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Natural Resource Stewardship and Science

Osprey, Peregrine Falcon, and Bald Eagle Nesting in North Cascades National Park Service Complex, Washington

Natural Resource Report NPS/NOCA/NRR—2022/2353

ON THIS PAGE
An osprey (*Pandion haliaetus*) carrying a fish over Diablo Lake, Washington.
NPS / JASON RANSOM

ON THE COVER
Osprey (*Pandion haliaetus*) nest with three young (upper left: NPS / ROGER CHRISTOPHERSEN), bald eagle (*Haliaeetus leucocephalus*) (upper right: NPS / ROGER CHRISTOPHERSEN), and a peregrine falcon (*Falco peregrinus*) in Newhalem, WA (bottom: WASHINGTON DEPARTMENT OF FISH AND WILDLIFE / PAUL DEBRUYN)

Osprey, Peregrine Falcon, and Bald Eagle Nesting in North Cascades National Park Service Complex, Washington

Natural Resource Report NPS/NOCA/NRR—2022/2353

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National Park Service
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Fort Collins, Colorado

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Executive Summary

Osprey (*Pandion haliaetus*), bald eagle (*Haliaeetus leucocephalus*), and peregrine falcon (*Falco peregrinus*) are ecologically important bird species that suffered dramatic population declines during the 1950s through 1970s. Those declines were fueled by accumulating high levels of environmental contaminants, such as lead and pesticides. Such contaminants can have adverse impacts on raptors, including thinning of eggshells that leads to poor reproductive success. Reproductive performance of these species has been used as an indicator of the health of populations. Since the banning of the pesticide dichlorodiphenyltrichloroethane (DDT) in 1974, populations have slowly rebounded. Information relating to their recovery and current status has prompted continued monitoring of these species in many states across the United States, and within North Cascades National Park Service Complex, Washington.

Study areas for this report included the Ross Lake and Lake Chelan National Recreation Areas of the park complex. We conducted surveys for nesting osprey, peregrine falcon, and bald eagle from 1979–2020, 2006–2020, and 2015–2020, respectively. We assessed reproductive output by annually conducting an early nesting survey in mid-April to determine nest occupancy, followed by at least two surveys during late season nesting in early to late July to determine reproductive output. Additional surveys were sometimes necessary during the late nesting period to accurately assess nest occupancy and productivity, depending on individual nesting circumstances. Successful nesting rates were measured by the number of successful nests per occupied nests during the early nesting period. Productivity was measured by the number of young seen on the nest, regardless of age.

We surveyed 1–13 osprey nesting territories annually, and found an occupancy rate of 73%, which is consistent with other populations that are stable; however, the successful nesting rate was only 33%, which is 10–35% lower than success rates reported for other populations. Successful nests averaged 1.4 young per year, which is within the normal range of mean productivity rates reported in western North America (1.3–1.8 young/nest). The percentage of osprey nest sites occupied, and nesting success, both appeared to increase gradually from 1979–2020.

We surveyed 3–7 peregrine falcon nesting territories annually, and found an occupancy rate of 72.5%, which is slightly less than 79–82% occupancy reported elsewhere in Washington. The successful nesting rate for peregrine falcons in the park complex was 51%, and other recovering populations ranged 62–83%. Productivity averaged 1.3 young per nest, which is within the range suggested for a sustainable population with potential for growth (1.25–1.5 young fledged per pair). Since 2009, the number of occupied peregrine falcon territories, successful nests, and peregrine falcon productivity in the park complex exhibited a notable decline.

We surveyed 3–4 bald eagle nesting territories annually, and found an occupancy rate of 47%. This is notably less than a statewide survey in 2005 that reported an occupancy average of 75%. The successful nesting rate in the park complex was 50%, and a minimum level of 45% nest success has been suggested as the threshold for populations to remain stable. Bald eagle nest productivity in in the park complex averaged 0.95 young per occupied nest, which is less than the average 1.2 young

per nest reported for the rest of the United States. Although the time series is short, the percent of occupied nests and nest success both declined from 2015–2020.

The nesting success of all three raptor species was variable from year to year within the study area, which is normal for raptors. Nesting parameters were on the lower end of suggested values for sustainable populations, yet likely represent stable populations. Factors that may affect the reproductive variability observed vary from observation bias to on-going threats arising from anthropogenic disturbance, environmental contaminants, and climate change. Empirical analytical results from liver biopsies of collected bald eagle and peregrine falcon mortalities in the park complex include detections of lead, mercury, and other heavy metals, as well as one polychlorinated biphenyl (PCB). No microplastics were found in gastrointestinal tracts of any of those individuals. Osprey, peregrine falcons, and bald eagles appear to be important sentinels of aquatic ecosystem health and warrant further monitoring. Management implications include the need for more holistic monitoring of ecosystem health that includes consistent community measures across trophic levels (e.g. raptors, fish, aquatic invertebrates), and environmental contaminants in particular, as well as continued assessment of visitor use management and the nexus of climate change with those factors.

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Introduction

Raptors are widely dispersed carnivorous birds that represent an important component of ecosystems, and due to their high trophic level position, often serve as good bioindicators of ecosystem health (Sergio et al. 2008). Some raptors are disproportionately threatened with population declines or extinction, due to their ecology and life history, as well as exposure to anthropogenic stressors (McClure et al. 2018). Their capacity as efficient predators and scavengers of small mammals, insects, and fish plays a vital role in healthy ecosystem functioning by regulating prey populations (Kross 2012, Ives & Dobson 1987), contributing to nutrient recycling and transfer (Şekercioğlu 2006), and promoting species richness in ecosystems (Brown et al. 1988).

The National Park Service (NPS) has surveyed three raptor species in the North Cascades National Park Service Complex (NOCA) through time: osprey (*Pandion haliaetus*), peregrine falcon (*Falco peregrinus*) and bald eagle (*Haliaeetus leucocephalus*). They are considered apex predator species and are protected by the Migratory Bird Treaty Act of 1918 (MBTA), the Bald and Golden Eagle Protection Act, and the Lacey Act of 1900. Despite these protections, all three species exhibited population declines that can be attributed to nest failures resulting from the widespread use of organochlorine pesticides, most notably dichlorodiphenyltrichloroethane (DDT) in the mid-1940s to the mid-1960s (Ratcliffe 1970). This pesticide was widely used in the United States for reducing mosquito populations. Concentrations of DDT in these raptor species had reached levels that impaired reproduction by altering calcium metabolism and causing eggshell thinning in contaminated birds. Severe declines in populations raised concern in the scientific community, which ultimately led to the federal listing of peregrine falcons in 1970 under the Endangered Species Conservation Act of 1969 (a precursor to the Endangered Species Act (ESA) of 1973) and the federal listing of bald eagles under the ESA in 1978. Osprey had suffered dramatic declines, but not devastating enough to warrant federal listing at that time. Since the banning of DDT in the United States in 1972, populations of osprey, peregrine falcons, and bald eagles have increased remarkably throughout their North American range. As a result of this comeback and other recovery goals being met in all recovery regions, the peregrine falcon was removed from the federal endangered species list in 1999 (50 CFR §17.46542) and the bald eagle was removed in 2007 (U.S. Fish and Wildlife Service 2007). The success and vitality of these apex predators is a good measure of the ecosystem health in local or regional areas, especially where large bodies of water occur. These three raptor species are considered Management Priority Species in NOCA because of historical declines, low density, high degree of sensitivity to disturbance from human activities, and strong potential to be affected by environmental toxins via bioaccumulation from aquatic prey species.

Osprey

The osprey is a piscivorous raptor found across all continents, except Antarctica. It is unique among North American raptors as a plunge-diving hunter, diving just below the surface to forage on shallow water and surface-schooling fish. Osprey generally occur along bodies of water where fish are readily available (Poole 1989). They build large stick nests, located historically in trees and cliff eyries, and increasingly on a variety of human-made structures (Poole et al. 2002). Osprey tend not to nest until at least three years of age, and typically incubate 2–4 eggs for 32–42 days; after which, young fledge at 48–58 days (Tekiela 2011). Their lifespan can be 20–25 years, and they may mate for life. Osprey are long-distance migrants, and may travel from NOCA as far as coastal California, Mexico, Central and South America (Tekiela 2011).

Following the ban of DDT use in the United States in 1972, osprey have recovered remarkably, and abundance may now exceed historic levels. The number of breeding osprey, which has been estimated since 1990, reflects a possible increase of ≥50–100% in many areas in recent years (Henry and Kaiser 1996). These changes also likely reflect increased availability of nest platforms and other artificial nesting sites, the osprey's ability to habituate to human activity, and the species' broad piscivorous diet (Poole et al. 2002). The creation of man-made reservoirs may have also contributed positively to osprey recovery by increasing food concentrations, while also increasing shoreline nesting habitat (Vana-Miller 1987). Despite these positive trends, emerging issues may continue to threaten piscivorous raptors, including microplastics accumulation through the trophic hierarchy (Eerkes-Medrano et al. 2015), and bioaccumulation of toxins such as methyl mercury, lead, and polychlorinated biphenyls (PCBs) in lakes and reservoirs (Grove et al. 2009).

Osprey are among the most well-established bioindicator bird species. Natural history traits such as a long lifespan, high nest site fidelity, and an exclusive piscivorous diet make ospreys particularly effective as sentinels of contaminant patterns around aquatic habitats (Henny et al. 2008, Grove et al. 2009). Their nest distribution and productivity are also highly responsive to changes and patterns in the local food webs (Poole 1989, Watts et al. 2004). Efforts to measure osprey population parameters, and collect biological samples from them when possible, may be among the most efficient means of detecting broad-scale ecological change, as well as spatial and temporal prevalence of contaminants in aquatic systems.

Osprey currently maintain nesting territories in NOCA, but they occur in low densities. Most breeding activity occurs along the reservoir shores of Ross Lake National Recreation Area (ROLA) and Lake Chelan National Recreation Area (LACH), and to a lesser extent along major rivers connected to these reservoirs. National Park Service surveys have identified 13 known nesting territories in the park complex.

Peregrine Falcon

Like osprey, peregrine falcons range across all continents except Antarctica, and can be found across all of North America, including the Arctic. The peregrine falcon's diet is mainly comprised of birds, but may include a range of small mammals, amphibians, fish, reptiles, and insects. They are colloquially known as "duck hawks" in some regions because of their persistence around large migratory flocks of ducks on open bodies of water. Peregrine falcons hunt by stooping, or plummeting rapidly down onto their prey, at high speed. With long pointed wings, tapered tail, and flat head, peregrine falcons can attain stooping speeds of 175–200 mph (Tekiela 2011).

Peregrine falcons are sexually dimorphic, with females larger in body size than males. Nesting generally takes place in scrapes (shallow depressions), on cliff ledges, or tall human structures. Availability of suitable nest sites is a factor limiting breeding density and population size (Newton 1988). Peregrine falcons typically nest near an open body of water (White et al. 2002). They are monogamous and solitary nesters, incubating 3–4 eggs for 29–32 days, with young fledging at 35–42 days (Tekiela 2011). Some peregrine falcons migrate to southwestern states, Mexico, Central and South America, while others remain in many parts of the West all year.

Peregrine falcons faced global decline after the introduction of organochloride pesticides in the 1940s, particularly DDT, which caused eggshell thinning and embryonic mortality (Hickey 1969). By the mid-1960s, peregrine falcon populations had plummeted across North America. They had been largely extirpated from the east coast, substantially reduced in the Rockies, and reduced by half in Arctic populations (Fyfe et al. 1976). An inventory published in 1941 reported only 212 nest ledges occupied east of the Mississippi River (Hickey 1942). Subsequently, peregrine falcons were listed as federally endangered in 1970. A combination of legislation banning the use of organochloride pesticides, along with reintroduction efforts through captive breeding and release programs, led to the start of peregrine falcon recovery by the late 1970s (Cade et al. 1988). As a result of this significant comeback and other recovery goals being met in all recovery regions, the peregrine falcon was removed from the US Fish and Wildlife Service's (USFWS) list of Threatened and Endangered Species in 1999 (50 CFR §17.46542). It continues to be listed as a federal Species of Concern and remains under the protection of the MBTA (Mesta 1999).

Peregrine falcons gained state protection in Washington in 1980, with only eight nesting pairs identified statewide. The most recent surveys of peregrine falcon nesting territories in Washington identified 108 territories in 2010, an increase from 91 sites identified in 2006, and 72 sites in 2001. Peregrine falcons were removed from the Washington State Sensitive Species List in 2016 (Vekasy & Hayes 2016).

Peregrine falcons occur in NOCA but are considered rare. Only seven nesting territories have been identified to date. Six are located in ROLA, and a new territory was established in LACH in 2020. Throughout 12 years of North Coast and Cascades Network Inventory and Monitoring surveys for landbirds in NOCA, only incidental observations of peregrine falcons were recorded (Ray et al. 2018). With the peregrine falcon's wide geographic distribution and expansive home range size, NOCA does not appear to represent a significant area of suitable nesting habitat (Hoffman et al. 2015).

Bald Eagle

The bald eagle is a massive, broad-winged raptor, widely distributed throughout North America. They acquire adult plumage at 4–6 years of age, consisting of a dark body with characteristic white head and tail. Both sexes have similar plumage, but are dimorphic, with females growing larger than males. Bald eagles can be found throughout Washington State but are more common in the maritime climate west of the Cascade Range, where they build large stick nests primarily along coasts, lakes, wetlands, and rivers. They often use the same nest year after year and add new nesting material each season. Bald eagles generally begin breeding in their sixth year and can form lifelong pair-bonds between mates (Stalmaster 1987, Jenkins and Jackman 1993). The oldest known wild bald eagle was at least 28 years old, and captive eagles have lived to 47 years (Stinson et al. 2007). Adults often share incubation of 2–3 eggs for 34–36 days, with young fledging in 75–90 days (Tekiela 2011). The bald eagle's primary diet is fish, but they are adept predators and are known to take a variety of mammals and birds (especially ducks), as well as depredating nests and feeding on carrion. Bald eagles have also been known to steal prey from mammals and other birds and have occasionally been observed hunting cooperatively (Stalmaster 1987, Stinson et al. 2007).

Since the arrival of European settlers, bald eagles have faced declines due to habitat loss, reduction of food sources, and persecution by humans. Because a variety of animals were overexploited during the last two centuries, the decrease in carrion from such species as bison, and the reduction in spawning fish populations may have contributed to long-term eagle declines. Development along coasts and lakes also reduced nesting and roosting habitat. Eagles were historically considered a pest species and regularly shot, trapped, and poisoned due to a largely erroneous belief that they posed a threat to lambs and other small stock animals. States would pay bounties for eagle carcasses, along with a variety of predator species, leading to widespread culling of both bald and golden eagles. Eagles were also killed for feathers and body parts (Stalmaster 1987, Stinson et al. 2007).

The use of DDT in the 1940s precipitated even more dramatic declines in eagle populations. Nest failure due to weakened eggshells and direct mortality in adult eagles was rapid, and by 1963, survey efforts found fewer than 700 breeding pairs in the lower 48 states (Stalmaster 1987). In the 1970s, the United States banned the use of DDT and some other environmental contaminants and enacted a number of legislative actions protecting eagles. Bald eagle populations began to rebound, and territories occupied by pairs in the lower 48 states increased from an estimated 791 to 9,789 between 1974 and 2007 (USFWS 2007): Washington saw a 707% increase in occupied territories from 1981–2005 (Stinson et al. 2007).

Bald eagles were one of the first species to be listed under the Endangered Species Preservation Act. Protection was carried over with the enactment of the current ESA in 1973 and expanded to include Washington and the rest of the lower 48 states in 1978. Bald eagles were de-listed from the federal ESA in 2007 (USFWS 2007) but remain under federal protection of the Bald and Golden Eagle Protection Act, the MBTA, and the Lacey Act.

The bald eagle's inclusion in the ESA, and its subsequent recovery, has been celebrated as a major victory for environmental legislation although current numbers are still significantly lower than estimates for pre-European settlement populations (Buehler 2000). Recent data from North America indicate that population growth between 1966 and 2013 was 5.37% annually, and modeling indicates that population growth across the range is projected to continue for another 10 to 20 years until the total population stabilizes at around 228,000 birds ((Kalasz and Buchanan 2016).

A review of all known bald eagle territories in the Washington Species Data Management System indicates that the number of territories has increased by an average of 28 per year since 2005 when the species was down-listed in the state to Sensitive. As of 2015, the total number of known territories in the state was 1,334, but this total reflects the cumulative number of sites and not the number that are known to be active in any particular year (Kalasz and Buchanan 2016). With continued federal protections meant to sustain the population, the species is expected to continue as an important and thriving part of the state's natural diversity for the foreseeable future.

NOCA supports large congregations of wintering bald eagles that come to feed on spawning salmon, particularly along the Skagit River. Winter bald eagle surveys occur between November and March and have been conducted at NOCA since 1982 (Dunwiddie and Kuntz 2001, Rubenstein et al. 2019). The average weekly count of bald eagles during winter on the Skagit River from 1982–2016 was 180 birds (range = 54–371) (Rubenstein et al. 2019). These data provide insight into the demographic and population trends of wintering eagles in NOCA. Wintering eagle populations in Washington can be three or four times those of the breeding population, with migrants arriving from Alaska, Canada, Montana and California (Stinson et al. 2007).

During the breeding season, bald eagles have historically been relatively rare in NOCA, with most breeding activity taking place along lower elevation rivers, lakes, and estuaries outside of park complex boundaries (Smith et al. 1997). However, in more recent years an increase in summer bald eagle activity has been noted in both ROLA and LACH. This information has led to more intensive surveys to determine the distribution, abundance, and reproductive parameters of nesting territories.

Survey Objectives

Survey information, such as territory occupancy, nest success, and productivity are indices of the overall health of raptor populations and are an important part of conservation efforts (USFWS 2003). This information is helpful for resource management, in identifying existing and emerging threats, and applying protection and conservation measures. Over time, population status and trends can be monitored to provide the data necessary for assessing population recovery and resilience.

Diurnal raptor survey efforts in NOCA have focused on osprey, peregrine falcon, and bald eagle. These species are relatively easy to detect by sight or by sound compared to other raptors, though surveys designed to locate nests and monitor reproduction can still be difficult and require a substantial commitment of resources. The primary objectives of these raptor surveys to date were to:

1. Determine the number of occupied nesting territories during each survey year.
2. Determine the number of successful nests each survey year.
3. Determine the number of young produced and fledged.
4. Document any new nesting territories discovered.

Study Area

North Cascades National Park Service Complex is comprised of North Cascades National Park, Ross Lake National Recreation Area (ROLA), and Lake Chelan National Recreation Area (LACH), and is located in north-central Washington (Figure 1). These NPS-managed lands consist of mostly roadless wilderness, except for one highway bisecting the park complex. Within NOCA, 93% of the land is designated as the Stephen Mather Wilderness. The majority of land surrounding NOCA is U.S. Forest Service (USFS)-managed land consisting of the Mount Baker-Snoqualmie National Forest, Wenatchee National Forest, and Okanogan National Forest, which includes the Mount Baker Wilderness, Glacier Peak Wilderness, Lake Chelan-Sawtooth Wilderness, Noisy-Diobsud Wilderness, and Pasayten Wilderness.

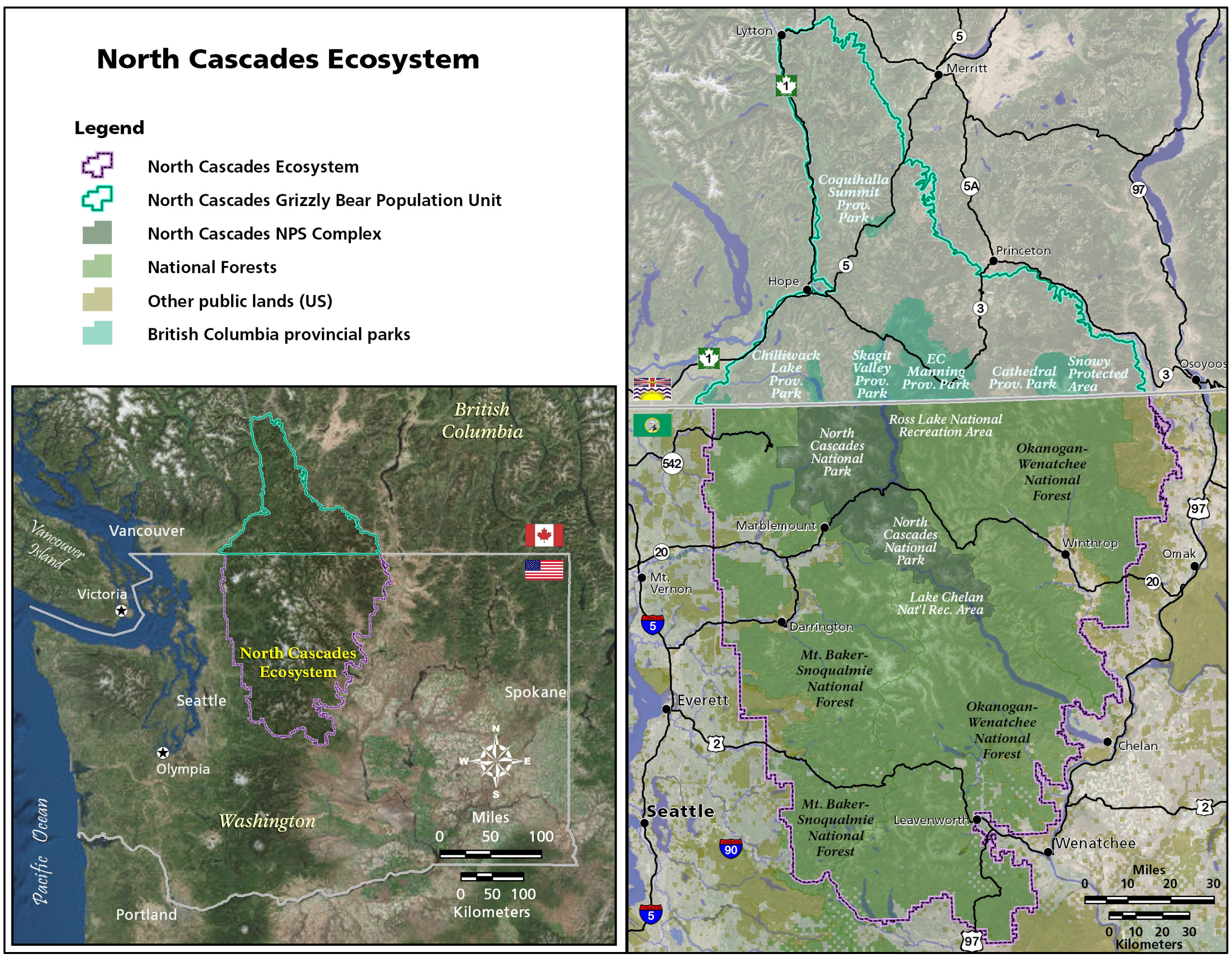

Figure 1. Location of North Cascades National Park Service Complex (North Cascades National Park, Ross Lake National Recreation Area, and Lake Chelan National Recreation Area), as part of the North Cascades Ecosystem.

The complex includes lands from low elevation forested valleys (119 m) to high elevation glaciated mountain peaks (2,806 m), encompassing a total of 276,815 ha. Spanning the crest of the Cascade Range, the park complex lies within two major biogeographic zones: the temperate marine west of the Cascades crest and semi-arid continental east of the Cascades crest (Franklin and Dyrness 1973). This orographic divide affects weather patterns, with the highest amounts of precipitation occurring to the west of the Cascade crest (>500 cm annually), and the least amounts to the east of the crest with <50 cm annually (Mote 2003). Because of the divide and the wide range in elevation and precipitation, the park complex contains a number of life zones (Pojar and MacKinnon 1994). The Douglas-fir (*Pseudotsuga menziesii*), western hemlock (*Tsuga heterophylla*), and western red cedar (*Thuja plicata*) zone is located at river valleys <600 m. The silver fir (*Abies amabilis*) zone exists in mountain forests at elevations of 600 m to 1700 m. The subalpine zone is located in mountain meadows at elevations between 1200 m and 2100 m, while the alpine zone exists at elevations >2100 m (Pojar and MacKinnon 1994).

The two main areas of NOCA where osprey, peregrine falcon, and bald eagle nesting surveys are conducted include the Ross Lake and Lake Chelan reservoirs within the park complex. Each of these areas contains a large reservoir, or chain of reservoirs, surrounded by plentiful forest- and cliff-nesting habitat along the shorelines, and abundant fish, waterfowl and passerines as prey for these raptors.

Methods

Raptors are often secretive about their nesting behavior, and occur in low densities, making them difficult to monitor. In general, the accepted methodology involves intensely searching suitable nesting habitat and locating and observing nests, with a minimum of two to three nest observation visits during the breeding season (Steenhof 1987). Data obtained during NOCA raptor surveys were used to determine various occupancy and productivity parameters, including number of territories surveyed, nesting territories occupied, young per occupied territory and overall nesting success.

Surveys

Surveys focused on known nesting territories of ospreys, peregrine falcons, and bald eagles within ROLA and LACH (Figure 2–4). As additional time and resources were available, observers scanned suitable habitat for potential new nesting territories, in particular osprey and bald eagle nests, that could be readily identified along shorelines.

Over the years, surveys were conducted by various methods including from a helicopter, from a boat paralleling the shoreline, and by foot on the ground with the aid of binoculars and/or spotting scope from locations offering unobstructed views in proximity to nest sites. The number and timing of surveys was sometimes modified slightly when some nesting territories were more accessible than others and could be checked more frequently, or if particular breeding pairs were consistently known to begin nesting earlier or later than other pairs.

Biologists identified nesting territories, counted numbers of adults and young, and mapped each nest location by marking with a hand-held GPS navigation unit. Nest locations were often recorded as nearest approximation, given the logistics and sensitivity of marking the exact occupied nest. We digitized locations of all nests into a Geographical Information System (GIS) layer to spatially map nesting territories and calculate nearest-neighbor distances among territory centers (e.g., the center of all nest locations belonging to a given territory). We used descriptive statistics to describe nest occupancy, nesting success and productivity parameters.

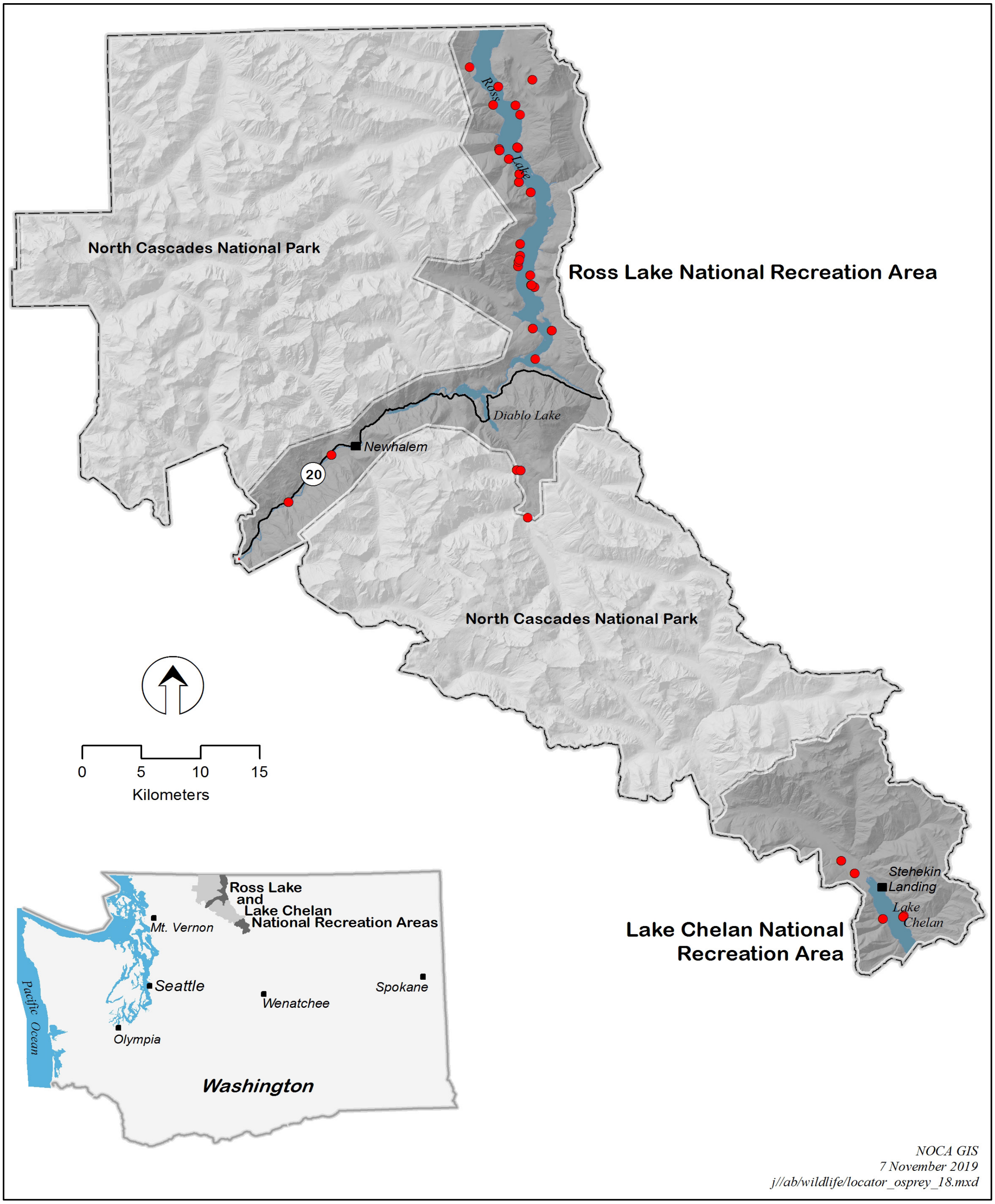

Figure 2. Study area and location of osprey nest territories monitored from 1979–2020 in North Cascades National Park Service Complex, Washington.

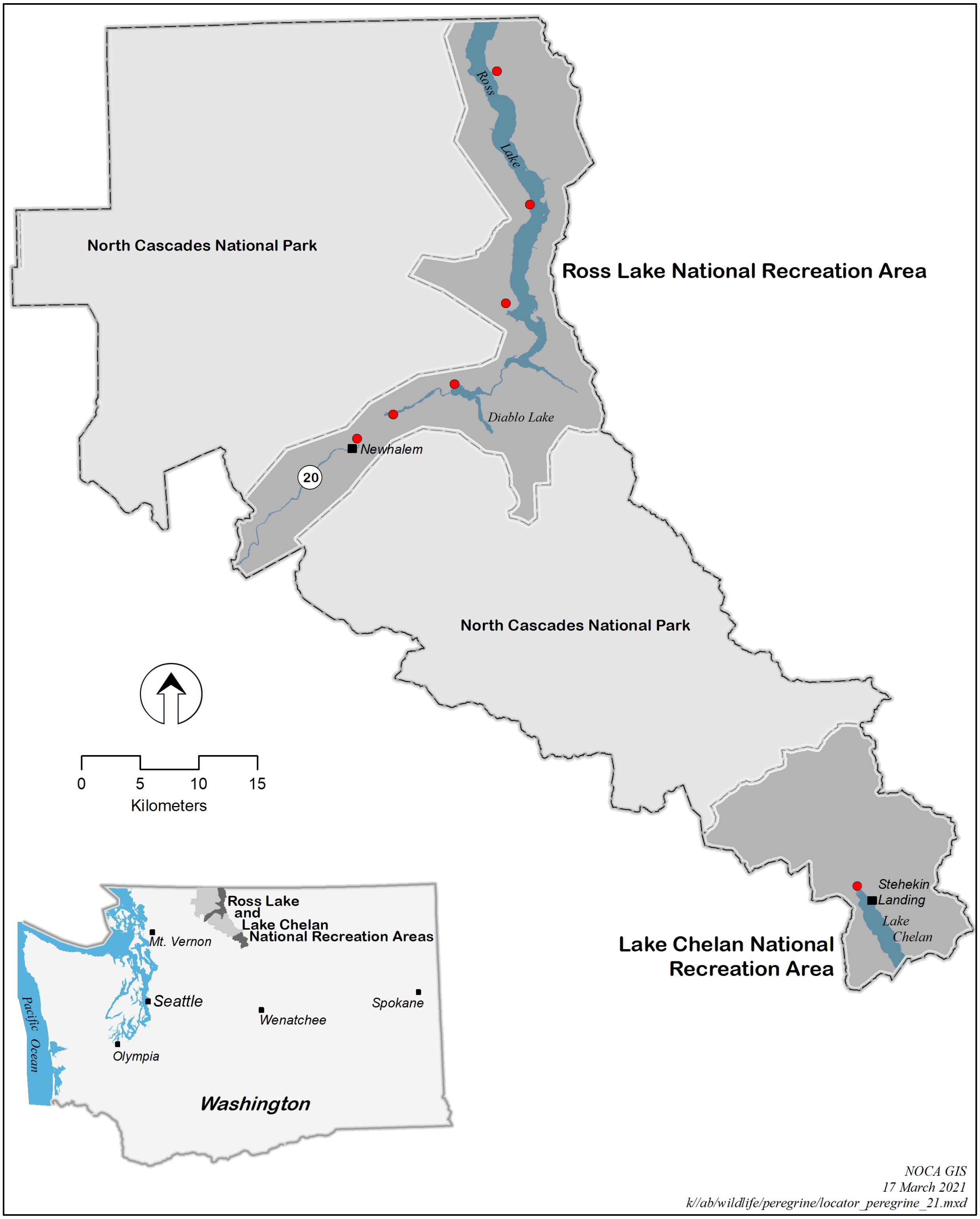

Figure 3. Study area and location of peregrine falcon nest territories monitored from 2006–2020 in North Cascades National Park Service Complex, Washington.

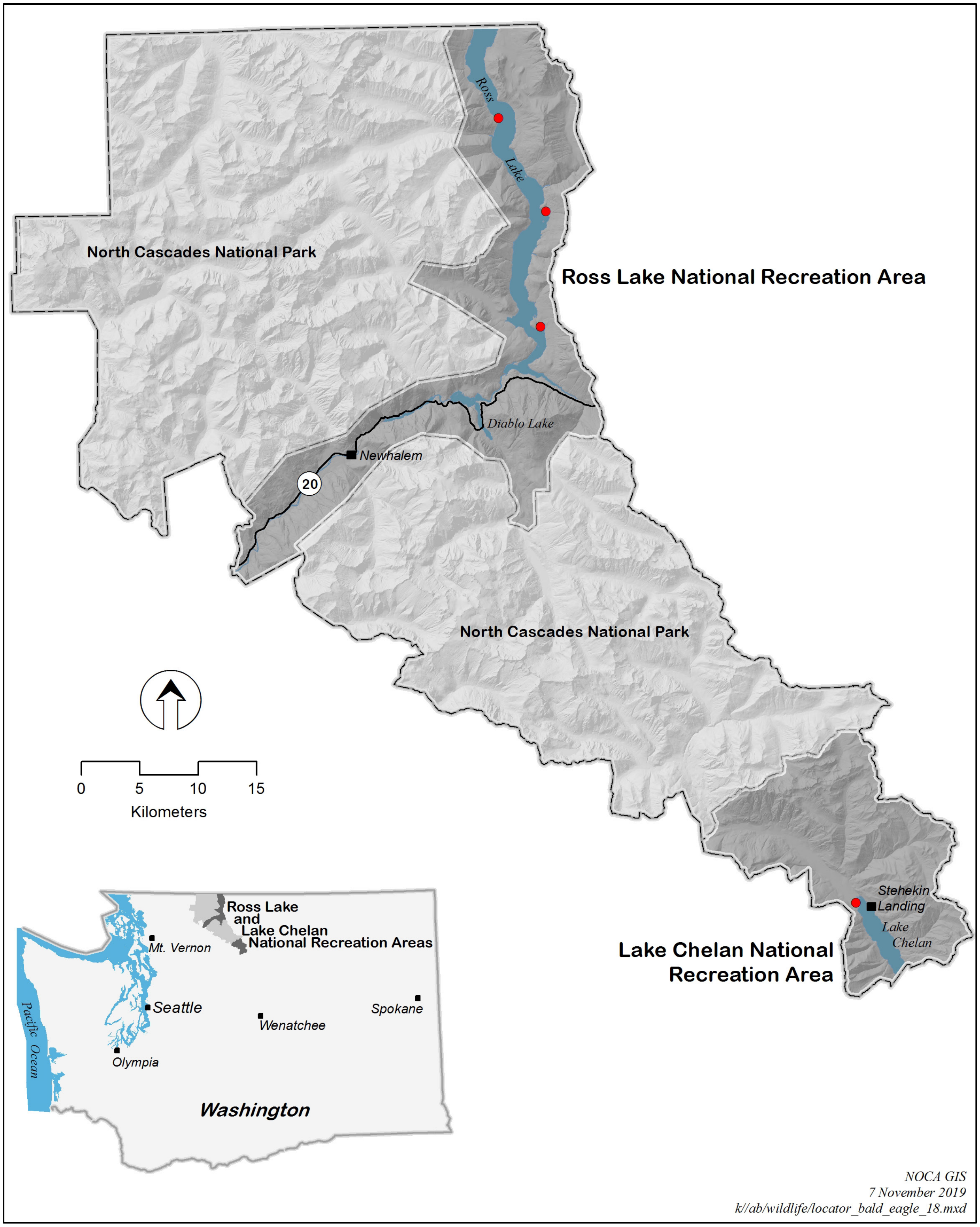

Figure 4. Study area and location of bald eagle nest territories monitored from 2015–2020 in North Cascades National Park Service Complex, Washington.

Terminology

Terminology in this report closely follows that developed by Postupalsky (1974) and Steenhoff (1987) with slight modifications for productivity and successful breeding.

Nesting Territory: A confined area with one or more nests, usually found in successive years, and where no more than a single mated pair has bred during any given year. Non-territorial raptors have greater mobility and can be difficult to count or keep track of. Therefore, as is often the case in determining nesting success and productivity of raptors, they have been excluded from analysis in this report.

Occupied Nesting Territory: A nesting territory where at least one adult was observed on or near a nest within the territory and exhibited normal reproductive behavior, such as courtship, feeding and nest building.

Unoccupied Nesting Territory: A classification given if no adults were observed in the vicinity of a historical nesting territory and no new nesting material was seen on the nest.

Active Nest: Although there is some ambiguity in the literature as to what constitutes an active nest, we reference the term in this report to broadly describe a nest that was occupied by a raptor during the breeding season. We use this term in making comparisons to other studies that used the term in this context.

Nesting Success: The proportion of nesting pairs that raise young to the age of fledging (i.e., the age when a fully feathered offspring voluntarily leaves the nest for the first time) in a given season. Some researchers suggest that nests of diurnal raptors be considered successful only if at least one nestling has reached 80% of the average age at first flight (Steenhof 1987). Yet, other researchers suggest a nesting pair is considered successful if it raises at least one young to 28 days, in the case of peregrine falcons, (Cade et al. 1996; USFWS 2003), or approximately 65% of first flight age. We did not attempt to estimate laying dates for the three focal species by backdating from estimated nestling ages. Therefore, we deviated slightly from these measures, since we were not able to accurately age young on the nest due to unknown hatch dates, difficult observation juxtapositions to accurately determine age of young, or we were not always able to conduct surveys at the precise time when young had fledged. Due to these uncertainties, we considered nesting successful if young were observed in the nest, regardless of age, and used this as a standard in comparing nest success among occupied territories and nest success from year-to-year.

P**roductivity**: A measure of reproductive output, defined as the number of viable chicks observed on the nest during the late nesting period, and reported as the number of young produced per occupied nest in a particular year. In this report, nest success and productivity measures were primarily reported relative to occupied nesting territories, because this method takes into account territories that were occupied during the early nesting season with possible nesting attempts, but may have failed, and were found unoccupied during late nesting surveys. For comparison, productivity relative to the number of successful nests is also provided, in order to examine the range of success.

Fledged young: Refers to young that had voluntarily left the nest for the first time and could fly.

Survey Timetable

Breeding chronology observed in the study areas was reasonably synchronous enough to conduct osprey, peregrine falcon, and bald eagle surveys simultaneously throughout the two study areas. However, we found that peregrine falcons nested earlier at the downstream sites within the Skagit River Gorge as compared to sites farther north, and at slightly higher elevations along the shores of Ross Lake. We found raptor nesting (particularly bald eagles) in the inland ROLA and LACH study areas tended to lag behind Washington coastal areas by as much as a few weeks. In general, surveys coincided with the following standard timing guidelines.

1. **Early to late-April (early nesting period)** – We used this first observation period to determine whether a territory was occupied and, if possible, to document if a pair was nesting. This visit was timed appropriately for the geographic area and occurred during late courtship, egg-laying, or early incubation period characteristic of the early nesting period. Surveyors recorded if the site was occupied and if so, how many adults were present, courtship behavior, evidence of nest repair or construction, and evidence of incubation.

2. **Early May to late-June (early nesting period) –** We used this observation period to check the 'unoccupied' status of a territory still in question, or if occupied during the first visit, to determine whether the breeding pair is still tending the nest during the early nesting season (incubating eggs or tending young nestlings).

3. **Early July to early August (late nesting period) –** We used this observation period to determine nesting success and productivity by confirming the number of young on the nest, and when possible, determine how many nestlings are approaching fledgling age or had recently fledged.

Osprey Survey Methods

Surveys for osprey in NOCA began in 1979. From 1979 to 1986 all surveys in ROLA were conducted by NOCA biologists, usually from a small motorboat operating along the shores of Ross Lake. In 1987, all osprey surveys in ROLA were conducted from a helicopter (Hughes 500). In 1992, 1998, and 1999 surveys in ROLA were conducted by a mix of ground, motorboat and helicopter methods. All osprey surveys for all years in the LACH study area were conducted either on foot from the ground or from a small motorboat along the shores of Lake Chelan. An attempt was made to complete a minimum of two early nesting surveys and one late nesting survey at all sites. Often at least two additional late nesting surveys were needed to confirm reproductive success and number of young present. Nests were observed from an adequate distance, preferably more than 100 m, to minimize any human disturbance at nest sites. Occasionally, observers would need to hike upslope above the nest to optimize a view into the nest to count nestlings that were otherwise crouched deep in the nest and undetectable at eye-level. Observers were not limited to a standard time limit or time of day for each survey, but more a matter of surveying when logistics of boat availability and weather conditions aligned and for as long as needed to determine the nesting parameters required.

Peregrine Falcon Survey Methods

In the early 1980s, NOCA biologists evaluated 13 areas of potential peregrine falcon nesting habitat primarily in the ROLA study area (Bjorkland 1984). Park biologists surveyed the highest rated areas for peregrine falcon activity from the ground beginning in 1985 and by helicopter in 1986 and 1987. From these surveys, no peregrine falcons or their nests were located (Bjorkland and Drummond 1987).

In 2006, as part of a nationwide monitoring plan to survey a sample of known and suspect peregrine falcon territories following peregrine falcon delisting, helicopter surveys were again conducted within ROLA by Washington Department of Fish and Wildlife (WDFW) biologists (WDFW unpublished data). Surveys were restricted to areas of recently discovered nesting activity, recently reported peregrine falcon sightings, and/or suitable potential nesting habitat determined to be worth the survey effort. Surveys continued in 2007 and 2009 by WDFW biologists. These efforts resulted in six peregrine falcon territories identified within ROLA. Surveys continued and were conducted primarily by WDFW and Seattle City Light (SCL) staff from 2010–2014. No surveys were conducted in 2008 and 2013. Beginning in 2015, NOCA biologists again became more involved as the primary investigators and in collaboration with WDFW and SCL staff have continued to survey the six known nesting territories through 2020.

Sport climbing in the Skagit River Gorge began to increase in recent years, and concern over recreation development at or near peregrine falcon eyries has become a conservation priority. As a result of several productive discussions between NOCA, the Access Fund, and Washington Climbers Coalition, a pilot project was implemented in spring 2019 to engage volunteers from the local and regional climbing community to assist with peregrine falcon monitoring at the Newhalem East and West crags, where historical and rather consistent peregrine falcon nesting has occurred. As part of this community science pilot project, trained volunteers conducted the majority of the peregrine falcon surveys at the Newhalem crags in 2019. NOCA biologists conducted occasional surveys at this particular peregrine falcon nesting territory for oversight and quality control purposes. During 2020, volunteer surveys were paused as part of the Covid-19 pandemic safety protocol for field work.

An attempt was made to visit each known territory in NOCA three or more times each year to determine occupancy, nesting success, and productivity. Surveys were conducted on foot from the ground in the Skagit River Gorge, and by using a small motorboat along the cliff shorelines of Ross Lake. No systematic peregrine falcon surveys have yet to be conducted in the LACH study area; however, one new eyrie was discovered and monitored in 2020.

Four to five-hour observation periods are often recommended to document territory occupancy of peregrine falcons (Cade et al. 1996, USFWS 2003). In most cases the first peregrine falcon occupancy survey began during the early morning foraging period beginning at 0600 h and continued for a standard 4-hour period at each site, ending at 1000 h. Even if no evidence of territory occupancy was found during the first 4-hour survey, a second 4-hour survey, (ideally two to three weeks later) was conducted to determine the occupancy status of the territory. Potential alternate nests within the same territory were also surveyed with enough effort to determine occupancy. During these visits, observers recorded the number of peregrine falcons detected within the territory and any behavioral displays or physical evidence of breeding activity. Once occupancy was determined, subsequent survey periods could sometimes be completed with shorter duration, dependent on how quickly a nesting ledge site could be located and other nesting parameters determined. As a minimum, a third survey was scheduled during the late nesting stage to determine nesting success and productivity. Depending on visit outcomes, available staff resources, and behavior of individual birds, additional periodic visits were sometimes necessary. During late nesting visits, the nest site location was recorded and described, number of young counted, and behavioral observations noted. Physical descriptions were documented to help report the approximate age of chicks, but this was often difficult to determine given the long distances and juxtaposition from observer to the nest, and observer experience in making an accurate determination. Attempts were made to avoid nesting surveys during inclement or poor visibility weather. Observations were recorded in field notebooks and later entered into a database.

Bald Eagle Survey Methods

Surveys were conducted at all known bald eagle territories in ROLA and LACH, with the aim of at least three visits during the nesting season, though more frequent visits were sometimes necessary to determine reproductive outcome. Surveys were initiated in early to mid-May during the early nesting and incubation period to determine occupancy, and if confirmed, to determine the number of adults present, any courtship behavior, evidence of nest repair or new decoration, and whether incubation was occurring. A second early nesting survey was conducted in early June to confirm whether a territory was unoccupied, or if occupied during the first visit, to determine whether the breeding pair was still tending the nest (incubating eggs or tending young nestlings). A final survey was conducted in late June to mid-July, or sometimes extended into early August, during the late nesting period of hatching/rearing of young and fledging period. All bald eagle surveys in ROLA were conducted from a small motorboat along the shorelines. Surveys in the LACH study area were conducted on the ground, though a small motorboat was used to access the nesting vicinity, followed by a short hike on shore to maximize visibility into the nest. Observers recorded notes in a field notebook and later entered this information into a database.

Historic Surveys

Archived NPS records indicate that on 28 May 1986 an interagency raptor survey was conducted from a helicopter in the northern Cascade Mountain Range. Participants included NPS, USFWS, USFS, and WDFW (formerly Washington Department of Game). The interagency raptor survey was designed to detect nests, measure productivity, and evaluate habitat of osprey, peregrine falcon, and bald eagle. The survey encompassed the Ross Lake, Skagit River Gorge, major tributaries to the Skagit River, and the Baker River area. During the survey, three osprey nests were identified (two on Ross Lake, one on the Skagit River), but no bald eagle or peregrine falcon nests were located within the park complex. Prior to this interagency survey, up to three osprey nests in ROLA were already being monitored by NPS since 1979. Data from these early years are included in this report.

Archived NPS records also indicate that on 14 June 1988 an interagency helicopter survey was conducted in the Stehekin area of the park complex. The survey was designed to focus primarily on potential peregrine falcon cliffs, though observers were also on the lookout for bald eagle and osprey nests. No peregrine falcon or bald eagle nests were observed during the survey. Two known osprey nests along the lower Stehekin River were surveyed, but both were inactive and no new nests were located. These data are not included in the following tables and figures due to limited details of the findings.

Results

Osprey

Osprey nesting territories and reproductive success was examined from surveys conducted during 24 of the 41 years from 1979–2020 in the ROLA and LACH study areas (Table 1). Additional survey details are presented in Appendix A. Surveys were not completed every year over this 41-year time period: there were four years between 1979 and 2000 when no surveys were completed, and no surveys were completed from 2001–2014. All nests were naturally constructed of sticks located at the tops of standing dead trees.

Table 1. Osprey nest occupancy and productivity in North Cascades National Park Service Complex for years surveyed from 1979–2020. Surveys were not conducted in 1980, 1982, 1990–1991, 2001–2014.

Year	Number of Nesting Territories Surveyed	Number of Nesting Territories Occupied	Percent of Nesting Territories Surveyed that were Occupied	Number of Successful Occupied Nesting Territories	Percent of Successful Occupied Nesting Territories	Number of young produced	Productivity per Occupied Nesting Territory[1]
1979	1	1	100	0	0	0	0.0
1981	3	3	100	1	33	1	0.3
1983	2	2	100	1	50	1	0.5
1984	3	3	100	0	0	0	0.0
1985	3	3	100	1	33	2	0.7
1986	6	5	83	2	40	2	0.4
1987	10	8	80	0	0	0	0.0
1988	8	6	75	1	17	1	0.2
1989	1	0	0	0	0	0	0.0
1992	11	9	81	5	56	9	1.0
1993	9	6	67	3	50	4	0.7
1994	9	8	89	5	63	6	0.8
1995	8	6	75	3	50	4	0.7
1996	5	5	100	1	20	1	0.2
1997	6	6	100	1	17	2	0.3
1998	9	5	56	3	60	7	1.4
1999	13	6	46	1	17	2	0.3
2000	8	4	50	0	0	0	0.0
2015	7	6	86	4	67	6	1.0

[1] Productivity is based on number of viable chicks seen on the nest regardless of age.

Table 1 (continued). Osprey nest occupancy and productivity in North Cascades National Park Service Complex for years surveyed from 1979–2020. Surveys were not conducted in 1980, 1982, 1990–1991, 2001–2014.

Year	Number of Nesting Territories Surveyed	Number of Nesting Territories Occupied	Percent of Nesting Territories Surveyed that were Occupied	Number of Successful Occupied Nesting Territories	Percent of Successful Occupied Nesting Territories	Number of young produced	Productivity per Occupied Nesting Territory[1]
2016	11	6	54	3	50	3	0.5
2017	12	5	42	3	60	6	1.2
2018	10	6	60	4	67	4	0.7
2019	8	6	75	1	17	1	0.2
2020	10	3	30	2	20	3	1.0

[1] Productivity is based on number of viable chicks seen on the nest regardless of age.

Osprey Nesting Territories

The number of nesting territories surveyed each year, during the 24 years of surveys, ranged from 1–13 (mean = 7.2 ± 0.7 (SE)). Of those, the number of nesting territories that were occupied each year ranged from 0–9 (mean = 4.9 ± 0.4). Of occupied nests, a mean of 1.9 ± 0.3 nests were successful each year. The percent of occupied nesting territories for the 24 years surveyed ranged from 0–100% with an average overall occupancy rate of 73%. There was a generally increasing trend of nest occupancy and success across the survey time period (Figure 5).

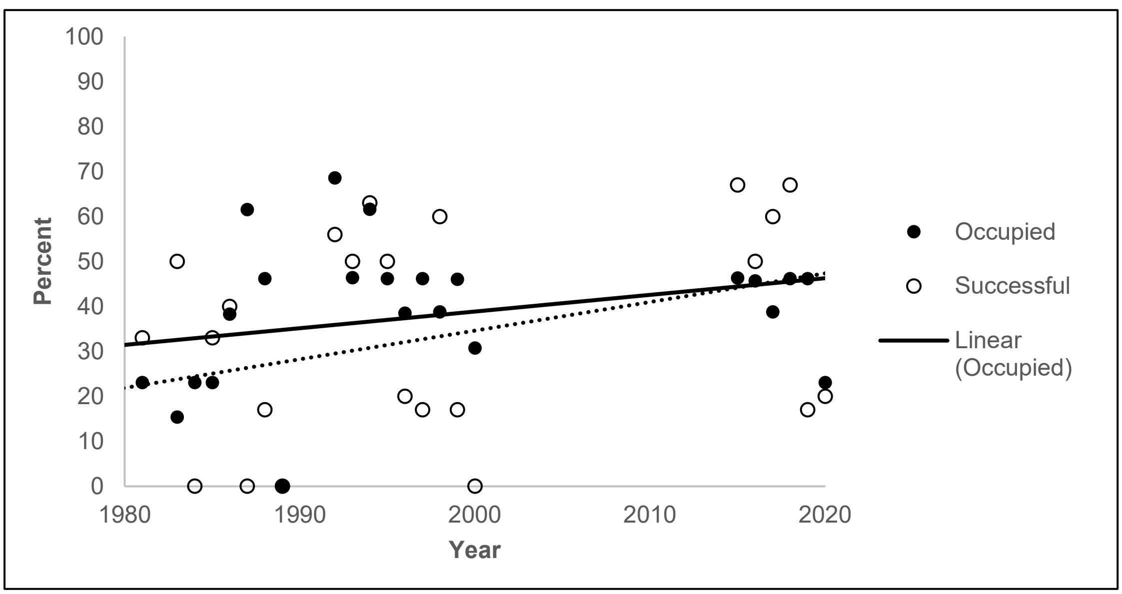

Figure 5. Percent of osprey nests that were occupied from 1979–2020 in North Cascades National Park Service Complex relative to number of nests surveyed, and percent of occupied nests that were successful. Linear trend is depicted as a solid line for occupied nests (r^2= 0.09), and as a dashed line for successful nests (r^2= 0.12).

Osprey Productivity

Productivity was confirmed in 19 of the 24 (79%) years and no young were produced in the remaining five years. Productivity ranged from 0–9 young per year (mean = 2.7 ± 0.5). The number of young produced per occupied nest ranged from 0–1.4 (mean = 0.5 ± 0.09). The overall 24-year nesting success rate, defined as young observed in the nest regardless of age, per occupied nest was 33%. A total of 65 young were known to be produced during the 24 years of surveys.

Over time, a greater number of nesting territories were identified and surveyed but the relative percent occupied and successful maintained an upward trend (Figure 5). There was variability in the number of nests surveyed each year for several reasons, including funding and staff availability, expansion of the project with time, and whether nests were still intact after annual windstorms. From 1979–1984, all surveys were conducted in the ROLA study area and in 1985, surveys were expanded to include the LACH study area. After 1985, both study areas were included in annual surveys. The number of osprey nests surveyed reached its highest count in 1999, with 13 known nests throughout the ROLA and LACH study areas. There were occasionally alternate osprey nests within a nesting territory, but in all cases only one nest was occupied at a time in any given year.

Peregrine Falcon

Peregrine falcon nesting territories and reproductive success were examined from surveys conducted in ROLA and LACH during 13 years of a 15-year time period between 2006 and 2020 (Table 2). Surveys were not completed in 2008 and 2013, owing to project funding priorities and available staff resources. Additional survey details are presented in Appendix B. Six peregrine falcon territories were located in ROLA, and a new eyrie was discovered in 2020 on a bluff near the head of Lake Chelan. All nest sites were located on vertical cliffs consisting of a small scrape on a ledge with a slight overhang to offer protection from the elements and predation.

During the first year of surveys in 2006, four peregrine falcon pair territories were documented (Newhalem, Gorge, Diablo, Skymo) and a single adult was observed at a fifth site (Pumpkin Mountain). In 2007, a pair of peregrine falcons was confirmed at the fifth site and a new sixth site (Little Jackass) was located and occupied by a pair (Figure 3). There were no surveys conducted in 2008 and 2013. Four sites were surveyed in 2011, and three sites surveyed in 2012 and 2014. All six sites were surveyed in years 2015–2020. Only one new nesting territory (Buehler's Bluff, LACH) has been confirmed since 2007, though there have been recent occurrence records of single adult peregrine falcon activity near the north end of Ross Dam, near the mouth of May Creek and near Little Beaver Creek Campground.

Table 2. Peregrine falcon nest occupancy and productivity in North Cascades National Park Service Complex for years surveyed from 2006–2020. NA means site was either not yet identified or not surveyed for that particular year.

Year	Number of Nesting Territories Surveyed	Number of Nesting Territories Occupied	Percent of Nests Surveyed that were Occupied	Number of Successful Occupied Nesting Territories	Percent of Successful Occupied Nesting Territories	Number of young produced	Productivity per Occupied Nesting Territory[1]
2006	5	5	100	3	60	8	1.6
2007	6	6	100	3	50	6	1
2008	0	NA	NA	NA	NA	NA	NA
2009	6	6	100	5	83	10	1.7
2010	6	6	100	4	67	15	2.5
2011	4	4	100	0	0	0	0
2012	3	3	100	2	67	4	1.3
2013	0	NA	NA	NA	NA	NA	NA
2014	3	1	33	1	100	2	2
2015	6	3	50	0	0	0	0
2016	6	2	33	1	50	2	1
2017	6	3	50	2	67	5	1.7
2018	6	3	50	1	33	2	0.7
2019	6	5	83	3	60	7	1.4
2020	7	3	43	2	29	3	1.5

[1] Productivity is based on number of viable chicks seen on the nest regardless of age.

Peregrine Falcon Nesting Territories

The number of peregrine falcon nesting territories surveyed each year ranged from 3–7 (mean = 5.4 ± 0.4). The number of territories that were occupied each year ranged from 1–6 (mean = 3.8 ± 0.5). The number of successful nests of those that were occupied per year ranged from 0–5 (2.1 ± 0.4). The percent of occupied nesting territories across the 13 years of surveys ranged from 33–100% with a mean overall occupancy rate of 72.5 ± 8.1%.

Peregrine Falcon Productivity

Reproduction was confirmed in 11 of 13 (85%) years with no young produced in 2011 and 2015. Productivity ranged from 0–15 young per year (mean = 4.9 ± 1.2). The number of young produced per occupied nesting territory ranged from 0–2.5 (mean = 1.3 ± 0.2). For successful nests, the brood size ranged 1–4 (mean = 2.4 ± 0.2) chicks. The overall average 13-year nesting success rate per occupied territory was 51%, with a total of 64 young produced.

The number of occupied peregrine falcon nesting territories over time and the number of young produced over time both indicate a gradual decline (Figure 6). While the number of occupied nest sites appears to be decreasing steadily over time, the success of those occupied nests reflects a weaker and more variable downward trend.

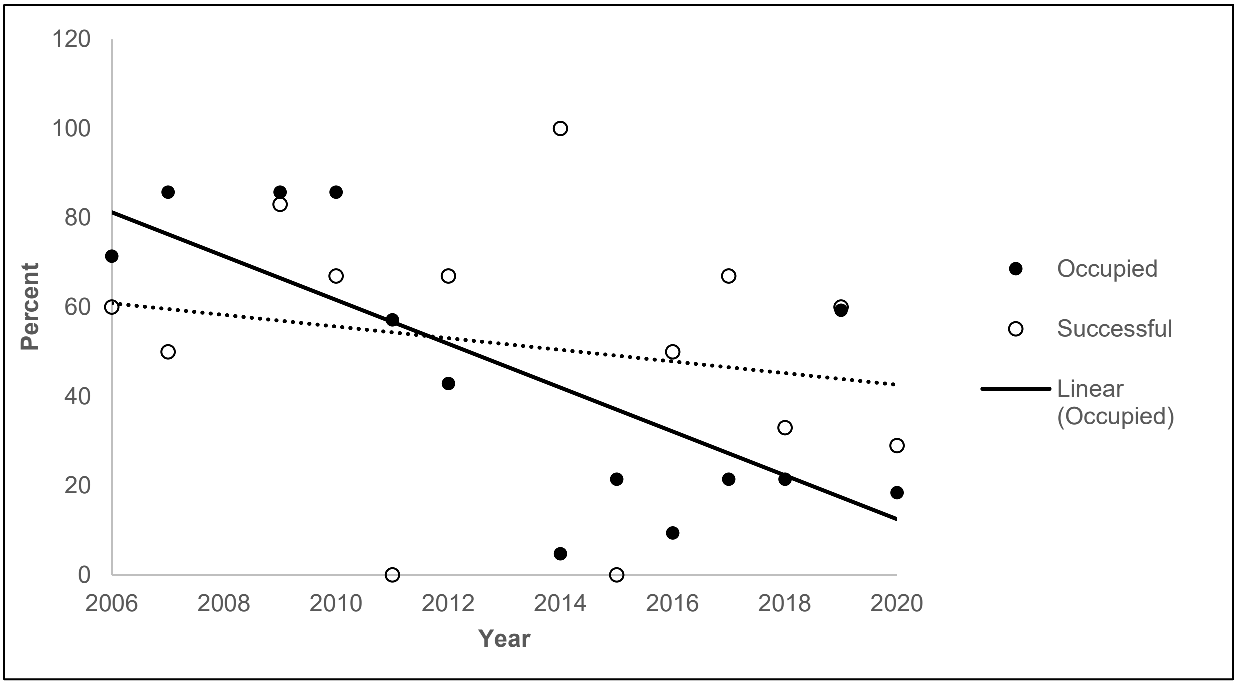

Figure 6. Percent of peregrine falcon nests that were occupied in North Cascades National Park Service Complex from 2006–2020, relative to number of nests surveyed, and percent of occupied nests that were successful. Linear trend is depicted as a solid line for occupied nests (r^2= 0.54), and as a dashed line for successful nests (r^2= 0.04).

We calculated peregrine falcon productivity at each individual nesting territory for each of the respective 13 years surveyed from 2006–2020 (Table 3). Productivity varied at each territory from year to year, with several sites not producing young in consecutive years. No sites produced young in every year surveyed. In 2011 and 2015, no young were produced from any of the six territories surveyed. The Skymo Creek and Little Jackass sites were the most productive over time, each producing young in five of 10 (50%) years surveyed. The Newhalem site was the next most productive, producing young in six of 13 (46%) years surveyed. The Gorge Lake and Diablo Dam sites each produced young in four of 13 (31%) years surveyed. The Pumpkin Mountain site was the least productive, with young observed in two of 11 (18%) years surveyed and has had no known occupancy since 2010.

Because the known peregrine falcon population is distributed along the dendritic pattern of the upper Skagit River, density of the population is expressed in "distance to nearest neighbor", which ranged from 3.8 to 12.5 km and averaged 7.5 km between all nest sites. Distances between nests increased progressively upstream. Average distance between peregrine falcon nesting territories was 5.1 km among territories downstream along the Skagit Gorge between Diablo and Newhalem, and averaged 10.6 km between territories located on Ross Lake.

Table 3. Peregrine falcon nesting productivity (number of fledglings) in North Cascades National Park Service Complex for years surveyed from 2006–2020. NA means site was either not yet identified or not surveyed for that particular year.

Year	Newhalem	Gorge Lake	Diablo Dam	Pumpkin Mountain	Skymo Creek	Little Jackass	Buehler's Bluff (LACH)	Total # of young
2006	4	2	2	NA	NA	NA	NA	8
2007	0	1	0	0	1	4	NA	6
2009	0	1	3	2	2	2	NA	10
2010	0	0	4	4	4	3	NA	15
2011	0	0	0	0	NA	NA	NA	0
2012	2	2	0	NA	NA	NA	NA	4
2014	2	0	0	0	0	0	NA	2
2015	0	0	0	0	0	0	NA	0
2016	2	0	0	0	0	0	NA	2
2017	3	0	0	0	2	0	NA	5
2018	0	0	2	0	0	0	NA	2
2019	3	0	0	0	2	2	NA	7
2020	0	0	0	0	0	1	2	3

Bald Eagle

Although there have been past occurrence records of summer bald eagle activity in NOCA, actual known nesting has only recently been documented. Nesting surveys were first conducted in 2015 after repeated adult and sub-adult occurrence records were reported in the ROLA and LACH study areas. During 2015 bald eagle nesting surveys, three active nest territories were documented (Roland Point, Little Beaver Creek., Weaver Point) with one nest identified per territory. By the end of the 2017 nesting season, a fourth bald eagle territory (Dry Creek) was documented with one nest identified, representing an increase of one new nest identified over a four-year time period. Three of the four nesting territories were located in ROLA (Roland Point, Little Beaver Creek, Dry Creek) and the remaining one nesting territory (Weaver Point) was located in the LACH study area (Figure 4).

We examined bald eagle nesting territories and reproductive success over a six-year period from 2015–2020 (Table 4). Additional survey details are presented in Appendix C. We conducted surveys each of the six years, but we only located three nests in 2015 and 2016. We located a fourth nest in 2017, with pair occupancy. We surveyed all four nests from 2017–2020 to determine occupancy and productivity. All bald eagle nests were located at the very top or in the upper quarter of the tallest tree in the vicinity, each approximately 50 m from the shoreline. All three nests located in the ROLA study area were in Douglas-fir trees (two live and one dead) and the one nest located in LACH was in a live black cottonwood (*Populous trichocarpa*) tree, located approximately 10 m beneath the canopy.

Table 4. Bald eagle nest occupancy and productivity in North Cascades National Park Service Complex for years surveyed from 2015–2020.

Year	Number of Nesting Territories Surveyed	Number of Nesting Territories Occupied	Percent Nesting Territories Surveyed that were Occupied	Number of Successful Occupied Nesting Territories	Percent of Successful Occupied Nesting Territories	Number of Young Produced	Productivity per Occupied Nesting Territory[1]
2015	3	3	100	0	0	0	0.0
2016	3	1	33	1	100	2	2.0
2017	4	4	100	2	50	3	0.8
2018	4	0	0	0	0	0	0.0
2019	4	0	0	0	0	0	0.0
2020	4	2	50	1	50	1	1.0

[1] Productivity is based on number of viable chicks seen on the nest.

Bald Eagle Nesting Territories

Bald eagle nesting territories were identified and surveyed for occupancy and reproductive success (Figure 7). The number of bald eagle territories surveyed across all six years ranged from 3–4 (mean = 3.7 ± 0.2). The number of occupied nesting territories over the six-year period ranged from 0–4 (mean = 1.7 ± 0.7). The number of successful nests of those that were occupied each year ranged from 0–3 (mean = 0.7 ± 0.3). The percent of occupied nesting territories spanning the six-year period ranged from 0–100% with an average overall occupancy rate of 47%.

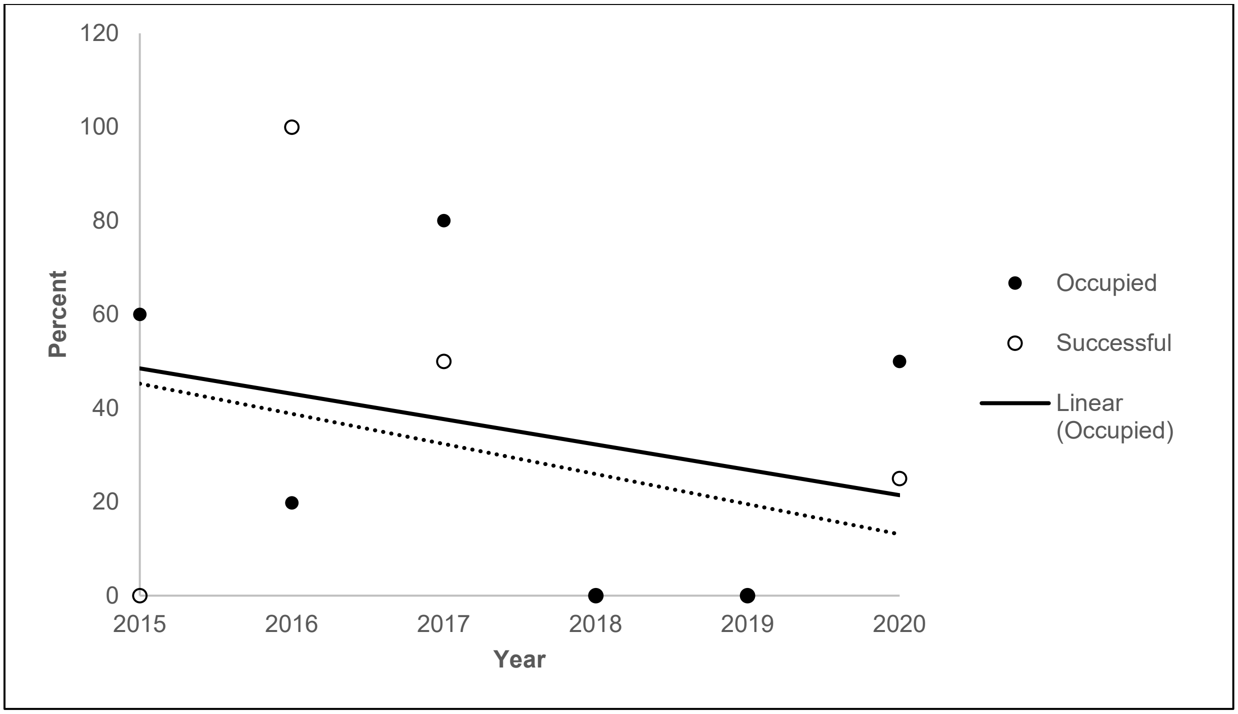

Figure 7. Percent of bald eagle nests that were occupied in North Cascades National Park Service Complex from 2015–2020, relative to number of nests surveyed, and percent of occupied nests that were successful. Linear trend is depicted as a solid line for occupied nests (r^2= 0.09), and as a dashed line for successful nests (r^2= 0.09).

Bald Eagle Productivity

We confirmed successful bald eagle reproduction in three of the six (50%) years surveyed. Across the six-year survey period at least six young were produced from three individual nest sites (Table 5). Overall productivity ranged from 0–3 young per year (mean = 1.0 ± 0.5). For successful nests, the minimum brood size ranged from 1–3 (mean = 2.0 ± 0.6) chicks. All young observed in the nest were later seen fledged and perched in close proximity to the nest tree during late nesting surveys.

Table 5. Bald eagle productivity in North Cascades National Park Service Complex for years surveyed from 2015–2020. NA indicates nesting territory was not known to exist during that year.

Year	Roland Point	Little Beaver Creek	Weaver Point	Dry Creek
2015	0	0	0	NA
2016	0	2	0	NA
2017	0	2	0	1
2018	0	0	0	0
2019	0	0	0	0
2020	0	0	1	0
Total	0	4	1	1

We determined bald eagle nesting success for each individual territory for 2015–2020 (Table 5). Two nests located in ROLA (Roland Point and Little Beaver Creek) and one nest in LACH (Weaver Point) were identified and surveyed in 2015 and 2016. In 2017, a fourth nest was located in ROLA (Dry Creek) and surveyed from 2017–2020. In 2017, all four nests were occupied during the early nesting period, but two were assumed to have failed and reported as unoccupied during late nesting surveys. The Little Beaver Creek pair produced two young in both 2016 and 2017, and the Dry Creek pair produced one young in 2017, for a total of five young reported as fledged over the 6-year period. Weaver Point produced at least one eaglet in 2020, though the nest is very deep and an accurate count of young from the ground is not possible. No young were produced at any known nest site in 2015, 2018 and 2019. During the breeding season in each year of the 6-year period, occurrence records of additional adult and sub-adult bald eagles were reported in both the ROLA and LACH study areas, but none could be linked to an active nesting territory and it was likely they were single non-breeders. At least a dozen bald eagles have been observed simultaneously along the lower Stehekin River during late summer/fall kokanee (*Oncorhynchus nerka*) spawning, while bald eagles can number into the hundreds along the Skagit River during winter salmon spawning (Rubenstein et al., 2018). None of those individuals are known to use nest sites in those areas.

In August 2017, the nest site named Little Beaver Creek was partially destroyed in a windstorm shortly after two young had successfully fledged. The nest was monitored in 2018 to determine the status of the territory and whether the pair would add new material to the remnant nest platform. No bald eagles were detected near the historic nest and no indication of nest repair was evident during 2018–2020 surveys, thus the historic site was recorded as unoccupied.

Bald eagle nest sites in ROLA were distributed in a linear fashion along the lakeshore, and the mean distance between nests was 9.8 km. Since there was only one nest identified in LACH, mean distance between nesting territories could not be reported. To date, no alternate bald eagle nests have been identified within any of the known territories.

Discussion

This report compiles all known nesting survey data for osprey, peregrine falcons, and bald eagles within NOCA. There were varying degrees of survey effort for each of these species across years. The largest data set is that of nesting osprey, comprising 24 years of surveys between 1979 and 2020. Peregrine falcon nesting surveys have been conducted for 13 years between 2006 and 2020. Surveys for bald eagle nesting are relatively new in NOCA; hence, the smallest of the three data sets, spanning six consecutive years from 2015–2020. The health of any raptor population depends largely on its breeding success. There were year-to-year fluctuations in nest success and productivity for each of the three raptor species surveyed. This variability is common in raptors, and short-term decreases in productivity do not necessarily portend risk to the long-term stability of populations.

Osprey

Occupancy rate. Osprey nest occupancy in NOCA averaged 73% across a 24-year period from 1979–2020. Although quantitative data is limited for nest occupancy rates in Washington State, this value appears to be within the expected range of a stable population when compared to other raptor species reports.

Nest success. The overall osprey nesting success rate (successful nests of those occupied) in NOCA averaged 33% over a 24-year period from 1979–2020. This value appeared somewhat low compared to a 68% success rate reported by Van Daele and Van Daele (1982) in Idaho and 44% reported by Swenson (1979) in Yellowstone National Park. It is possible that this lower success rate can at least in part be attributed to survey biases: some territories in the early years of monitoring were surveyed on only one occasion, and young on the nest may have been missed and were potentially unaccounted for during the late nesting period. Another source of bias is that most surveys were ground-based, making it much more difficult to observe young if they were crouched deep in the nest. It often requires patience and extended survey time to make accurate determinations. Any variation in sampling effort could lend itself to a possible source of measurement error.

Productivity. Osprey productivity rates across 24 years of surveys in NOCA from 1979–2020 averaged 0.5 young per occupied nest. This average productivity rate is low when compared to an average productivity of 1.37 young per active nest in west-central Idaho (Van Daele and Van Daele 1982) and is below the normal range of mean productivity rates of 1.3–1.8 young per active nest for eight conterminous western states (Bjorkland 1987, unpub. report). A long-term productivity average of 0.95–1.30 young per active nest (Henny and Wight 1969, Henny 1977) and a population composed of 5–10% nonbreeding pairs (Henny and Van Velzen 1972) have been suggested for the maintenance of a stable osprey population. Although we did not have sufficient data to report on nonbreeding pairs, our productivity average suggests it is below what is needed for a stable osprey population. However, when examining osprey productivity per successful nest in NOCA the average rate increased to 1.4 young per successful nest, which is within the normal suggested range of a stable population. The literature is inconsistent in how results are reported for nests that are initially occupied and those that successfully produced young, in part because success is sometimes defined by disparate age categories for fledglings when observed. We defined success as presence of any young.

The number of osprey nesting territories identified, along with annual productivity, has increased slightly over the 24 years of surveys. This is likely due, in part, to greater survey effort and total area surveyed as time advanced. This increase may have also been attributed to the possibility of observers historically counting alternate nest trees within the same territory, thus potentially inflating overall territory numbers. There was some variability in the number of territories that pairs defended from year to year, yet there appears to be a slight increase in the overall long-term trend in percentage of nest sites occupied, as well as nesting success. The results of osprey nesting surveys and the long period of recorded occupancy of multiple nesting territories in ROLA and LACH strongly suggest these two study areas continue to afford both suitable nesting and foraging habitat for a relatively small population of osprey.

Peregrine Falcon

Peregrine falcons are considered rare in NOCA and to date only seven nesting territories have been identified in the park complex. Only incidental observations of peregrine falcons were recorded during landbird surveys from 2005–2020 (Ray et al. 2017, NPS unpublished data). With the peregrine falcon's wide geographic distribution and expansive home range size, NOCA does not appear to represent a significant proportion of its suitable habitat (Hoffman et al. 2015). Most of the best suitable peregrine falcon habitat in ROLA was surveyed in the late 1980s by Bjorkland and Drummond (1987), resulting in no peregrine falcons observed at that time. The presence of six known peregrine territories in previously unoccupied areas suggests there is increasing recovery of peregrine falcons within the park complex.

Occupancy rate. Peregrine falcon occupancy rates in NOCA averaged 72.5% across a 13-year period from 2006–2020. This is slightly less than, yet similar to, other peregrine falcon occupancy rates in Washington, which are reported as 79% for a 10-year period from 1992–2001, 82% for a 5-year period from 1997–2001 (Hayes and Buchanan 2002), and continued high rates reported at 79% in 2006 and 82% in 2009 (Vekasy and Hayes 2016).

Nest success. Overall peregrine falcon nesting success in NOCA averaged 51% across a 13-year period from 2006–2020. This is slightly lower than other Washington State surveys conducted between 1992 and 2001. Nest success averaged 62% during that 10-year period, and similarly, averaged 64% during the 5-year period between 1997 and 2001, with some regional variation (Outer Coast at 57%, Puget Sound at 65%, Upland Forested at 76%, and Arid at 69%) (Hayes and Buchanan 2002). These values are all comparable to more recent surveys in 2006 (68%), but a lower success rate of 37% was reported in 2009, rebounding to 76% in 2012 (Vekasy and Hayes 2016). Nest success rates observed for other recovering populations include an average of 73% (1984–1996) for a population in northern New England and New York (Corser et al. 1999), 62% (1991–1995) for a population in the Midwest (Tordoff and Redig 1997), and 70–83% (2005–2009) for populations in Colorado, Montana, and Wyoming (Enderson et al. 2012).

Productivity. Peregrine falcon productivity in NOCA averaged 1.3 young per occupied nest over a 13-year period from 2006–2020. This is slightly less than an average productivity of 1.53 young per occupied nest from Washington State surveys conducted over a 5-year period from 1997–2001 (Vekasy and Hayes 2016). A productivity rate of 1.25 to 1.5 young fledged per nesting pair has been suggested for a sustainable population with potential for growth (Grier and Barclay 1988, Wootton and Bell 1992).

Since 2009, peregrine falcon survey results in NOCA indicated a notable decline in the number of occupied territories, successful nests, and productivity, yet the number of territories surveyed remained constant. Reasons for this decline are unclear but may be explained in part by inconsistencies in survey effort. The remoteness of some survey sites resulted in more complicated logistics and time involved to adequately survey these territories, compared to more accessible sites that ultimately received greater survey effort. Differences and inconsistency in observer experience post-2009 may also bias these data.

Bald Eagle

Annual wintering bald eagle surveys have been conducted in NOCA from 1982–2016, with population numbers peaking in the mid-1990s and leveling off but remaining stable in recent years (Dunwiddie and Kuntz 2001; Rubenstein et al. 2019). However, during the spring/summer breeding season, bald eagles have historically been relatively rare in NOCA, with most breeding activity taking place along lower elevation rivers, lakes, and estuaries outside of park boundaries (Smith et al. 1997). An increase in bald eagle activity during the breeding season has been noted in both the ROLA and LACH study areas of the park complex. These observations have led to more intensive nesting surveys with the first nest site (Weaver Point) confirmed in 2015 within the LACH study area. The total number of confirmed bald eagle nests in NOCA has since increased to four, based on surveys conducted through 2020 (three in ROLA and one in LACH), producing a total of six offspring across the 6-year period.

Occupancy rate. Bald eagle occupancy at known nesting territories in NOCA averaged 47% over a 6-year period from 2015–2020. This is notably less than a WDFW Washington State survey occupancy average of 75% as reported in 2005 (Stinson et al 2007). However, NOCA represents a much smaller data set and survey period compared to Washington State surveys. The last state-wide survey conducted in 2015 identified 1,334 bald eagle nesting sites known to be occupied, indicating an increase of 281 territories since 2005 (Kalasz and Buchanan 2016). This total reflects the cumulative number of sites as opposed to the number known to be active in any given year.

Nest success. Overall bald eagle nesting success in NOCA averaged 50% for the six-year period from 2015–2020. This is lower than the Washington State average of 65% recorded from 1980–1998 (Stinson et al. 2007). Sprunt et al. (1973) suggested that a minimum level of 45% nest success is required for populations to at least remain stable. NOCA bald eagle nesting represents a much smaller data set over a shorter period of time which may, in part, explain these smaller values.

Productivity. Bald eagle nest productivity in NOCA averaged 0.95 young per occupied nest from a 6-year period from 2015–2020. This rate is consistent with the Washington state-wide productivity average of 0.95 reported from 1980–1998 (Stinson et al. 2007). Across the species' range in the United States, productivity was estimated at 1.2 young per occupied nest (Millsap et al. 2016). Although the productivity level in NOCA appears lower than the continental average, there were specific sites and complete years with no young produced, which may have skewed productivity values. Strong inference should not be made across this relatively small sample size over a short-term period.

Factors Potentially Affecting Populations

From on-site assessments, there appears to be adequate nesting strata and resources for osprey, peregrine falcon, and bald eagle in the ROLA and LACH study areas; yet the number of active nests identified is relatively small for the amount of available habitat. Given the conspicuous nature of osprey and bald eagle nests, this is unlikely a result of detection bias; however, such bias may arise for peregrine falcon nests due to their cryptic appearance. Understanding the mechanisms that influence density of nesting territories and annual reproductive success is challenging. It was beyond the scope of this monitoring to quantitatively investigate potential factors that could influence raptor breeding success. However, it is widely known that prey base resources and weather contribute greatly to the success or failure of raptor nesting attempts (Buehler 2000). Other factors may include human disturbance, environmental contaminants, manipulated water levels of the reservoirs, and climate change. Territorial defense between species, such as bald eagles and osprey, may also be a factor worthy of consideration. Additional investigations are needed to monitor the sustainability of these small breeding populations.

Food Availability

Food availability has a strong influence on reproduction measures in birds, particularly raptors (Newton 1979, Newton 2002). For example, osprey typically lay more eggs and are able to raise more young to fledging age during years and in regions associated with higher food availability (Bowman et al. 1989, Steidl et al. 1991, Poole et al. 2002). When food is scarce, sibling rivalry and competition increases, leading to starvation of some young. This positive correlation between productivity and prey availability has been reported in other western U.S. osprey populations (Koplin et al. 1972, MacCarter and MacCarter 1979). All of the existing osprey nest sites in NOCA are located on reservoirs which provide recreational opportunities and hydroelectric power. With that comes fluctuating water levels to accommodate storage capabilities from spring runoff. Low reservoir levels occur in the winter/spring and high levels during the summer/fall months. Shallow spawning areas are most vulnerable to osprey prey capture (Swenson 1979). As this habitat type shifts or becomes limited with fluctuating water levels during osprey nesting season, prey availability decreases and negatively impacts osprey fishing success (Prevost 1977). This interaction of high-water levels and a shift in prey availability may potentially affect osprey nesting success in NOCA during the late nesting period when young are rapidly growing, and food demands increase.

Recent vegetation mortality arising from the 2015 Goodell fire in the Skagit River Gorge may have temporarily affected avian fauna that peregrine falcons depend on for prey. It is unknown whether there has been a recent shift in prey availability or selection, but anecdotal information suggests a recent increase in waterfowl and gull carcasses at the base of the Newhalem peregrine falcon eyrie in particular.

Human Disturbance

Human disturbance can affect different nesting raptors in different ways. Both ROLA and LACH study areas support large amounts of recreational use, primarily as boating, fishing, hiking and sport climbing opportunities. Much of this activity is in close proximity to, or within, osprey, peregrine falcon, and bald eagle nesting territories. Osprey, peregrine falcon and bald eagle are known to be adaptable and highly mobile raptors, which allow them to successfully nest in a variety of conditions and subsequently adjust to some human disturbances (Henny et al. 1974, Henny and Noltemeier 1975, Lind 1976, Spitzer 1977). Depending on the type of activity, particular individuals, and the period of time it takes for nesting raptors to adjust to the disturbance, such activities may jeopardize their nesting success, especially during the critical early nesting period. Shoreline human disturbance within 1 km of a nest was highly suggestive of negatively affecting osprey reproduction in Yellowstone National Park (Swenson 1979). Numerous recreational motorboats on the reservoirs of ROLA and LACH pass by osprey, peregrine falcon, and bald eagle nesting territories within this suggested disturbance threshold distance on a daily basis during the busy summer season. Anecdotal observations suggest that all three of these focal species tend to flush from the nest when a boat approaches too close, yet it is unknown if or to what extent this activity may affect the nesting success of these raptors in NOCA.

There has recently been an increase in sport climbing activity in the Skagit River Gorge of the ROLA study area. Human disturbance could be influencing peregrine falcon nesting success where territories overlap with climbing activity. There are currently four approved Climbing Management Units (CMUs) within the Skagit River Gorge (36 CFR §1.5: USDOI 2020). There are also three known peregrine falcon nesting territories that are on or near developed climbing crags within these CMUs. In addition, two areas that are not authorized CMUs have recently been discovered to contain illegal fixed climbing anchors (Space Wall and Canoehalem): one of which (Canoehalem) has a history of successful peregrine falcon nesting. However, there has been no known peregrine falcon nesting at this crag since it was illegally developed with bolted routes in 2018, and one route was bolted directly through an established peregrine falcon eyrie. This activity suggests that human disturbance may be directly responsible for the lack of nesting since 2018. Other factors such as nearby nesting ravens may also have contributed to changes in peregrine falcon nest site selection.

Weather

Rainfall and cold temperatures during the critical spring egg laying, incubation and hatching months have previously been identified as potential drivers of reduced reproduction in peregrine falcons (Ratcliffe 1984, Mearns and Newton 1988, Olsen and Olsen 1989) and bald eagles (Gerrard and Whitfield 1979). Frequency of heavy rain has a much greater impact on nestling survival than the total amount of precipitation recorded during the rearing period (Anctil et al. 2014). Although weather was not investigated thoroughly within the scope of monitoring efforts in NOCA, it could be a major factor in explaining low productivity in some years.

Contaminants

Studies in the United States, Canada, Mexico, Europe, and elsewhere have shown the osprey to be a particular useful sentinel species for monitoring selected environmental contaminants, including compounds emerging in lakes, reservoirs, rivers, and estuaries. In the Pacific Northwest, a study from 1991–1997 showed elevated levels of organochlorine pesticide DDT in osprey where DDT use was historically limited, suggesting continued DDT application on overwintering grounds outside of the United States, and atmospheric deposition may be potential sources of these contaminants (Elliott et al. 2000). Philippe et al. (2019) also reported long range deposition of DDT in osprey and prey (rainbow trout) from high lakes in western Canada. While residual low-level concentrations of contaminants may still pose threats to raptors, it is expected populations will continue to increase despite those threats.

Other toxic chemicals reported in osprey eggs include polychlorinated biphenyls (PCBs), heptachlor, dioxins, dieldrin, chlorodanes, mercury (Elliott et al 2007, Elliott et al. 2005, Elliott et al. 2000), and heavy metals such as lead, copper, and arsenic near historic mining operations (Langner et al. 2012). High levels of mercury have also been detected in bald eagle tissues across the United States (Stinson et al. 2007). A study of 15 watersheds in western Canada suggested the primary contributor of mercury was atmospheric deposition (Guigueno et al. 2012). In Washington and Oregon, organochlorines and mercury levels in ospreys have exhibited a declining trend from 2003–2007, with concentrations found at levels that were not implicating risk to eggs or chicks (Johnson et al. 2009). Of note, a study in Quebec reported mercury levels in feathers and chicks of ospreys to be five times higher at reservoirs than at nearby ponds and lakes (DesGranges et al. 1998). This is of significance since all osprey nesting sites surveyed in NOCA are along the shores of two separate reservoirs with historic mining in each of the respective watersheds.

Data on bioaccumulation of toxins and environmental contaminants in raptors at NOCA are scarce. Three raptors and one adult common loon (*Gavia immer*) have been recovered and tested for toxins and contaminants. All three raptor carcasses tested negative for West Nile Virus and Avian Influenza (frequent causes of death for raptors in Washington). During 2016 peregrine falcon surveys, a fledged juvenile peregrine falcon was found dead at the base of the cliff at the Newhalem eyrie in ROLA. Lab analyses of liver, brain, and kidney tissue detected lead (0.70 ppm) and mercury (0.18 ppm), and this bird likely died from starvation/malnutrition. It is unclear if toxicity contributed to premature death of this fledgling, but it does indicate the presence of lead in the local food chain and that peregrine falcons, as tertiary consumers, are vulnerable. A second peregrine falcon mortality was discovered in 2019 near a cliff adjacent to Ross Dam in ROLA. This area has recent peregrine falcon occurrence records, but no pair occupancy or nesting has been confirmed to date. Brain and liver tissue from this adult carcass were analyzed and elevated iron was detected (2400 ppm). Elevated liver iron concentrations can result from congestion, hemolysis, overexposure to iron, iron storage abnormalities or starvation. Manganese (5.6 ppm), mercury (4.7 ppm), molybdenum (0.51 ppm), zinc (83 ppm), copper (5 ppm), cadmium (0.42 ppm), and methyl mercury (1500 ppb) were also detected in this falcon. We also screened this bird for 8 PCBs, which are highly toxic industrial compounds. One PCB was detected, Aroclor 1260 (10 ppm), indicating a likely exposure in the local food chain. Aroclor 1260 may come from a variety of industrial applications, but is most commonly used in large capacitors and transformers (National Library of Medicine, 2021). This falcon was also found to have an apparent Aspergillosis infection in its lungs, which may have become pervasive following malnutrition.

An adult bald eagle was recovered near the Cascade River (just outside of the park complex), after being electrocuted on power lines in 2019. Toxicology screening of liver tissue from this eagle revealed elevated levels of iron (1400 ppm), and detectable levels of mercury (9.8 ppm), methyl mercury (2500 ppb), manganese (4.1 ppm), molybdenum (1.2 ppm), zinc (43 ppm), and copper (8.9 ppm), but no detection of lead, arsenic, or PCBs. The adult common loon recovered in 2019 on Ross Lake in ROLA also provides some insight into avian piscivorous consumers in our study area. Liver tissue from this bird contained manganese (0.79 ppm), iron (130 ppm), mercury (1.9 ppm), zinc (27 ppm), copper (7.4 ppm), and methyl mercury (1200 ppb). Notably, this bird drowned in fishing gear and did not exhibit any signs of poor health.

An emerging and pervasive environmental contaminant, microplastic, is also a potential threat to raptors through bioaccumulation (Wagner et al. 2014). Microplastics are plastic fragments smaller than 5 mm that may pervade the environment through deposition. These microplastics are of great ecological concern in aquatic systems because they can be easily ingested and accumulate as indigestible matter throughout a food web. Study of this issue in aquatics organisms is ongoing in the park complex. Primary microplastics analyses (tissue digestions and ultraviolet detection) of gastrointestinal tracts from the 2019 peregrine falcon, 2019 bald eagle and 2019 common loon were conducted at the University of Alaska in 2020. No microplastics were detected in any of the birds we sampled. While encouraging, this small sample size and basic analysis does not rule out the potentially serious risk that bioaccumulation of microplastics in raptors poses.

Climate Change

During the next 20 to 40 years, the climate of the Pacific Northwest is projected to change significantly, and with potential consequences for forest ecosystems. Predicted changes include warmer, drier summers, and warmer, wetter autumns and winters, resulting in diminished snowpack, earlier snowmelt, and an increase in extreme heat waves and precipitation events (Littel et al. 2009, Salathé et al. 2010, Mote and Salathé 2010). Notably, an extreme heat wave impacted western Washington in late June 2021, and regional raptor nest monitoring reports from camera-monitored nests included fledgling mortalities from this single weather event.

One of the largest potential effects on Pacific Northwest forests is likely to come from an increase in fire frequency, duration, and severity (Littell et al. 2009, Westerling et al. 2006). The winter of 2014–2015 was a record-low snowpack season, but it is unknown if this factor alone presented a direct relationship with low productivity during the nesting season to follow. However, the reduced winter snowpack was followed by an unusually dry summer with 34 wildfire ignitions in NOCA during summer 2015 (NPS unpublished data). Most notably, the Goodell fire actively burned throughout much of the Newhalem and Gorge Lake peregrine falcon nesting territories with high burn severity in some areas. The fire was also in close proximity to the Diablo nesting territory. The burn intensity resulted in heavy and persistent smoke accumulation in the area. Smoke from two additional wildland fires drifted heavily over three other peregrine falcon territories along Ross Lake, thus all six peregrine falcon nesting territories surveyed were impacted by wildland fires during the late nesting season and may have adversely affected 2015 nesting success, during which no reproduction was documented. Further, the burned area near peregrine falcon eyries in the Skagit River Gorge has dramatically reduced the visual buffer that vegetation previously provided, which may potentially cause a greater threat to nesting peregrine falcons from predators and human activities.

Potential for Sampling Error

There is certain inherent potential for sampling bias in the raptor nesting surveys conducted for this report. For example, alternate nest sites were used by osprey and peregrine falcons within some nesting territories in different years. A lack of activity at a single nest does not necessarily preclude activity elsewhere in the territory. Therefore, special attention must be given to other potential nest habitat within a territory that may otherwise appear unoccupied. This was relatively easy to correct for when conducting osprey surveys, but not as attainable for peregrine falcon surveys due to multiple cliff walls and pinnacles in the surrounding area requiring significantly more survey time to detect their often subtle activity and cryptic nesting behavior.

Bald eagle, osprey and peregrine falcon surveys from a boat made nesting determinations relatively easy, owing to an unobstructed view and an adjustable distance from the nest while operating the boat. However, a single known bald eagle site in LACH was more challenging because of its more remote location and the difficulty of obtaining an observation point from a distance that would allow direct view at the rim or into the nest. Observers therefore had to be cognizant of additional evidence that might indicate occupancy or nesting, such as bones, feathers, and whitewash underneath the nest tree and the presence of perched adults or fledglings nearby during the late nesting period.

Positioning of bald eagle nests can sometimes present detection challenges: three of the four identified nest sites were located about 10 m below a live tree-top with canopy cover masking the nest, making for a more difficult and obscured view for the observer. Because there has been a recent increase in anecdotal observations of adult bald eagle activity during the summer months within both study areas, there may be additional nests that are set back farther from the reservoir shoreline, up adjacent river channels or beneath the forest canopy that have not yet been identified. This limitation may have impacted survey results if nesting occurred at an undocumented alternate nest site within the same or possibly a new territory that went unnoticed by the observer. In addition, the relatively inaccessible habitat and widely spaced nest sites of peregrine falcons may be factors that led to underestimating nesting territories and their population status within the study area.

There were several different observers involved over the many years of these raptor surveys, potentially creating some inconsistency in survey skill level and experience. There were also some inconsistencies in survey effort, particularly in the earlier years when the program was still evolving. For example, during a few of the early years of osprey surveys, only one or two surveys were conducted during the early nesting period, which may have overlooked late nesting results and underestimated nesting success. These limitations may have underestimated overall occupancy and productivity results.

Management Implications

Information on the population status of osprey, peregrine falcons and bald eagles is important for the adaptive management of park resources. As top avian predators, these species act as sentinels of larger ecological change, as they are especially vulnerable to environmental contaminants, human disturbances, and a changing climate. New threats to these species and ecosystems emerge on a routine basis, and many are conflated with changing climate. Unexpected changes such as the massive influx of park visitors stemming from broad societal response to the COVID-19 pandemic, can quickly change the success or failure of raptor nesting in any given year. Earlier snowmelt, longer growing season, earlier plant flowering and invertebrate emergence, and shifting migration phenology could all influence food availability and initiation of earlier breeding to synchronize with resource availability. These same biological shifts also portend earlier, and more frequent, visitor access to sensitive nesting areas in the park complex. Management of resources for park managers is complex, interconnected, dynamic, and often time-sensitive. Some potential risks can be mitigated with detailed plans through time, such as development of a comprehensive sport climbing management plan to minimize adverse impacts to known peregrine falcon nesting areas. Some risks, such as wildland fire, are mediated by real-time information connecting fire crews with locations of sensitive resources like raptor nests, that need specific types of protection. This is accomplished through annual (or more frequent) updates to the NOCA Resource Advisors Guide. Some risks, such as environmental contamination through atmospheric deposition, require regional, continental, or global scale mitigations to address. Other environmental contaminants may arise locally and be traced and mitigated at the source. One major limitation of the work in this report is the lack of information concerning prey abundance for each of the three raptor species monitored. This has not historically been conducted due to limited resources; however, some important long-term monitoring data on fish abundance and landbirds trends could provide insight. This type of rigorous monitoring conducted simultaneously with nesting surveys could help emphasize the relevance of such data for understanding the primary drivers of raptor ecology.

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Appendix A. Osprey nest occupancy and productivity, North Cascades National Park Service Complex 1979–2020.

Table A-1. Osprey nest occupancy and productivity, North Cascades National Park Service Complex 1979–2020.

Year	Site Name	NAD 83 UTM Easting	NAD 83 UTM Northing	Elevation (m)	Number of Surveys	Method	Territory Occupied	Number of Adults Observed	Number of Young Observed
1979	Hozomeen Lake	643878	5424591	865	1	Ground	Y	1	0
1981	Hozomeen Lake	643878	5424591	865	1	Ground	Y	1	0
1981	Thunder Creek South	642865	5390365	451	1	Ground	Y	2	0
1981	Arctic Creek North	642549	5390417	457	1	Ground	Y	2	1
1983	Cougar Island West	643895	5402808	534	1	Ground	Y	1	0
1983	Thunder Creek South	642865	5390365	451	1	Ground	Y	2	1
1984	Cougar Island West	643895	5402808	534	1	Ground	Y	2	0
1984	Thunder Creek South	642865	5390365	451	1	Ground	Y	2	0
1984	Babcock Creek	626891	5391732	158	1	Ground	Y	2	0
1985	Cougar Island West	643895	5402808	534	1	Ground	Y	2	2
1985	Thunder Creek South	642865	5390365	451	1	Ground	Y	1	0
1985	Boulder Creek (Stehekin)	671110	5355084	342	1	Ground	Y	2	0
1986	Arctic Creek North	642549	5390417	457	1	Ground	Y	2	1
1986	Cougar Island West	643895	5402808	534	1	Ground	Y	2	1
1986	No Name Creek North	642751	5416320	555	1	Ground	Y	3	0
1986	Babcock Creek	626891	5391732	158	1	Ground	Y	2	0
1986	Boulder Creek (Stehekin)	671110	5355084	342	1	Ground	N	0	0

Table A-1 (continued). Osprey nest occupancy and productivity, North Cascades National Park Service Complex 1979–2020.

Year	Site Name	NAD 83 UTM Easting	NAD 83 UTM Northing	Elevation (m)	Number of Surveys	Method	Territory Occupied	Number of Adults Observed	Number of Young Observed
1986	Buckner (Stehekin)	669970	5356186	353	1	Ground	Y	2	0
1987	Arctic Creek North	641037	5418522	532	2	Air	Y	1	0
1987	Cougar Island West	643895	5402808	534	2	Air	Y	2	0
1987	No Name Creek North	642751	5416320	555	2	Air	Y	2	0
1987	Hozomeen Lake	643878	5424591	865	2	Air	N	0	0
1987	Thunder Creek North	642549	5390417	457	2	Air	Y	2	0
1987	Thunder Creek South	642865	5390365	451	1	Air	Y	2	0
1987	Babcock Creek	626891	5391732	158	3	Both	Y	2	0
1987	Thursday Creek	642820	5409176	490	2	Air	Y	2	0
1987	Boulder Creek (Stehekin)	671110	5355084	342	1	Ground	N	0	0
1987	Buckner (Stehekin)	669970	5356186	353	1	Ground	Y	1	0
1988	Arctic Creek North	641037	5418522	532	2	Ground	Y	2	0
1988	Cougar Island West	643895	5402808	534	4	Ground	Y	1	0
1988	No Name Creek North	642751	5416320	555	2	Ground	Y	2	0
1988	Thursday Creek	642820	5409176	490	2	Ground	Y	2	0
1988	Thunder Creek North	642549	5390417	457	1	Ground	Y	1	0
1988	Babcock Creek	626891	5391732	158	6	Ground	Y	2	1
1988	Boulder Creek (Stehekin)	671110	5355084	342	1	Ground	N	0	0
1988	Buckner (Stehekin)	669970	5356186	353	1	Ground	N	0	0
1989	Buckner (Stehekin)	669970	5356186	353	1	Ground	N	0	0

Table A-1 (continued). Osprey nest occupancy and productivity, North Cascades National Park Service Complex 1979–2020.

Year	Site Name	NAD 83 UTM Easting	NAD 83 UTM Northing	Elevation (m)	Number of Surveys	Method	Territory Occupied	Number of Adults Observed	Number of Young Observed
1992	Sky Creek	623248	5387602	138	10	Both	Y	1	2
1992	Cougar Island East	645489	5402631	494	5	Ground	Y	2	1
1992	Cougar Island West	643895	5402808	534	2	Both	N	0	0
1992	Thursday Creek	642820	5409176	490	7	Both	Y	2	2
1992	No Name Creek South	643718	5414730	505	6	Ground	Y	2	0
1992	No Name Creek Middle	642710	5415596	731	2	Ground	N	0	0
1992	No Name Creek North	642751	5416320	555	4	Ground	Y	2	2
1992	Arctic Creek North	641037	5418522	532	3	Both	Y	1	0
1992	Arctic Creek South	641086	5418382	492	3	Both	Y	2	0
1992	Thunder Creek North	642549	5390417	457	2	Ground	Y	1	0
1992	Babcock Creek	626891	5391732	158	9	Both	Y	2	2
1993	Sky Creek	623248	5387602	138	5	Ground	Y	2	1
1993	Cougar Island East	645489	5402631	494	3	Ground	Y	2	2
1993	Thursday Creek North	642682	5408637	490	2	Ground	Y	1	0
1993	No Name Creek South	643718	5414730	505	1	Ground	N	0	0
1993	No Name Creek Middle	642710	5415596	731	1	Ground	N	0	0
1993	No Name Creek North	642751	5416320	555	1	Ground	Y	1	0
1993	Arctic Creek	641086	5418382	532	1	Ground	N	0	0
1993	Babcock Creek	626891	5391732	158	5	Ground	Y	1	1
1993	Castle Creek (Stehekin)	673490	5351123	340	1	Ground	Y	1	0

Table A-1 (continued). Osprey nest occupancy and productivity, North Cascades National Park Service Complex 1979–2020.

Year	Site Name	NAD 83 UTM Easting	NAD 83 UTM Northing	Elevation (m)	Number of Surveys	Method	Territory Occupied	Number of Adults Observed	Number of Young Observed
1994	Sky Creek	623248	5387602	138	2	Ground	Y	1	1
1994	Cougar Island East	645489	5402631	494	2	Ground	Y	2	1
1994	Thursday Creek North	642682	5408637	490	1	Ground	Y	1	0
1994	No Name Creek Middle	642710	5415596	731	1	Ground	N	1	0
1994	No Name Creek North	642751	5416320	555	2	Ground	Y	2	2
1994	Arctic Creek	641086	5418382	532	3	Ground	Y	2	1
1994	Babcock Creek	626891	5391732	158	1	Ground	N	0	0
1994	McAllister Creek	643466	5386227	580	1	Ground	Y	2	1
1994	Castle Creek	673490	5351123	340	1	Ground	Y	1	0
1995	Sky Creek	623248	5387602	138	5	Ground	Y	1	1
1995	Cougar Island East	645489	5402631	494	2	Ground	Y	2	2
1995	Thursday Creek North	642682	5408637	490	2	Ground	Y	2	0
1995	No Name Creek South	643718	5414730	505	4	Ground	N	1	0
1995	Arctic Creek	641086	5418382	532	1	Ground	N	0	0
1995	Babcock Creek	626891	5391732	158	1	Ground	N	0	0
1995	Roland Point	644116	5400106	504	1	Ground	Y	2	0
1995	Silver Creek	638558	5425684	544	1	Ground	Y	1	1
1996	Sky Creek	623248	5387602	138	1	Ground	Y	1	0
1996	Cougar Island East	645489	5402631	494	1	Ground	Y	1	0
1996	No Name Creek South	643718	5414730	505	1	Ground	Y	1	0

Table A-1 (continued). Osprey nest occupancy and productivity, North Cascades National Park Service Complex 1979–2020.

Year	Site Name	NAD 83 UTM Easting	NAD 83 UTM Northing	Elevation (m)	Number of Surveys	Method	Territory Occupied	Number of Adults Observed	Number of Young Observed
1996	Thursday Creek North	642682	5408637	490	1	Ground	Y	2	1
1996	Arctic Creek	641086	5418382	532	1	Ground	Y	2	0
1997	Sky Creek	623248	5387602	138	1	Ground	Y	1	unk
1997	Cougar Island East	645489	5402631	494	1	Ground	Y	2	unk
1997	Thursday Creek North	642682	5408637	490	1	Ground	Y	2	unk
1997	No Name Creek	641885	5417641	516	1	Ground	Y	2	unk
1997	Arctic Creek	641086	5418382	532	1	Ground	Y	1	unk
1997	Bacon Creek	618793	5382474	113	1	Ground	Y	2	2
1998	Sky Creek	623248	5387602	138	2	Both	Y	2	3
1998	Rainbow Point	644034	5406437	490	2	Both	N	0	0
1998	Cougar Island East	645489	5402631	494	2	Both	Y	2	2
1998	Thursday Creek South	642644	5408228	491	2	Both	N	0	0
1998	Thursday Creek North	642682	5408637	490	2	Both	Y	1	2
1998	No Name Creek South	643718	5414730	505	2	Both	Y	1	0
1998	No Name Creek Middle	642710	5415596	731	2	Both	Y	2	0
1998	No Name Creek North	642751	5416320	555	2	Both	N	0	0
1998	Arctic Creek	641086	5418382	532	2	Both	N	0	0
1999	Sky Creek	623248	5387602	138	2	Both	Y	1	0
1999	Rainbow Point	644034	5406437	490	2	Both	NA	NA	NA
1999	Cougar Island East	645489	5402631	494	2	Both	Y	2	2

Table A-1 (continued). Osprey nest occupancy and productivity, North Cascades National Park Service Complex 1979–2020.

Year	Site Name	NAD 83 UTM Easting	NAD 83 UTM Northing	Elevation (m)	Number of Surveys	Method	Territory Occupied	Number of Adults Observed	Number of Young Observed
1999	Thursday Creek South	642644	5408228	491	2	Both	N	0	0
1999	Thursday Creek North	642682	5408637	490	2	Both	Y	1	0
1999	No Name Creek South	643718	5414730	505	1	Both	NA	NA	NA
1999	No Name Creek Middle	642710	5415596	731	2	Both	NA	NA	NA
1999	No Name Creek North	642751	5416320	555	2	Both	Y	1	0
1999	No Name Creek	641885	5417641	516	2	Both	Y	1	0
1999	Arctic Creek	641086	5418382	532	2	Both	N	0	0
1999	Jack Point West	640545	5422374	512	1	Both	N	0	0
1999	Thunder Creek North	642549	5390417	1500	1	Both	Y	1	0
1999	Thunder Creek South	642865	5390365	1480	1	Both	N	0	0
2000	Sky Creek	623248	5387602	138	1	Ground	Y	1	unk
2000	Cougar Island East	645489	5402631	494	1	Ground	Y	2	unk
2000	Thursday Creek South	642644	5408228	491	1	Ground	N	0	unk
2000	Thursday Creek North	642682	5408637	490	1	Ground	N	0	unk
2000	No Name Creek North	642751	5416320	555	1	Ground	Y	1	unk
2000	No Name Creek	641885	5417641	516	1	Ground	N	0	unk
2000	Arctic Creek	641086	5418382	532	1	Ground	Y	1	unk
2000	Jack Point West	640545	5422374	512	1	Ground	N	0	unk
2015	May Creek	643754	5406597	490	4	Ground	Y	2	0
2015	Rainbow Creek North	643672	5407461	491	4	Ground	N	0	0

Table A-1 (continued). Osprey nest occupancy and productivity, North Cascades National Park Service Complex 1979–2020.

Year	Site Name	NAD 83 UTM Easting	NAD 83 UTM Northing	Elevation (m)	Number of Surveys	Method	Territory Occupied	Number of Adults Observed	Number of Young Observed
2015	Rainbow Creek South	643810	5406617	491	4	Ground	Y	1	0
2015	Little Jackass Mountain	640984	5423986	491	2	Ground	Y	2	3
2015	Desolation Peak	642654	5418588	504	2	Ground	Y	2	1
2015	Lake Chelan West	673490	5351123	340	4	Ground	Y	2	1
2015	Lakeshore Trail East	675196	5351298	378	4	Ground	Y	1	1
2016	May Creek	643754	5406597	490	4	Ground	N	0	0
2016	Rainbow Creek North	643672	5407461	491	4	Ground	N	0	0
2016	Rainbow Creek South	643810	5406617	491	4	Ground	Y	2	0
2016	Little Jackass Mountain	640984	5423986	491	3	Ground	Y	2	1
2016	Boundary Bay	642425	5422347	490	3	Ground	Y	2	0
2016	Desolation Peak	642654	5418588	504	3	Ground	Y	2	0
2016	Desolation Peak Upper	642577	5418655	490	1	Ground	N	0	0
2016	Thursday Creek North	642819	5410195	493	3	Ground	N	0	0
2016	Thursday Creek South	642773	5408804	490	3	Ground	N	0	0
2016	Lake Chelan West	673490	5351123	340	4	Ground	Y	2	1
2016	Lakeshore Trail East	675196	5351298	378	4	Ground	Y	2	1
2017	May Creek	643754	5406597	490	4	Ground	N	0	0
2017	Rainbow Creek North	643672	5407461	491	5	Ground	N	0	0
2017	Rainbow Creek South	643810	5406617	491	5	Ground	N	0	0
2017	Little Jackass Mountain	640984	5423986	491	4	Ground	Y	1	2

Table A-1 (continued). Osprey nest occupancy and productivity, North Cascades National Park Service Complex 1979–2020.

Year	Site Name	NAD 83 UTM Easting	NAD 83 UTM Northing	Elevation (m)	Number of Surveys	Method	Territory Occupied	Number of Adults Observed	Number of Young Observed
2017	Boundary Bay	642425	5422347	490	3	Ground	N	0	0
2017	Boundary Bay CG	642851	5421504	490	2	Ground	N	0	0
2017	Desolation Peak	642654	5418588	504	3	Ground	Y	1	0
2017	Desolation Peak Upper	642577	5418655	490	4	Ground	N	0	0
2017	Thursday Creek North	642819	5410195	493	4	Ground	N	0	0
2017	Thursday Creek South	642773	5408804	490	4	Ground	Y	2	0
2017	Lake Chelan West	675266	5351400	340	3	Ground	Y	2	1
2017	Lakeshore Trail East	675196	5351298	378	3	Ground	Y	2	3
2018	Rainbow Creek South	643810	5406617	491	3	Ground	N	0	0
2018	Little Jackass Mountain	640984	5423986	491	3	Ground	Y	1	1
2018	Little Jackass North	640033	5425444	491	2	Ground	N	0	0
2018	Boundary Bay middle	642425	5422347	490	3	Ground	Y	2	1
2018	Boundary Bay CG	642851	5421504	490	2	Ground	N	0	0
2018	Desolation Peak	642577	5418655	490	2	Ground	N	0	0
2018	Desolation Peak Upper	642654	5418588	504	3	Ground	Y	2	0
2018	Thursday Creek South	642773	5408804	490	3	Ground	Y	1	0
2018	Lake Chelan West	673490	5351123	340	3	Ground	Y	2	1
2018	Lakeshore Trail East	675196	5351298	491	3	Ground	Y	2	1
2019	Rainbow Creek South	643810	5406617	491	2	Ground	Y	2	0
2019	Little Jackass North	640033	5425444	491	1	Ground	N	0	0

Table A-1 (continued). Osprey nest occupancy and productivity, North Cascades National Park Service Complex 1979–2020.

Year	Site Name	NAD 83 UTM Easting	NAD 83 UTM Northing	Elevation (m)	Number of Surveys	Method	Territory Occupied	Number of Adults Observed	Number of Young Observed
2019	Boundary Bay middle	642425	5422347	490	1	Ground	N	0	0
2019	Boundary Bay CG	642851	5421504	490	2	Ground	Y	2	0
2019	Desolation Peak Upper	642654	5418588	504	3	Ground	Y	2	1
2019	Thursday Creek South	642773	5408804	490	2	Ground	Y	2	0
2019	Lake Chelan West	673490	5351123	340	1	Ground	Y	2	unk
2019	Lakeshore Trail East	675196	5351298	378	1	Ground	Y	2	unk
2020	Rainbow Creek South	643810	5406617	491	1	Ground	N	0	0
2020	Little Jackass North	640033	5425444	491	1	Ground	N	0	0
2020	Boundary Bay middle	642425	5422347	490	1	Ground	N	0	0
2020	Boundary Bay CG	642851	5421504	490	1	Ground	N	0	0
2020	Desolation Peak Upper	642654	5418588	504	2	Ground	N	0	0
2020	Thursday Creek South	642773	5408804	490	2	Ground	N	0	0
2020	Lake Chelan West	673490	5351123	340	2	Ground	Y	1	1
2020	Lake Chelan West 2	673237	5351456	336	1	Ground	Y	1	2
2020	Lakeshore Trail East	675196	5351298	378	4	Ground	Y	1	0

Appendix B. Peregrine falcon nest occupancy and productivity, North Cascades National Park Service Complex 2006–2020.

Table B-1. Peregrine falcon nest occupancy and productivity, North Cascades National Park Service Complex 2006–2020.

Year	Site Name	NAD 83 UTM Easting	NAD 83 UTM Northing	Elevation (m)	Number of Surveys	Method	Territory Occupied	Number of Adults Observed	Number of Young Observed
2006	Newhalem	629379	5393361	235	2	Air	Y	2	4
2006	Gorge Lake	632464	5395416	416	1	Air	Y	2	2
2006	Diablo	637734	5398032	443	2	Air	Y	1	2
2007	Newhalem	629379	5393361	235	1	Ground	Y	2	0
2007	Gorge Lake	632464	5395416	416	2	Ground	Y	2	1
2007	Diablo	637734	5398032	443	2	Both	Y	1	0
2007	Pumpkin Mountain	642099	5404925	807	2	Ground	Y	2	0
2007	Skymo Creek	644156	5413372	511	2	Ground	Y	2	1
2007	Little Jackass	641351	5424754	975	1	Ground	Y	2	4
2009	Newhalem	629379	5393361	235	2	Ground	Y	2	0
2009	Gorge Lake	632464	5395416	416	4	Ground	Y	2	1
2009	Diablo	637734	5398032	443	2	Ground	Y	2	3
2009	Pumpkin Mountain	642099	5404925	807	2	Ground	Y	2	2
2009	Skymo Creek	644156	5413372	511	2	Ground	Y	2	2
2009	Little Jackass	641351	5424754	975	3	Ground	Y	2	2
2010	Newhalem	629379	5393361	235	2	Ground	Y	2	0
2010	Gorge Lake	632464	5395416	416	2	Ground	Y	2	0

Table B-1 (continued). Peregrine falcon nest occupancy and productivity, North Cascades National Park Service Complex 2006–2020.

Year	Site Name	NAD 83 UTM Easting	NAD 83 UTM Northing	Elevation (m)	Number of Surveys	Method	Territory Occupied	Number of Adults Observed	Number of Young Observed
2010	Diablo	637096	5397250	923	1	Ground	Y	2	4
2010	Pumpkin Mountain	642099	5404925	807	1	Ground	Y	2	4
2010	Skymo Creek	644156	5413372	511	1	Ground	Y	2	4
2010	Little Jackass Mountain	641351	5424754	975	1	Ground	Y	2	3
2011	Newhalem	629379	5393361	235	4	Ground	Y	2	0
2011	Gorge Lake	632464	5395416	416	3	Ground	Y	2	0
2011	Diablo	637096	5397250	923	6	Ground	Y	2	0
2011	Pumpkin Mountain	642099	5404925	807	1	Ground	Y	1	0
2012	Newhalem	629379	5393361	235	3	Ground	Y	2	2
2012	Gorge Lake	632464	5395416	416	2	Ground	Y	2	2
2012	Diablo	637096	5397250	923	2	Ground	Y	2	0
2014	Newhalem	629379	5393361	235	2	Ground	Y	1	2
2014	Gorge Lake	632464	5395416	416	1	Ground	N	0	0
2014	Diablo	637096	5397250	923	1	Ground	N	0	0
2015	Roland Point North (incidental)	643994	5406170	494	3	Ground	Y	2	0
2015	Pumpkin Mountain	642099	5404925	807	3	Ground	N	0	0
2015	Skymo Creek	644156	5413372	511	3	Ground	N	0	0
2015	Little Jackass Mountain	641351	5424754	975	3	Ground	N	0	0
2015	Diablo Dam	637734	5398032	443	4	Ground	N	0	0

Table B-1 (continued). Peregrine falcon nest occupancy and productivity, North Cascades National Park Service Complex 2006–2020.

Year	Site Name	NAD 83 UTM Easting	NAD 83 UTM Northing	Elevation (m)	Number of Surveys	Method	Territory Occupied	Number of Adults Observed	Number of Young Observed
2015	Gorge Lake	632464	5395416	416	4	Ground	Y	2	0
2015	Newhalem	629379	5393361	235	6	Ground	Y	2	0
2016	Pumpkin Mountain	642099	5404925	807	3	Ground	N	0	0
2016	Skymo Creek	644156	5413372	511	3	Ground	N	0	0
2016	Little Jackass Mountain	641351	5424754	975	3	Ground	N	0	0
2016	Diablo Dam	637734	5398032	443	3	Ground	Y	0	0
2016	Gorge Lake	632464	5395416	416	4	Ground	Y	2	0
2016	Newhalem	629379	5393361	235	6	Ground	Y	2	2
2017	Pumpkin Mountain	642099	5404925	807	3	Ground	N	0	0
2017	Skymo Creek	644156	5413372	511	4	Ground	Y	1	2
2017	Little Jackass Mountain	641351	5424754	975	3	Ground	N	0	0
2017	Diablo Dam	637734	5398032	443	1	Ground	N	0	0
2017	Gorge Lake	632464	5395416	416	4	Ground	Y	2	0
2017	Newhalem	629379	5393361	235	4	Ground	Y	2	3
2018	Pumpkin Mountain	642099	5404925	807	2	Ground	N	0	0
2018	Skymo Creek	644156	5413372	511	4	Ground	Y	2	0
2018	Little Jackass Mountain	641351	5424754	975	2	Ground	N	0	0
2018	Diablo Dam	637734	5398032	443	4	Ground	Y	2	2
2018	Gorge Lake	632464	5395416	416	4	Ground	N	0	0
2018	Newhalem	629379	5393361	235	4	Ground	Y	2	0

Table B-1 (continued). Peregrine falcon nest occupancy and productivity, North Cascades National Park Service Complex 2006–2020.

Year	Site Name	NAD 83 UTM Easting	NAD 83 UTM Northing	Elevation (m)	Number of Surveys	Method	Territory Occupied	Number of Adults Observed	Number of Young Observed
2019	Pumpkin Mountain	642099	5404925	807	3	Ground	N	0	0
2019	Skymo Creek	644156	5413372	511	3	Ground	Y	2	2
2019	Little Jackass Mountain	641351	5424754	975	2	Ground	Y	2	2
2019	Gorge Lake	632464	5395416	416	6	Ground	Y	1	0
2019	Newhalem	629379	5393361	235	17	Ground	Y	2	3
2019	Diablo/ELC	638145	5398319[1]	443	3	Ground	Y	1	0
2020	Pumpkin Mountain	642099	5404925	807	3	Ground	N	0	0
2020	Skymo Creek	644156	5413372	511	2	Ground	N	0	0
2020	Little Jackass Mountain	641351	5424754	975	1	Ground	Y	1	1
2020	Gorge Lake	632464	5395416	416	5	Ground	N	1	0
2020	Newhalem	629379	5393361	235	7	Ground	Y	2	0
2020	Diablo/ELC	638145	5398319	443	1	Ground	N	0	0
2020	Buehler's Bluff (LACH)	672175	5355130	458	4	Ground	Y	4	2

Appendix C. Bald eagle nest occupancy and productivity, North Cascades National Park Service Complex 2015–2020.

Table C-1. Bald eagle nest occupancy and productivity, North Cascades National Park Service Complex 2015–2020.

Year	Site Name	NAD 83 UTM Easting	NAD 83 UTM Northing	Elevation (m)	Number of Surveys	Method	Territory Occupied	Number of Adults Observed	Number of Young Observed
2015	Roland Point	645109	5403462	504	4	Ground	Y	2	0
2015	Little Beaver Creek	641533	5421305	522	4	Ground	Y	1	0
2015	Weaver Point (Stehekin)	672089	5354217	339	3	Ground	Y	1	0
2016	Roland Point	645109	5403462	504	4	Ground	N	1	0
2016	Little Beaver Creek	641533	5421305	522	4	Ground	Y	2	2
2016	Weaver Point (Stehekin)	672089	5354217	339	2	Ground	N	1	0
2017	Roland Point	645109	5403462	504	5	Ground	Y	1	0
2017	Little Beaver Creek	641533	5421305	522	6	Ground	Y	2	2
2017	Dry Creek	645581	5413319	498	2	Ground	Y	2	1
2017	Weaver Point (Stehekin)	672089	5354217	339	2	Ground	Y	1	0
2018	Roland Point	645109	5403462	504	3	Ground	Y	1	0
2018	Little Beaver Creek	641533	5421305	522	3	Ground	N	0	0
2018	Dry Creek	645581	5413319	498	3	Ground	N	2	0
2018	Weaver Point (Stehekin)	672089	5354217	339	2	Ground	N	0	0
2019	Roland Point	645109	5403462	504	4	Ground	N	0	0
2019	Little Beaver Creek	641533	5421305	522	1	Ground	N	0	0
2019	Dry Creek	645581	5413319	498	2	Ground	N	0	0

Table C-1 (continued). Bald eagle nest occupancy and productivity, North Cascades National Park Service Complex 2015–2020.

Year	Site Name	NAD 83 UTM Easting	NAD 83 UTM Northing	Elevation (m)	Number of Surveys	Method	Territory Occupied	Number of Adults Observed	Number of Young Observed
2019	Weaver Point (Stehekin)	672089	5354217	339	1	Ground	N	0	0
2020	Roland Point	645109	5403462	504	4	Ground	Y	2	0
2020	Little Beaver Creek	641533	5421305	522	2	Ground	N	0	0
2020	Dry Creek	645581	5413319	498	1	Ground	N	0	0
2020	Weaver Point (Stehekin)	672089	5354217	339	3	Ground	Y	1	1

Appendix D. North Cascades National Park Service Complex Osprey Survey Form.

OSPREY DATA SHEET

Location ____________________

Date ______________

Time of visit: From ______ to ______

Adults in nest: Y/N/U ___, Number ___

Adults in territory (not in nest): Y/N/U ___, Number ___

Unknown aged in nest: Y/N/U ___, Number ___

Unknown aged in territory (not in nest) : Y/N/U ___, Number ___

Eggs in nest: Y/N/U ___, Number ___

Young in nest: Y/N/U ___, Number ___

Fledged young (not in nest): Y/N/U ___, Number ___

Comments ____

____

____

During the first visit of the breeding season complete following:

Attributes of nesting tree:

UTM coordinates ____________________

Approximate distance to water _______

Species ______________________________________

Dead or alive _______ Approximate DBH _______

Approximate height of tree _______

Approximate height of nest _______

Characteristics of adjacent vegetation/habitat ____________

____

____

Figure D-1. Image of the North Cascades National Park Service Complex osprey survey form. The form's text is provided below.

North Cascades National Park Service Complex Osprey Survey Form Text

Osprey Data Sheet

Location (text field)

Date: (text field)

Time of visit:

From (text field)

To (text field)

Adults in nest:

☐ Y

☐ N

☐ U

Number (text field)

Adults in territory (not in nest):

☐ Y

☐ N

☐ U

Number (text field)

Unknown aged in nest:

☐ Y

☐ N

☐ U

Number (text field)

Unknown aged in territory (not in nest):

☐ Y

☐ N

☐ U

Number (text field)

Eggs in nest:

- ☐ Y
- ☐ N
- ☐ U

Number (text field)

Young in nest:

- ☐ Y
- ☐ N
- ☐ U

Number (text field)

Fledged young (not in nest):

- ☐ Y
- ☐ N
- ☐ U

Number (text field)

Comments: (text field)

During the first visit of the breeding season complete following:

Attributes of nesting tree:

UTM coordinates (text field)

Approximate distance to water (text field)

Species (text field)

Dead or alive (text field)

Approximate DBH (text field)

Approximate height of tree (text field)

Approximate height of nest (text field)

Characteristics of adjacent vegetation/habitat (text field)

Photo: An immature bald eagle (*Haliaeetus leucocephalus*) on the Skagit River near Newhalem, Washington. NPS / JASON RANSOM.

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NPS 168/179522, February 2022

National Park Service
U.S. Department of the Interior

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