wildthing@dfw.wa.gov or call 360-902-2515