

Conservation Assessment

For

Great Gray Owl

(*Strix nebulosa*)

USDA Forest Service Region 6 and
USDI Bureau of Land Management, Oregon and Washington



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Disclaimer

This Conservation Assessment was prepared to compile information on the Great Gray Owl. This Assessment does not represent a management decision by the U.S. Forest Service Region 6 (USFS R6) or the Oregon/Washington Bureau of Land Management (OR/WA BLM). Although the best scientific information available was used and subject experts were consulted in preparation of this document, it is expected that new information will arise. In the spirit of continuous learning and adaptive management, if you have information that will assist in conserving the Great Gray Owl, please contact the interagency Special Status/Sensitive Species Conservation Planning Coordinator in the Portland, Oregon Forest Service Region 6 and OR/WA BLM offices.

Executive Summary

Species and Taxonomic Group

Great Gray Owl, *Strix nebulosa*, Owls

Management Status

See Section 1C: Management Status for complete status listings.

Species of Least Concern on the International Union for the Conservation of Nature IUCN Red List. For updated status visit <http://www.iucnredlist.org/apps/redlist/search>.

NatureServe Global Rank: G5. G5 status indicates that species is widespread and abundant. For updated NatureServe status, visit <http://www.natureserve.org/explorer>.

Considered Not at Risk by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). Updated COSEWIC status can be found at <http://www.cosewic.gc.ca>.

Not federally listed and not a candidate for listing under the Endangered Species Act. For updated status visit <http://www.fws.gov/endangered/species/index.html>.

Interagency Special Status/Sensitive Species Program (ISSSSP) Status: Sensitive Species in Washington. For updated status visit <http://www.fs.fed.us/r6/sfpnw/issssp>.

Northwest Forest Plan Survey and Manage Species. For updated status visit <http://www.blm.gov/or/plans/surveyandmanage/>.

State Endangered in California (California Department of Fish and Game). For updated status visit http://www.dfg.ca.gov/wildlife/nongame/t_e_spp.

Range and Habitat

The Great Gray Owl occupies 30 million km² of boreal forest across North America and Eurasia (Mikkola 1983; Clark and Smith 1987), with its northern limit coinciding with treeline and its southern range extending into other forest types (Verner 1987; Quintana-Coyer et al. 2004). Its range in North America extends from Canada and Alaska to the subalpine and montane forests of Washington, Oregon, Idaho, Montana, east-central California, west-central Nevada, and northwestern Wyoming (Winter 1986; Bryan and

Forsman 1987; Bull and Henjum 1987; Franklin 1988; Bull and Duncan 1993; Duncan and Hayward 1994). In eastern North America, it is found in northwestern Minnesota, south-central Ontario, and Quebec (Nero 1980; Collins 1990).

The Great Gray Owl uses a variety of habitats, primarily mature forests interspersed with open areas suitable for foraging (Duncan and Hayward 1994). Older and mature forests with high canopy closure, adjacent to open areas suitable for foraging, are preferred for nesting, although second-growth forests are sometimes used (Winter 1986; Bryan and Forsman 1987; Bull and Henjum 1990; Duncan 1997). Its preferred foraging habitat includes montane meadows and open forests. Bogs, clearcuts, and early successional forests are also used for foraging (Nero 1980; Mikkola 1983; Winter 1986; Bryan and Forsman 1987; Franklin 1988).

Threats

Habitat loss and fragmentation through timber harvest and development are the primary threats facing Great Gray Owl populations both regionally and globally. Other threats include fire suppression (leading to forested-stand density increases and conifer encroachment into meadows), fire, direct human impacts (e.g. car strikes, electrocution), competition and predation from other birds, starvation during winter, and West Nile Virus. Potential climate change impacts are unknown.

Management Considerations

Retain sufficient landscape-level habitat features when implementing forest management actions to ensure the persistence of Great Gray Owl populations. These include retaining and actively maintaining open areas for foraging adjacent to stands of mature or old-growth trees for nesting and roosting; limiting clearcut/regeneration harvest unit sizes; utilizing variable harvest patch sizes or clearcuts/regeneration harvests with irregular borders to increase forest edge area; retaining forested corridors between cut areas; retaining forested stands around nest sites or potential nest sites; and retaining hunting perches (large trees, large snags, or artificial platforms) in harvest patches (Duncan 1992; Hayward 1994a; Sulkava and Huhtala 1997). At local and site-specific scales, the protection and maintenance of existing nest sites; minimization of disturbance around nest sites during the breeding season; and the provision of artificial nest structures is recommended (Bryan and Forsman 1987; Hayward 1994a).

Research, Inventory and Monitoring Opportunities

A systematic inventory of Great Gray Owls in Washington is a critical priority. Other research, inventory and monitoring opportunities include studies of Great Gray Owl habitat associations, movements, and metapopulation dynamics, prey population dynamics and the relationship between prey species and microhabitat; the effects of grazing on prey populations; territoriality and spacing, especially as they relate to prey abundance; dynamics of Great Gray Owl nest sites and nest site production (Hayward 1994b); and the effects of fire and fire exclusion on Great Gray Owl foraging and nesting habitat (Quintana-Coyer et al. 2004).

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I. Introduction

A. Goal

The goal of this Conservation Assessment is to summarize existing information regarding the biology and ecology of the Great Gray Owl (*Strix nebulosa*), threats to the species, and management considerations, and to provide information to land managers to assist in the formulation of options for management activities. The species is of concern in Washington due to the low number of observations and limited information on breeding pairs. Source habitat for this species appears to have undergone significant losses in quality/function in large areas of Washington state.

Federal management for this species in Washington state follows USFS R6 Sensitive Species (SS) and/or OR/WA BLM Special Status Species (SSS) policies. For OR/WA BLM administered lands, SSS policy details the need to manage for species conservation. For USFS R6 SS policy requires the agency to maintain viable populations of all native and desired non-native wildlife, fish, and plant species in habitats distributed throughout their geographic range on National Forest System lands. Management “must not result in a loss of species viability or create significant trends toward federal listing” (FSM 2670.32) for any identified SS.

B. Scope

The geographic scope of this assessment and recommendations contained herein includes consideration of the known and suspected range of the Great Gray Owl on Forest Service and BLM lands in Washington and Oregon. Species knowledge compiled from federal and non-federal lands outside this area are included as it is relevant to the overall conservation of the species. This assessment summarizes existing knowledge of Great Gray Owls on USFS R6 and OR/WA BLM lands, and other areas where appropriate. Information in this assessment was compiled from peer-reviewed scientific literature, technical reports, gray literature, personal communications, and unpublished data. Although the species’ range is widespread, a lack of knowledge about the abundance, distribution, and habitat associations of Great Gray Owls on USFS R6 and OR/WA BLM lands poses a management challenge. This assessment summarizes existing knowledge and draws inferences where appropriate in order to guide management of the species.

Uncertainty and inference are acknowledged where appropriate. Periodic updates may be necessary to keep this assessment current with time. Threats named here summarize known or suspected existing threats, which also may change with time.

C. Management Status

Global: The Great Gray Owl is listed as a species of Least Concern on the International Union for the Conservation of Nature (IUCN) Red List. Updated IUCN Red List status can be found at <http://www.iucnredlist.org/apps/redlist/search>.

NatureServe Global Rank is G5. G5 indicates that the species is widespread and abundant. Updated NatureServe status can be found at <http://www.natureserve.org/explorer/>.

Canada: Considered Not at Risk by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). Updated COSEWIC status can be found at <http://www.cosewic.gc.ca>. COSEWIC status history: the species was designated Special Concern in April 1979. Its status was re-examined and confirmed in April 1990. Its status was re-examined in 1996 and it was designated Not at Risk. Reason for Designation: This is a widespread species with a population estimate of 25,000 pairs. There is no sign of population decline or change in habitat availability.

United States: Not federally listed and not a candidate for listing under the Endangered Species Act (ESA). Updated ESA status can be found at <http://www.fws.gov/endangered/species/index.html>.

Pacific Southwest Region: Listed as a Sensitive Species by the Regional Forester for the Pacific Southwest Region. Management of the species is subject to Forest Service policy found in FSM 2672.1, which states: "Sensitive species of native plant and animal species must receive special management emphasis to ensure their viability and to preclude trends toward endangerment that would result in the need for Federal listing" (Beck and Winter 2000).

Northwest Forest Plan Area: Listed as a Survey and Manage Species under the Northwest Forest Plan. Category C (Uncommon: Pre-disturbance surveys practical; manage high-priority sites). <http://www.blm.gov/or/plans/surveyandmanage/>.

Interagency Special Status/Sensitive Species Program (ISSSSP): Listed as a Sensitive Species in Washington by the ISSSSP (USDA Forest Service Region 6 and OR/WA BLM). For updated status visit <http://www.fs.fed.us/r6/sfpnw/issssp/agency-policy/>.

California: California Department of Fish and Game State Endangered species. Statewide census estimates range from 200-300 individuals (Beck and Winter 2000). Find CFGC status updates at http://www.dfg.ca.gov/wildlife/nongame/t_e_spp/.

California Natural Diversity Database State Rank: S1. Critically Imperiled in the state because of extreme rarity (often five or fewer occurrences) or because of some factor(s)

such as very steep declines making it especially vulnerable to extirpation from the state/province. For updated California Natural Diversity Database information, visit http://www.dfg.ca.gov/biogeodata/cnddb/plants_and_animals.asp

California Bureau of Land Management and the California State Board of Forestry Sensitive Species. Management Indicator Species (MIS) on the Stanislaus, Tahoe, and Inyo National Forests. Source: Sierra Forest Legacy, 2010: http://www.sierraforestlegacy.org/FC_SierraNevadaWildlifeRisk/GreatGrayOwl.php.

Idaho: No special status. Idaho Fish and Game species status can be found at http://fishandgame.idaho.gov/cms/tech/CDC/cwcs_pdf/appendix%20b.pdf.

Montana: Montana Natural Heritage Program State Species of Concern in Montana and Sensitive Species. Montana NatureServe Rank: S3 (Vulnerable). S3: Potentially at risk because of limited and/or declining numbers, range and/or habitat, even though it may be abundant in some areas. View updated Montana Natural Heritage Program and Montana NatureServe updates at <http://mtnhp.org/SpeciesOfConcern/?AorP=a>.

Oregon: Oregon Biodiversity Information Center (ORBIC) (formerly Oregon Natural Heritage Program) List rank: 4 (Not rare and apparently secure, but with cause for long-term concern, usually with more than 100 occurrences). NatureServe/Natural Heritage Network State Rank: S3 (Rare, uncommon or threatened, but not immediately imperiled, typically with 21-100 occurrences). View ORBIC status updates at <http://orbic.pdx.edu/>.

Oregon Department of Fish and Wildlife (ODFW) Rank: SV. Vulnerable sensitive species (SV) are facing one or more threats to their populations and/or habitats. Vulnerable species are not currently imperiled with extirpation from a specific geographic area or the state but could become so with continued or increased threats to populations and/or habitats. ODFW Strategy Species. ODFW Sensitive Species List updates can be found at http://www.dfw.state.or.us/wildlife/diversity/species/sensitive_species.asp.

Oregon Conservation Strategy Strategy Species. View updated Oregon Conservation Strategy Status at <http://www.oregonexplorer.info/wildlife/OregonBirds/ConservationStrategyBirds>.

Washington: Washington Natural Heritage Program State Rank: S2B: Imperiled: 6-20 occurrences, very vulnerable to extirpation. "B" and "N" qualifiers are used to indicate breeding and nonbreeding status, respectively, of migrant species whose nonbreeding status (rank) may be quite different from their breeding status in the state (e.g. S1B, S4N for a very rare breeder that is a common winter resident). Washington Natural Heritage Program updates can be found at http://www1.dnr.wa.gov/nhp/refdesk/lists/animal_ranks.html.

Washington Department of Fish and Wildlife: State Monitored. View updated Washington Department of Fish and Wildlife State Species of Concern lists at

<http://wdfw.wa.gov/conservation/endangered/lists/search.php?searchby=All&orderby=AnimalType,%20CommonName%20ASC>

The Washington Department of Fish and Wildlife's Landowner Incentive Program's Species at Risk List lists the Great Gray Owl as a "Species of Greatest Conservation Need (SGCN)" in the Washington Comprehensive Wildlife Strategy. The list also indicates a Natural Heritage S rank of S2 (imperiled), State Status of M (Monitor), and Taxa of potential concern. View the Washington Department of Fish and Wildlife's Landowner Incentive Program's species list at http://wdfw.wa.gov/grants/lip/species_at_risk.html#birds%29.

Wyoming: Wyoming Game and Fish Department Species of Special Concern with a Native Species Status of 4 (NSS4). A ranking of 4 indicates that the species' population status and trends are unknown, although they are expected to be stable, and because its habitat is restricted and vulnerable, although there is no ongoing significant loss of habitat. NatureServe Rank: S2 (Imperiled). View updated Wyoming Natural Diversity Database status at <http://uwadmnweb.uwyo.edu/wyndd/info.asp?p=3911>

II. Classification and Description

A. Systematic and Synonymy

Owls, Great Gray Owl (*Strix nebulosa*). The Great Gray Owl is in the Order Strigiformes, Family Strigidae. There are two recognized subspecies: *Strix nebulosa nebulosa* in North America, and *Strix nebulosa lapponica* in Europe and Asia (Bull and Duncan 1993). Recently a third subspecies designation, *Strix nebulosa yosemitensis*, has been proposed for the population of Great Gray Owls restricted to Yosemite National Park (Hull et al. 2010). DNA analysis suggests that relatives include the Mottled Owl (*Ciccaba virgata*, found in open woodland and second growth from Mexico to northeast Argentina) and the Barred Owls (*Strix varia*) (Sibley and Ahlquist 1990; Beck and Winter 2000).

B. Species Description

The Great Gray Owl is a large owl with gray plumage and a distinct round facial disc. Its plumage is dusky to sooty gray overall; its upperparts are irregularly marked with dark and light, and the underparts are boldly streaked over fine barring (Figure 1). The facial disc is patterned with concentric bands of pale gray on a dusky white background, and is subtended by two conspicuous white crescents and a narrow black patch beneath the bill (Beck and Winter 2000). Adults have two or sometimes three generations of flight or tail feathers that are conspicuously faded in color from varying degrees of wear. The Great Gray Owl has prominent white lores and white "bow-tie" patches in the middle of the fore neck. Its bill is yellow. It has no ear tufts. Its eyes are bright yellow and appear small relative to its size. Its tail is wedge-shaped and long, and is mottled gray and brown. Its tarsi and feet are fully and densely feathered (Beck and Winter 2000). Hatching year Great Gray Owls look like adults by September, however, they retain pointed, white terminal tips on their tail feathers until the middle of their first winter (Figure 2). Its flight has been described as "slow, almost effortless, heron-like" (Voous 1988).

Total length is 61-84 cm (Bull and Duncan 1993). The species is sexually dimorphic; the male is smaller than the female. Males weigh between 700 and 1175 g, while females weigh between 925 and 1700 g (Duncan 1992). Wing chord measurements: (unflattened) males 370–430 mm, females 390–455 mm (Duncan 1992); (flattened) males 410–447 mm, females 430–465 mm (Johnsgard 1988). Wing span is 1.5 m (Bull and Henjum 1990).

The Great Gray Owl is distinguished from the Barred Owl (*Strix varia*) and the Northern and California Spotted Owl (*Strix occidentalis*) by its large size, bright yellow eyes, unbarred breast, conspicuous white throat markings, and more definite concentric rings on facial disc (Godfrey 1967). Juveniles, especially just after leaving the nest, can be confused with Great Horned Owls of a similar age, especially because the two species are often found in the same habitats (Beck and Winter 2000). Great Gray Owls always have gray facial disks, while Great Horned Owls always have brown facial disks. Also, Great Horned Owls have ear tufts and Great Gray Owls do not.

The Great Gray Owls' call is low and booming. The female's call has a slightly higher pitch. The territorial call of both sexes is a series of low, evenly spaced *hoos*. This call is given most frequently during breeding and near a nest. A second call consisting of low, soft double hoots may be a contact call and associated with defense of territory (Collins 1980; Nero 1980). A low, softer version of the territorial call is sometimes given by the male just before he delivers prey to the female. Another variation of *hoos* is given by the female when agitated, usually by human disturbance. A soft single call that can be given in repetition (*whoop* or *who-ooop*) is the typical food demand call of the female. The frequency and volume of the call depends on degree of hunger. This call is also used to maintain contact between the male and female as well as with young (Bull and Duncan 1993). Nestlings frequently hiss at intruders. Adults, or an adult and young, will exchange high-pitched, excited chatter while exchanging prey (Collins 1980). A loud, erratic call similar to the chatter is sometimes given by the female when the nest or young are threatened. She often performs a distraction display while emitting this call.

III. Biology and Ecology

A. Life History

Great Gray Owls are relatively long lived and have a low reproductive rate. Adult mortality is likely low. It is estimated that Great Gray Owls live between 10 and 20 years in the wild (Bull et al. 1989a). A female bird banded as an adult was recaptured 13 years later (Duncan and Hayward 1994). Seven and nine year old birds have also been reported in the wild (Oeming 1964; Cramp 1985). Korpimaki (1986) cites a life span of 11 years. Great Gray Owls first breed at three years, and rarely at one or two years (Bull et al. 1989b). There is no known phenotypic plasticity or hybridization.

Great Gray Owls are most vocal during the courtship and breeding season from January through July. The territorial call is primarily nocturnal, while female and nestling begging calls are often given at night, in the early morning, and the evening. In California, calling activity was greatest at 01:00 am with a second peak at 22:00 pm; 56% of calls were between 01:00 am and 04:00 am; and calling declined conspicuously around midnight

(Winter 1986). Great Gray Owls are most often seen in winter, in more heavily settled areas in the southern portions of their range (Duncan 1997). They sometimes appear in large numbers locally in winter, a behavior referred to as an influx or invasion. Groups of up to 15 individuals have been observed in late winter in Manitoba and Minnesota (Nero 1980). These events are different from the large-scale irruptions that the species is known to undergo during periods of winter prey scarcity (Collins 1980).

Great Gray Owls are mostly solitary in autumn and early winter, becoming increasingly gregarious toward March (Nero 1980). Adult males establish their territory by vocalizing in the vicinity of the nest site. Territories are established as early as the autumn prior to nesting (Duncan 1987a). Pair formation occurs as early as January and as late as two weeks prior to egg laying in April and May, and courtship typically begins in late February or March (Collins 1980; Duncan 1987b; Franklin 1988; Bull and Henjum 1990). In Manitoba, courtship behavior and nest site inspections have been observed as early as November (Duncan 1987b). Adults are known to repeatedly visit nests 17 to 25 days before nesting (Franklin 1988) and may visit several sites before selecting a nest. Females lay eggs between late March and early June. The mean date of the first egg ranges from mid March to mid April in northeastern Oregon (Bull and Henjum 1990); mid April to late May in California (Natural Heritage Program 2011); April 5th in Manitoba (Duncan and Hayward 1994), May 5th in Idaho and Wyoming (Franklin 1988); late March to May in Alberta; and late April to early June in Ontario (Natural Heritage Program 2011). The timing of egg laying appears to depend on snow cover and prey availability, and egg laying is delayed in years of heavy snow cover (Franklin 1988; Voous 1988; Bull et al. 1989a). Some pairs may not breed in years of low prey abundance. Great Gray Owls usually produce one brood per year, although they are known to re-nest if the first nest fails (Bull and Henjum 1990).

Eggs are laid at one to three day intervals. Eggs are dull white, and are more ovoid than eggs of other *Strix* owls. Egg size ranges: Alberta, 54.3 x 42.4 mm (Oeming 1964); Manitoba, 53.1 x 43.3 mm (Collins 1980); Scandinavia, 53.2 x 42.4 mm (Mikkola 1983). Clutch size is two to five, usually between two and four. Average clutch sizes in Europe vary from 0 to 4.6 eggs, seemingly in response to prey availability (Mikkola 1983). Korpimäki (1986) cited a mean clutch size of 4.4 eggs. Mean clutch sizes reported in North America are: up to five in Oregon (Bull and Henjum 1990) and in Manitoba (Collins 1980); two to three in California (Beck and Winter 2000; Bull and Duncan 1993); and three to 3.3 in Idaho and Wyoming (Franklin 1988). Only females develop a brood patch and only females incubate the eggs, beginning with the first egg laid. During incubation, the female broods the eggs while the male brings food. Males typically bring three to five prey per day to the female. In one study males hunted up to 3.2 km from their nest while breeding (Bull et al. 1988a). During incubation, females only leave the nest to defecate and regurgitate pellets (Bull and Henjum 1990). Female Great Gray Owls consume the feces and pellets of their young until about a week before the young fledge. Reported average incubation periods vary from 29.7 days in Idaho and Wyoming (Franklin 1988); to 28 to 36 days in Scandinavia; (Mikkola 1983); to 31 days in captivity (Duncan and Hayward 1994).

In 67 nesting attempts during a four year study in northeastern Oregon, 78% of nests fledged young (Bull et al. 1989a). In studies in Idaho and Wyoming, 70.5% of nests fledged young (Franklin 1988); and in Manitoba and Minnesota 81 % fledged young (Duncan 1987b). Of 427 Finnish nests, 95% hatched eggs and 69% fledged (Cramp 1985).

Pair bonds are not maintained outside the breeding season, but pairs will reform their bond if both birds return to the same breeding territory. In Oregon, Idaho, and California, pairs possibly remain together as long as both live, but either sex will re-mate if its mate disappears (Duncan and Hayward 1994). While Great Gray Owls are typically monogamous, it is suspected that they are occasionally polygynous (Cramp 1985). An immature male was observed feeding a mated female brooding young while the adult male was hunting 30 m away (Bull and Duncan 1993). Cooperative breeding attempts have been made in captivity (Bull and Duncan 1993).

Great Gray Owls typically nest in the same home range year after year (Bull et al. 1988b). They demonstrate strong fidelity to breeding and wintering areas (Bull et al. 1988b), but less to specific nest sites. They will, however, often reuse nests, and a pair will sometimes return to the same nest site year after year (Franklin 1988; Bull et al. 1988b; Duncan 1992). In northeastern Oregon, seven of 18 nest sites were re-used (Bull et al. 1988b), while in a study in southwestern Oregon, none of 10 nests were re-occupied in subsequent years (ed. Marshall et al. 2006). When they change nest sites they typically move less than five km (Bull et al. 1988b; Duncan 1992). In Manitoba, some individuals return to former nest sites after dispersing up to 500 km (Duncan 1992). Given adequate prey, adult males will maintain a territory around the nest site all year (Bull and Duncan 1993).

Brood size is two to five, usually between two and four. The mean number of fledged young per successful nest are 2.3 (SD = 0.87, range 1-5 from Oregon study) in Oregon and Alberta (Bull et al. 1989; Stepnisky 1997); 2.7-3.0 (SD = 0.4, range 1-4) in Idaho and Wyoming (Franklin 1988); 2.8 in Manitoba (Bull and Duncan 1993); and 2.4 in Finland (Mikkola 1983).

Great Gray Owl chicks are nidicolous and semi-precocial at birth. The young are born covered in down. In one study the weights of four newly hatched young ranged from 36 to 39 g (Collins 1980). The female broods her young immediately after hatching for two to three weeks, after which she begins roosting near the nest. Adults may sometimes favor their smaller or weaker offspring (Bull et al. 1989a). The young begin to leave the nest at three to four weeks. Juveniles leave the nest over several days, with usually the largest leaving first (Oeming 1964; Nero 1980; Bull and Henjum 1990). Juveniles either fall or jump from the nest (Franklin 1988, Bull et al. 1989a). Reported weights of juveniles leaving the nest range from 360 to 755 g (Bull and Henjum 1990). After leaving the nest, juveniles roost off the ground. After leaving the nest, and before they are able to fly, they use their talons, beak, and wings to climb dead and leaning trees (Bull et al. 1988b).

Juveniles fly seven to 14 days after leaving the nest (Franklin 1988). Juveniles' mean weight at fledging was 507 g in Manitoba (Collins 1980), and 609 g in Oregon (Bull et al. 1989a). The female stays nearby after the young leave the nest, while the male continues to feed both the female and young for several days, then just the young (Bull et al. 1989a; Bull and Henjum 1990; Duncan 1992). After fledging, the young are usually fed directly by the male. Fledged young are known to join other fledged broods and may be fed by more than one male (Duncan and Hayward 1994). Young Great Gray Owls are fed at all times of day but primarily around dawn and dusk. Few data document feeding rates at nests. Four young (more than 2 weeks old) at a nest in Finland were fed, on average, 10.3 voles per day over nine days (Cramp 1985). Collins (1980) reported 0.27 feeding trips per hour by the male to the nest during the nestling stage in 135 hours of observation.

Females typically leave the area after three to six weeks, while the male continues to feed the young for up to three months (Bull et al. 1989a; Bull and Henjum 1990; Duncan 1992), although females have also been observed remaining near the nest site during the post fledging period (Godwin pers. comm. 2011). During the post fledging period, females may visit other adjacent family groups, occasionally returning to their own mate and young (Duncan 1987b). Juveniles can fly well at five to six weeks (Franklin 1988) and they start hunting on their own at about 3 months. They are independent after about four to five months, by late fall or winter (Franklin 1988). Young typically disperse at this time, although in Manitoba, some immatures did not disperse from their natal site until March (Duncan 1987a).

In Oregon, radio-tagged juveniles moved 9- to 31 km from their nest during their first year, while adults moved 3 to 43 km during same period (Johnsgard 1988). The maximum distance radio-tagged juveniles dispersed from natal sites in their first year ranged from 7.5 to 32 km in Oregon (Bull et al. 1988a), and up to 753 km in Canada (Duncan 1992). Some juveniles may remain on their parent's breeding territory all year; while others move irregularly in search of suitable foraging habitat. Of 21 young followed for about a year in northeastern Oregon, 24% went 0 to 10 km, 76% went 10 to 50 km, and 0% went more than 50 km (straight line distance from nest to farthest location where individual was located). Three young followed for two years (none nested) traveled maximum straight line distances of 9.9, 17.9, and 28 km, respectively (Bull and Henjum 1990). In a study in Oregon, two birds were found nesting 8.5 and 33 km from their natal site (Bull and Henjum 1990).

Franklin (1988) reports that young Great Gray Owls have a 63% chance of surviving from egg to flight stage; Mikkola (1983) reports a 58% chance. In Oregon, Bull et al. (1989a) found that the probabilities of juveniles surviving to the following ages were: 12 months old = 53%; 18 months old = 39%; and 24 months old = 31% ($n=32$). Mortality was due to starvation, falling from the nest, or predation. Adults have higher survival rates. The annual probability of survival for nesting females in Oregon was 84% (95% confidence limit [CL] 70%-100%) and for nesting males 91% ([CL] 78%-100%) (Bull et al. 1989a). In Manitoba, 29% of 51 radio-marked adult owls (10 of 23 males and 5 of 28 females) died within two years (Bull and Duncan 1993). It is estimated that at least 20% of adult mortality is due to starvation during winter (Voous 1988).

B. Activity Pattern and Movements

Great Gray Owl movements are highly variable and appear to be influenced mainly by changes in prey biomass and availability (Nero 1980; Mikkola 1983; Duncan 1992). The species has been described as resident, nonmigratory, and nomadic (Nero 1980; Mikkola 1983; ed. Marshall et al. 2006). The species appears to move longer distances during years when prey is scarce (Duncan et al. 1997). Movements among northern populations appear to be longer than those among southern populations. In the northern portions of their range, individuals are known migrate distances of up to 700 km (Nero 1980; Duncan 1992). These movements may be more closely related to prey availability than to snow depth, although the links between Great Gray Owl movements, prey availability, and snow depth are not well understood. Bull et al (1988a) suggested that longer migrations in the north may occur because Great Gray Owls must travel farther to change elevation or snow depth. Northern vole populations are thought to fluctuate with larger amplitude than southern populations, possibly explaining larger movements in response to prey availability. Greater mobility has been documented during years when prey is scarce (Duncan 1987a). In one study in Canada, dispersal followed rodent population crashes, and individuals failing to disperse following prey declines frequently died over the winter (Duncan 1992). Cramp (1985), however, noted no correlation in the European literature between the extent of movement and rodent population levels.

In some parts of the southern portion of their range, Great Gray Owls appear to move to lower elevations with less snow cover in winter (Beck and Winter 2000). In Yosemite National Park, for example, Great Gray Owls are frequently known move to lower elevations in winter (Riper and Wagtendonk 2006). Bull et al. (1988a) noted considerable variability in the local movements of Great Gray Owls in Oregon. In this study, individuals traveled between 2 and 43 km from their nest site during winter but 78% returned to within one km of their previous nest site the following year (Bull et al. 1988a). The authors noted that Great Gray Owls moved to areas with thinner snow cover in winter. Likewise, Franklin (1988) found birds wintering at lower elevations than where they nested in southeastern Idaho, suggesting they moved to avoid deep snow. Telemetry studies in southern Oregon found that Great Gray Owls moved to lower elevations in winter, but also moved to higher elevations in some cases, and sometimes moved back and forth (Godwin pers. comm. 2011). There appears to be considerable variability in movements among individuals and populations, and between years, throughout the Great Gray Owls' range. This variability suggests that Great Gray Owls' movements are relatively plastic and opportunistic.

In Manitoba and northern Minnesota, adult females traveled farther and earlier (mean 372 km) than adult males (mean 235 km), but no difference was observed between males and females in the mean direction of movement (Duncan 1992). Juvenile Great Gray Owls are thought to travel farther than adults during dispersal movements.

Great Gray Owls are one of several owl species in North America that are known to exhibit irruptive behavior, or large, irregular, continental-scale movements (Collins 1980). Irruptions are thought to be the result of one or more years of high reproductive

success followed by a widespread decline in prey availability on the breeding range. Multiple irruptions have been reported in North America and Scandinavia over the past 150 years (Godfrey 1967; Collins 1980; Nero 1980). During the winter of 1978-1979, about 40 birds gathered near Toronto, Ontario; and more than 100 individuals were found in southeastern Manitoba within a 30 km radius (Bull and Duncan 1993). While most irruptive movements occur south of the species' winter range, the species has also been known to winter north of its breeding range or to disperse north following prey population crashes (Cramp 1985; Duncan 1992). Irruptions are distinct from local invasions or influxes of Great Gray Owls that sometimes occur, especially during winter, and are thought to be in response to localized prey abundance (Nero 1980; Duncan 1992; Bull and Duncan 1993).

C. Food Habits

Great Gray Owls feed primarily on small mammals. Across the majority of their range, especially the northern portions, voles from the *Microtus* genus dominate their diet (Collins 1980; Nero 1980; Mikkola 1983; Bull et al. 1989b; Duncan 1992). During the breeding season, over 90% of the prey in Great Gray Owl diets in Europe and Canada was in the family Microtidae (Oeming 1955; Nero 1969; Sulkava and Huhtala 1997). In Manitoba and Minnesota, owls select *Microtus* voles in proportions greater than their availability, while they appear to underutilize shrews (family Soricidae) and red-backed voles (genus *Clethrionomys*) (Duncan 1992).

In the western United States Great Gray Owls prey primarily on voles (*Microtus* spp.) and pocket gophers (*Thomomys* spp.) (Franklin 1988; Winter 1986; Reid 1989; Winter 1986; Bull and Henjum 1990). Pocket gophers appear to be an important prey in the southern portion of their North American range. Pocket gophers are a primary prey in Yosemite National Park, southeastern Idaho, and northwestern Wyoming (Winter 1986; Franklin 1988). In southeastern Idaho and northwestern Wyoming, pocket gophers and *Microtus* spp. constituted 92.0% (by frequency) and 92.9% (by biomass) of 435 prey items identified from pellets collected at eight nests (Franklin 1988). Even when pocket gophers are abundant, it appears that Great Gray Owls may not breed in the absence of voles. This may be due to the difficulty of catching pocket gophers (Winter 1986). In California, prey emphasis shifts between voles and pocket gophers as prey availability changes. In southwestern Oregon moles (*Scapanus* spp.) are also an important part of their diet (ed. Marshall et al. 2006; Godwin pers. comm. 2011). Duncan (1992) found the diet of Great Gray Owls in boreal forest regions of North America more similar to that of European Great Gray Owls than to that of owls in Oregon, Idaho, or California. Red-backed voles (*Clethrionomys gapperi*) are the only other prey species known to represent over 10% of the Great Gray Owl's diet in North America (Duncan and Hayward 1994).

In the absence of their primary prey, especially in winter when food is scarce, Great Gray Owls will opportunistically take a variety of small prey. In a pellet study in southwestern Oregon, pocket gophers were the most abundant prey by number and weight, comprising 248 of 438 prey items, and 67.49% of prey biomass. Other primary prey items were broad-footed mole (34), *Microtus* vole spp. (29), and western red-backed vole (17). Other prey included creeping vole (12), montane vole (9), northern flying squirrel (9), shrew

mole (8), chipmunk spp. (9), woodrat (9), juvenile rabbits (6), great grig cricket (5), Oregon Junco (2), Northern Pygmy Owl (1), Western Bluebird (1), unknown small and medium birds (10), and a frog, among other items (Godwin pers. comm. 2011). Other known prey include shrews (*Sorex* spp., *Blarina brevicauda*, *Microsorex hoyi*), moles, deer mouse (*Peromyscus maniculatus*), red squirrel (*Tamiasciurus* spp.), flying squirrel (*Glaucomys* spp.), jumping mouse (*Zapus* spp.), and grasshopper mouse (*Onychomys* spp). In Canada, known prey include the star-nosed mole (*Condylura cristata*), northern bog lemming (*Synaptomys borealis*), heather vole (*Phenacomys intermedius*), least chipmunk (*Eutamias minimus*), least weasel (*Mustela rixosa*), short-tail weasel (*Mustela erminea*), snowshoe hare (*Lepus americanus*), Sharp-shinned Hawk (*Accipiter striatus*), Broad-winged Hawk (*Buteo platypterus*), Gray Jay (*Perisoreus canadensis*), American Robin (*Turdus migratorius*), Spruce Grouse (*Dendragapus canadensis*), *Anas* spp., and wood frog (*Rana sylvatica*) (Duncan 1992).

Great Gray Owls hunt primarily from perches, listening and watching the ground intently. Once prey is detected, they usually fly a short distance—less than 50 m—in pursuit. Bull and Henjum (1990) recorded an average perch to prey distance of 10.5 m. Great Gray Owls can detect and capture prey by sound alone, and can capture prey as deep as 45 cm below the snow surface (Law 1960; Godfrey 1967; Nero 1969; Collins 1980). They do so by hovering above the snow, then plunging face downward and breaking through the snow with clenched feet, attempting to grasp the prey with their feet and talons (Collins 1980; Nero 1980; Cramp 1985). In summer, they may break into gopher burrows in much the same way. Small mammals are normally swallowed whole, while larger prey is consumed by picking meat off the carcass (Bull and Henjum 1990). Great Gray Owls sometimes cache prey at the nest or in nearby trees (Nero et al. 1974).

Prey population dynamics are thought to play a significant role in Great Gray Owl movements and population dynamics (Nero 1980; Mikkola 1983; Duncan 1992). Few studies, however, have examined the relationships between Great Gray Owl movements, prey dynamics, and habitat attributes in the western U.S. See Section IIIB, “Activity Pattern and Movements,” for a discussion of the relationship between rodent levels, snow depth, and Great Gray Owl movements. Microtines are thought to undergo dramatic, geographically asynchronous population fluctuations, while pocket gopher populations exhibit less annual variation (Duncan and Hayward 1994). For this reason, it is thought that pocket gopher populations act as a “buffer” species, allowing Great Gray Owls in the western United States to avoid large nomadic movements and to remain on or near their breeding range year-round (Duncan and Hayward 1994).

Prey habitat selection likely affects Great Gray Owl distribution, abundance, and movements. *Microtus* voles generally occupy moist grass/sedge openings and open herbaceous forests, while pocket gophers prefer drier meadows (Chase et al. 1982). Populations of voles are more abundant in grasslands and less common in closed canopy forests. Pocket gophers inhabit both forested and unforested habitats, but are not thought to be abundant in closed canopy forests. Red-backed voles inhabit forest environments and are most abundant in mature and older forests.

Daily food intake for a captive female Great Gray Owl was about 90 g per day (Bull and Duncan 1993), and 60-80 g per day for an incubating wild female (Cramp 1985). In winter, adults can consume up to seven vole-sized prey (45 g each) each day (Duncan 1992). Bull and Henjum (1990) calculated that an individual Great Gray Owl's yearly consumption was more than 1,400 voles. Data on food habits are derived primarily from pellet analysis collected from nest sites. Some caution is needed in the analysis of pellets from nest sites, because breeding males appear to deliver large prey to the nest and eat smaller prey themselves away from the nest (Bull and Henjum 1990).

There seems to be little overlap in most years between the diets of Great Gray Owls and other owls sharing the same habitat. For example, Great Horned Owls normally eat large prey such as grouse and hares, while Great Gray Owls take smaller prey. In northeastern Oregon, the Long-eared Owl's diet is most similar to that of the Great Gray Owl, although the latter eats mostly adult pocket gophers while the former take juveniles (Bull et al. 1988b). Competition between species is likely more severe during years when prey are scarce.

Voous (1988) suggests that Great Gray Owls may have an unusual ability to withstand starvation. He notes that "in winter, the birds apparently survive lean body weights of 280 and 340 g which is around 30% of the normal body weight. The birds then appear lethargic and are usually extraordinarily tame towards man, though they may in fact be too weak to move around and be concentrating exclusively on food."

D. Range, Distribution, and Abundance

The Great Gray Owl is distributed holarctically across the boreal forests of North America and Eurasia, with its range extending south into the montane coniferous forests of Asia, Europe, and North America (Duncan and Hayward 1994). The northern limits of the Great Gray Owl's range generally coincide with treeline (Quintana-Coyer et al. 2004). Its winter range is the same as breeding range, except for the tendency to wander irregularly south in winter (Nero 1969; Brunton and Pittaway 1971). See Section IIIB, "Activity Pattern and Movements," for a detailed discussion of Great Gray Owl movements. The Great Gray Owl is the only member of the *Strix* genus found both in North America and Eurasia.

In Eurasia the Great Gray Owl is found in boreal forests from northern Scandinavia, northern Russia, and northern Siberia south to central Russia, northern Mongolia, northern Manchuria, Amurland, and Sakhalin (Mikkola 1983; Cramp 1985; Bull and Duncan 1993;). Its range extends southward into the boreal coniferous forests of some central Asiatic mountains, corresponding to similar extensions south into the Rocky Mountain, Cascade, and Sierra Nevada mountain ranges in the western United States (Voous 1988). In Canada the Great Gray Owl inhabits forests from near tree line in the northern Yukon Territory, northwest and central Mackenzie, northern Saskatchewan, Manitoba, and northern Ontario, south through southern Yukon and interior British Columbia, north and central Alberta, Manitoba, and central Ontario; and likely Quebec (Godfrey 1967). In the United States, it occupies boreal forests from central and southern Alaska south to the subalpine and montane forests of central Washington, northeastern,

central and southwestern Oregon, northern, central and southeastern Idaho, western Montana, east-central California, and northwestern Wyoming (Winter 1986; Bull and Henjum 1987; Forsman and Bryan 1987; Bull and Duncan 1993; Duncan and Hayward 1994) (Figure 3).

Accurate population estimates for Great Gray Owls are challenging due to uneven and variable distribution and movements, low density of occurrence, lack of long-term data, and population fluctuations over three to five year periods that are thought to be related to prey population cycles (Nero 1980; Bull and Duncan 1993; Duncan 1992; Duncan et al. 1997; Duncan 1997). Detectability is also an issue. Appropriate survey methodology to conclude the species is not present may include two years of survey effort, with six visits each year. This extensive level of survey effort is challenging to implement and has not occurred over a broad swath of the species range. Across most of its range the species appears to be stable and there is no evidence of population decline, but population data are lacking for many areas (Kirk et al. 1995). Global population estimates range from 10,000 to 1,000,000 individuals. Nero (1969) estimated the North American population to be between 5,000 and 50,000 individuals, while Duncan (1992) estimated the North American population to be between 20,000 and 70,000 breeding pairs. In the early 1990's, the number of breeding pairs in Canada was estimated to be between 10,000 and 25,000 (Johnsgard 1988; Kirk and Duncan 1995). Great Gray Owl abundance estimates for North America range from 0.15 pairs/km² in Minnesota (Spreyer 1987) to 1.88 pairs/km² in Manitoba and northern Minnesota (Duncan 1987a). Bull and Henjum (1990) reported 0.74-1.72 pairs/km² in northeastern Oregon, while Winter (1986) recorded a nesting density of 0.66 pairs/km² in California. Reported densities are much higher in Europe (Mikkola 1983; Duncan 1987a; Bull and Henjum 1990).

Great Gray Owls are relatively uniformly distributed range-wide. Populations in the western U.S. appear more fragmented than northern populations, although this may be simply due to the fact that the species is at the edge of its range in the western U.S. Little is known about the metapopulation structure of Great Gray Owls, either range-wide or regionally.

There are no reliable population estimates for Great Gray Owls across Oregon and Washington. The Partners in Flight Landbird Species Assessment Database estimates 1,200 individuals for Oregon, with no data available for Washington (Table 1). Across the range of USFS R6 and the OR/WA BLM, Great Gray Owl distribution appears patchy (Table 2, 3) (Figure 4, 5, 6). In Washington there have been few detections of Great Gray Owls and it is unknown whether there is a viable breeding population in the state. In Washington the species has been detected on the Colville, Gifford-Pinchot, Mount Baker-Snoqualmie, Okanogan-Wenatchee, and Olympic National Forests, with confirmed breeding on the Okanogan-Wenatchee National Forest (Table 2) (Figure 4). In Washington, the Vale District of the BLM lists the species as suspected, and the Spokane District BLM lists it as Documented (Table 3) (Figure 5). In Oregon, there appear to be strong breeding populations in the Siskiyou mountains of southwestern Oregon, as well as in the Blue and Willowa mountains and surrounding areas of northeastern Oregon. Nest sites have been located in the western Cascade mountains and

foothills, as well as in central Oregon east of the Cascade crest, but it is unknown whether there are strong breeding populations there (Table 2, 3) (Figure 4, 5) (ed. Marshall et al. 2006). On Forest Service lands in Oregon, the species has been detected on the Deschutes, Fremont-Winema, Malheur, Mt. Hood, Ochoco, Rogue River-Siskiyou, Umatilla, Umpqua, and Willamette National Forests, with confirmed breeding on the Deschutes, Fremont-Winema, Malheur, Rogue River-Siskiyou, Umpqua, and Willamette National Forests. On BLM lands in Oregon, the species has been detected on three districts: Lakeview, Medford, and Roseburg, with confirmed breeding on all three districts (Table 3) (Figure 5). Since the inception of the Northwest Forest Plan (NWFP) Standards and Guidelines in 1994, a concerted survey effort in the Oregon Western Cascades, Oregon Eastern Cascades, and Oregon Klamath provinces has greatly increased the number of Great Gray Owls known in these areas. With the Standards and Guidelines came a requirement to conduct surveys when projects might potentially impact nesting habitat. Prior to the NWFP Standard and Guidelines, the species was known from few sites in these areas. Now, over 115 known sites (pairs or nests) are known within this geographic area.

Little is known about the historical distribution of Great Gray Owls in Oregon and Washington (Forsman and Bull 1989; Hayward 1994a; Beck and Winter 2000). Scattered sightings have been reported in Oregon since the early 1800's (Marshall et al. 2006). Historically, the species was considered a rare winter visitor or vagrant to the area, but survey efforts beginning in the 1980's revealed that the species was more widespread and abundant than was previously thought.

It is thought that there is a gap in the distribution between the breeding population of Great Gray Owls in Yosemite National Park in the central Sierra Nevada of California and breeding populations in southwestern Oregon (Bull and Duncan 1993). There have been scattered detections of Great Gray Owls in the Sierra Nevada and southern Cascade regions of northern California. The distribution of Great Gray Owls in northern California is not well understood, but appears to be limited. For example, the California Natural Diversity Database revealed a single detection near Patterson Meadow in Modoc County, although a nest was not found. A query of the Biogeographic Information and Observation System indicated 15 additional locations where a Great Gray Owl or its feathers was observed. The USDA Forest Service has provided anecdotal information for at least six locations along the Siskiyou Crest and Mumbo Basin (California Department of Fish and Game 2011). In 2009 and 2010, the California Department of Fish and Game conducted strategic surveys for Great Gray Owls in Siskiyou, Modoc, Lassen, Shasta, Trinity, and Tehama counties. Using a standardized protocol, 134 survey visits were completed at 15 to 20 meadow complexes, along with approximately eight to 12 daytime follow up visits. In 2009, a territory was located in northern Modoc County, just south of the Oregon border, and a juvenile was detected at the same site. The following year, a reproductive adult pair was detected in a nearby meadow approximately three miles to the southeast. A single male was detected on the fifth visit of the second year in eastern Tehama County (Croteau unpub. data 2011). Breeding Great Gray Owls have also recently been detected in the Sierra Nevada foothills of Yuba County, California (Knudson 2011).

Few data are available to substantiate the Great Gray Owl's historic global or regional range or abundance (Forsman and Bull 1989). No data substantiate historical changes in distribution, although some have suggested possible changes in Europe (Mikkola 1983; Voous 1988) and in North America (Oeming 1964; Nero 1980). According to Sulkava and Huhtala (1997), Great Gray Owls increased in abundance in Europe in recent decades. The authors attribute this increase to an increase in clearcuts, providing more open habitat and increasing the number of voles. They also note that increases in positive attitudes towards owls and other birds of prey have coincided with increases in Great Gray Owls since the late 1960's. Nero et al (1984) speculated that more Great Gray Owls now inhabit southern Manitoba than in the past. A breeding population in the Targhee National Forest in Idaho increased and then decreased between 1974 and 1989 (Groves and Zehner 1990). These authors speculated that these changes were related to changing timber harvest regimes.

Metapopulation dynamics of Great Gray Owls are poorly understood, both regionally and range-wide. Populations in western Canada appear to be larger and more genetically diverse than populations farther south in the western United States; while southerly populations appear to be more fragmented and geographically isolated from each other (Hull et al. 2010). Genetic data suggest that the population in the central Sierra Nevada of California has been genetically isolated for an extensive period of time, while less significant genetic divergences were found among owls across Pacific Northwest sites, suggesting relatively recent divergences among these populations (Hull et al. 2010).

The Great Gray Owl is not represented in the fossil record of North America, although other, possibly related *Strix* species have been identified in South Dakota's Tertiary deposits and in the Tertiary deposits of northcentral Nebraska (Olson 1984). Olson (1984) described a *Strix* specimen from Ladds, and Howard (1933) described a specimen from Rancho La Brea, California, both of which were comparable in size to the modern-day Great Gray Owl.

E. Population Trends

Historic population trends cannot be inferred for Great Gray Owls in Oregon and Washington. Populations in North America are thought to have been stable for the past 10 to 100+ years (Bull and Henjum 1990; Duncan 1997). Declines in populations over the past several decades due to the loss of mature and old-growth forest have been inferred, however, there are few data to substantiate this. For example, Bryan and Forsman (1987) surmised that Oregon populations declined as a result of habitat loss, since all Great Gray Owl locations on their study occurred in mature to old-growth timber, but the suspected decline cannot be substantiated. Winter (1986) surmised from limited data that Great Gray Owl populations in California have declined from ancestral levels due to habitat degradation.

Because there exists a lack of long-term standardized survey data for Great Gray Owls (particularly in Washington), it is important to look to assessments of habitat for Great Gray Owls, and how these habitats have changed over time, in order to better understand population trends. Wisdom et al. (2000) assessed changes in source habitat for Great

Gray Owls in the interior Columbia Basin. The authors defined source habitat as old and unmanaged young forests (for nesting and roosting), stand initiation forests, and open stands (for foraging). The authors found that source habitats have increased in the Southern Cascades, Upper Klamath, Blue Mountains, and Central Idaho Mountains Ecological Reporting Units (ERUs), primarily due to an increase in late-seral montane forests. These findings are largely consistent with NWFP survey results for Great Gray Owls in Oregon, where populations appear stable in the Southern Cascades, Upper Klamath, and Blue Mountains ERUs. Decreases in source habitat were projected for the Columbia Plateau, Northern Glaciated Mountains, Lower Clark Fork, Upper Clark Fork, and Snake River Headwaters ERUs, while mixed trends were projected for the Northern Cascades ERU. These declines were attributed to reductions in late-seral montane and subalpine forests and early seral forests (Hann et al. 1997). These findings are largely consistent with existing surveys results, which show few detections in Washington state, except for on Forest Service lands in the north-central portion of the state.

Wisdom et al. (2000) noted that results for source habitats are likely overestimated, as the analysis did not take into account the Great Gray Owls' requirement for a "juxtaposition" of habitats for nesting and foraging. The authors also noted that basin-wide, large and medium trees as well as snag structure have declined, likely reducing the availability of nest sites for Great Gray Owls.

F. Demography

Metapopulation dynamics of Great Gray Owls are poorly understood, and the degree of isolation between populations is unknown (Bull et al. 1988a). Due to a lack of knowledge about the Great Gray Owl's historic range, it is unknown whether local populations have been extirpated. The population in the central Sierra Nevada is small, isolated, and genetically distinct from other populations. There is concern that this population is at risk for inbreeding depression, and if mortality outpaces the reproductive rate, the population will face extirpation (Hull et al. 2010). Car strikes are a major source of mortality for Great Gray Owls in Yosemite National Park, further increasing the populations' risk of extirpation (Hull et al. 2010).

Prey availability is considered the most important factor limiting population growth. Many species of owls are food limited and adequate foraging habitat is critical in maintaining populations (Korpimäki 1984). Habitat availability and quality, especially the availability of nest sites, are also important limiting factors (Duncan and Hayward 1994). In California, the loss of mature forest habitat due to logging and the overgrazing of meadows have been identified as the primary causes for the species' decline (Winter 1986; California Partners in Flight 2002). Competition with other raptor species for territory or prey appears to have a relatively small impact on Great Gray Owl populations (Brunton and Pittaway 1971; Nero 1980).

Great Gray Owl home ranges are often relatively small, depending on food supply. Average home range size calculated for breeding adults in Oregon was 4.5 km² (n = 5 males, range 1.3-6.5 km², minimum convex polygon), while average winter home range size was 67.3 km² (Bull et al. 1988a, Bull and Henjum 1990). The distance adults traveled

from nest sites averaged 13.4 km (range = 2.4-43.2 km) (Bull et al. 1988a). In Yosemite National Park in California, breeding female home range size averaged 61.47 hectares during the breeding season and 2457.27 hectares during winter, while males averaged 19.89 and 2112.87 hectares (Riper and Wagtendonk 2006). Large post-breeding movements account for the large winter home ranges. In this study, juveniles and nonbreeding birds had home-range sizes intermediate between the seasonal values of breeding owls. Great Gray Owl home ranges in California were larger than has been recorded elsewhere in North America, but smaller than in Europe.

Great Gray Owls do not defend a large territory and will often only defend the area immediately surrounding the nest site (Bull and Henjum 1987; Duncan 1987a). They appear to be highly tolerant of conspecifics. For example, up to four adult males and their fledged young were observed hunting in the same field (Duncan 1987a). In California, however, they have been observed defending foraging territories (Reid 1989). Because Great Gray Owls do not defend a large territory, breeding home ranges can overlap and high densities can be obtained on breeding grounds (Servos 1986). Pairs readily nest within 500 m of each other in the western United States (Nero 1980; Duncan 1987a; Bull et al. 1988a, Godwin pers. comm. 2011). In northeastern Oregon, two active nests were found within 430 m of each other (Bull et al. 1988b). Reported nest densities are even higher in Europe. Mikkola (1981) found 8 nests in 100 km², and (Wahlstedt 1974) found five nests and an additional four suspected nesting pairs in a 100 km² area in Sweden.

Great Gray Owls are capable of moving great distances. In the boreal forests of Canada and Alaska, individuals migrate up to 700 km (Nero 1980; Duncan 1992). Radio-tracking has shown that individuals can travel up to 40 km in 24 hours and 650 km in three months (Duncan 1992). In Oregon, the distance radio-tagged juveniles dispersed from natal sites in their first year ranged from 7.5 to 32 km (Bull et al. 1988a). It is thought that dispersing juveniles provide connectivity between Great Gray Owl populations (Bull et al. 1988a; Bowman 2003; Sutherland et al. 2000).

G. Habitat

Great Gray Owls occur in a variety of habitats. In the northern portions of their range, they occupy habitats lower in elevation than in the western U.S. In Manitoba the mean elevation of Great Gray Owls was 640 m (2,101 ft). In the western U.S., it was previously thought that the species occupied habitats between 915-1829 m (3,000-6,000 ft) (Winter 1986; Forsman and Bryan 1987; A. B. Franklin 1988; Bull and Henjum 1990). In recent years, however, nests have been located at much lower elevations in Oregon, as low as 48 m (157 ft) above sea level (Quintana-Coyer et al. 2004). Studies in southwestern Oregon have detected Great Gray Owls as low as 518 m (1,700 ft) above sea level (Bryan and Forsman 1987). In one study, 90% of all nests occurred below 915 m (3,000 ft) (Bryan and Forsman 1987). Fetz et al. (2003) suggested that when shaded nest sites are available, Great Gray Owls may nest at lower elevations than is typical. In California, Great Gray Owls are thought to occupy habitats between 750 and 2,250 m (2,460-7,382 ft) (Winter 1986). Recent sightings in California indicate that Great Gray Owls are breeding at elevations around 609 m (2,000 ft) in the pine/oak foothill ecosystems of the Sierra Nevada (Knudson 2011). These recent findings suggest that Great Gray Owls may have

more flexible elevation and temperature requirements, and may be more tolerant of heat, than was previously thought.

Great Gray Owls are considered a resident species and winter habitat is generally the same as breeding habitat, although individuals tend to wander irregularly south in winter in response to prey availability. See the Section IIIB, “Activity and Movements,” for a detailed discussion of winter movements. Broad-scale habitat characteristics are mature coniferous and hardwood forests interspersed with meadows or other open areas suitable for foraging (Nero 1980; Duncan and Hayward 1994). In Canada, breeding habitat consists of taiga interspersed with bogs, muskegs, and other open spaces for foraging (Nero 1980; Voous 1988; Godfrey 1967). In Manitoba, tamarack (*Larix laricina*) bogs are preferred for nesting; while drier pine stands, habitats with dense shrub layers, and open areas without trees are avoided (Servos 1986). In Manitoba, wintering birds select tamarack, black spruce (*Picea mariana*), and aspen forests (Bouchart 1991); elsewhere in Canada wintering habitat also includes open fields with scattered large trees, shrubs, and fencerows (Brunton and Pittaway 1971). Quintana-Coyer et al. (2004) note that tree species and forest composition appear to matter less than the presence of mature stands for roosting and nesting located near open, grassy areas for foraging.

In the western U.S., Great Gray Owls breed in relatively dry, mature deciduous or coniferous forests up to 2,800 m in elevation. In the central and southern Cascades of Oregon, they occur mostly in lodgepole (*Pinus contorta*)/ponderosa pine (*Pinus ponderosa*) forests (Bull and Henjum 1990, Goggans and Platt 1992). In central Oregon, they select meadow systems associated with coniferous forests (Bryan and Forsman 1987). In northeastern Oregon, all forest types sampled had nests, with 50% of nests in Douglas fir (*Pseudotsuga menziesii*) forests (Bull and Henjum 1990). In the Blue mountains of northeastern Oregon, they select Douglas fir/grand fir (*Abies grandis*) and western larch (*Larix occidentalis*)/lodgepole pine forests (Bull et al. 1988b). In southwestern Oregon, Great Gray Owls select oak (*Quercus* spp.)/Pacific madrone (*Arbutus menziesii*) and coniferous forest habitats (Godwin pers. comm. 2011). Specifically, they have been found to be associated with north-facing slopes of late successional Douglas fir forests adjacent to Oregon white oak (*Quercus garryana*) woodlands and chaparral (Bryan and Forsman 1987). In Idaho and Wyoming, over 90% of Great Gray Owl sightings were in the lodgepole pine/Douglas fir/aspen (*Populus tremuloides*) zone (Franklin 1988). In California, Great Gray Owls select pine and fir forests adjacent to montane meadows between 750 and 2,250 m in elevation (Winter 1986).

Large broken-top snags, stumps, trees with large mistletoe clumps (*Arceuthobium* spp.), artificial nest platforms, and abandoned raptor and corvid stick nests are used for nesting (Figure 6) (Nero 1980; Mikkola 1983; Voous 1988; Bull and Henjum 1990). They are also known to use old western gray squirrel nests. Great Gray Owls rarely nest on the ground or on rock cliffs or haystacks (Duncan 1992; Mikkola 1983). In a study in southeastern Idaho, 60% (nine) of the nests were in shallow depressions on the tops of broken-top snags (Franklin 1988). Five of these were in lodgepole pine snags, three in Douglas-fir snags and one in an Engelmann spruce (*Picea engelmannii*) snag. All of the snags were in advanced stages of decay. In a study in southeastern Idaho and

northwestern Wyoming, 40% (six) nests were in old stick nests; four were in lodgepole pines, one was in an aspen, and one was in a Douglas fir snag (Franklin 1988). The use of snags as nest sites appears to increase in lower latitudes (Franklin 1988). In southwestern Oregon, Godwin (pers. comm. 2011) noted that elevation appears to influence nest site selection. At higher elevation sites, Great Gray Owls frequently selected broken-top snags, particularly white fir (*Abies concolor*), for nesting. At lower elevation sites, where fewer shaded broken-top snags were available, abandoned stick nests were more frequently used. Nests are typically located within .3 km of a meadow or other opening (Mikkola 1983; Winter 1986; Bryan and Forsman 1987). In southwestern Oregon, 61 of 63 nest sites were located in forests adjacent to meadows, and all nest sites were in old growth or mature stands (Bryan and Forsman 1987). Lodgepole pine or lodgepole pine/ponderosa pine forests predominated at 59 sites, and mixed conifer associations predominated at four sites. Great Gray Owls will frequently return to the same nest site year after year, and often reuse nests (Franklin 1988; Bull et al. 1988b; Duncan 1992). In northeastern Oregon, of 18 nesting attempts, 39% were on the same nest the next year, 39% were within one km of the nest used the previous year, and 22% were farther than one km away from the previous nest (Bull et al. 1988b).

Great Gray Owls appear to prefer nesting within forest stands rather than on forest edges. In Manitoba, nest distance to forest opening averaged 256 m, and in Idaho and Wyoming it averaged 143 m (Franklin 1988; Bouchart 1991). A study in northeastern Oregon found that 52 to 99% of the area within 500 m of nest sites was forested (Bull and Henjum 1990). There is some evidence that Great Gray Owls prefer large, undisturbed forest stands for nesting. In northeastern Oregon, 72% of nests occurred in unlogged stands, even though the majority of each study area had been logged within 15 years of the study (Bull and Henjum 1990). A study in central Alberta found that Great Gray Owls selected larger forest patches, areas with a greater percent of forested area in the home range, and forest patches with less edge in relation to area (Stepnisky 1997). Studies have found Great Gray Owl presence to be positively correlated with high forest canopy closure within a 200 m forest buffer surrounding a meadow (Bryan and Forsman 1987; Bull et al. 1988b; Bull and Henjum 1990; Whitfield and Gaffney 1997). These data suggest that while forest edge is an important component of Great Gray Owl habitat, the extent of forested area adjacent to the edge is equally important.

Great Gray Owls readily use artificial nest structures (Nero et al. 1974; Collins 1980; Bohm 1985; Bull and Henjum 1990). In a study of nest structure types in northeastern Oregon, Great Gray Owls preferred open-style (vs. box) structures within forest stands (vs. adjacent to a clearcut), and preferred structures 15 m high vs. 9 m high (Bull and Henjum 1990). Canopy closure exceeded 60% at most nest sites, and the percentage of forested area within a 500 m radius of nests varied between 52% and 99%. A study in Oregon using nest platforms demonstrated that individuals prefer nest structures within forest stands rather than on the edge of clearcuts (Duncan and Hayward 1994).

Great Gray Owls forage primarily in open habitats. Suitable foraging habitats include natural meadows, open forest stands, early successional forests, recent clearcuts, montane meadows, grassy habitats, bogs, fens, muskegs, and peatlands (Nero 1980; Winter 1986;

Bryan and Forsman 1987; Atkinson 1989; Stepnisky 1997). In Oregon, Great Gray Owls select montane meadows, as well as open stands of mature forest with grass as the dominant ground cover, as preferred hunting areas (Winter 1986; Bryan and Forsman 1987; Bull et al. 1988a, Fetz et al. 1999). A strong herbaceous layer was preferred in northeastern Oregon (Bull et al. 1988b). Old growth and late successional forests, as well as selectively logged and clearcut forests, are used for foraging, but not as often as natural forest openings (Nero 1980; Mikkola 1983; Winter 1986; Bull et al. 1988b; Atkinson 1989; Goggans and Platt 1992). In studies in California and southcentral Oregon, Great Gray Owls foraged primarily in natural meadows (Winter 1986; Bryan and Forsman 1987). In northeastern and southwestern Oregon, Great Gray Owls have been observed foraging in open canopy forests (Bryan and Forsman 1987; Bull et al. 1988b; Bull and Henjum 1990; Godwin pers. comm. 2011). In northeastern Oregon, male owls foraged in stands with 11-59% canopy closure. These stands had heavy ground cover (average 88%) dominated by grasses (Bull and Henjum 1990). In studies in the Rocky and central Cascade mountain ranges, Great Gray Owls foraged primarily in clearcuts (Franklin 1988; Goggans and Platt 1992).

Downed wood appears to be an important component of foraging habitat. In northeastern Oregon, downed wood was found within one m of where prey was caught or attempted to be caught 80% of the time (Bull and Henjum 1990). Snags are another important habitat component. They are used for nesting, as perches while foraging, and by juveniles for climbing (Schaeffer 1993). While hunting, Great Gray Owls perch in both live trees and in snags adjacent to open areas. In a study in northeastern Oregon, perch heights for males averaged 5.5 m, and perch to prey distance averaged 10.5 m (Bull and Henjum 1990). Perches are critical, because Great Gray Owls rarely hunt while sitting on the ground or while flying (Collins 1980; Nero 1980; Winter 1986; Duncan 1987a; Reid 1989; Bull and Henjum 1990).

Great Gray Owls roost in trees near the trunk, and they frequently change their roost tree. When roosting, they close their eyes and “fold” their facial disc to blend in with the surrounding bark patterns (Cramp 1985). They typically roost in trees with fairly dense canopy, especially during warm weather. In a study in northeastern Oregon, 71% of adult males roosted in stands with 11 to 59% canopy closure, and 29% percent used forests with >59% canopy closure (Bull et al. 1988b; Bull and Henjum 1990). Great Gray Owls appear to prefer roosting within forest stands as opposed to forest edges. In California, roosts averaged 90 m from openings and 10.9 m above the ground; and trees with less than 23 cm dbh were avoided (Winter 1986). The species appears to be relatively intolerant of heat. Large nestlings avoid sunlit nests and seek shade; the underwing apteria of adults may help dissipate heat (Voous 1988). Winter (1986) noted that Great Gray Owls roosted at lower heights during warmer weather, possibly as a thermoregulatory response. Godwin (pers. comm. 2011) has observed female Great Gray Owls leaving nest sites to roost in areas with higher canopy closure after fledging young. In winter, Great Gray Owls occasionally roost in sunny areas atop snags or in trees with an open canopy (Winter 1986; Bull and Duncan 1993).

Leaning dead and live trees and low perches near the nest tree are important habitat components for juvenile Great Gray Owls, as they leave the nest about two weeks before they are able to fly (Bull et al. 1988b; Bull and Henjum 1990; Whitfield and Gaffney 1997). Within several days of leaving the nest, and before fledging, juveniles use their talons, bills and wings to “climb” leaning and deformed trees (Bull et al. 1988b). In one study, juveniles appeared most readily able to climb large diameter trees with deeply fissured bark as characteristic of mature and old-growth trees (Bull and Henjum 1990). After learning to fly and before dispersing, juveniles appear to restrict their movements to forests with greater than 60% canopy cover, perhaps to avoid predation (Bull and Henjum 1990; Bull et al. 1988b). In another study, roost height correlated positively with the age of recently fledged young (Franklin 1987).

Foraging habitat characteristics like meadow vegetation height, vegetation cover, and meadow soil moisture may influence foraging habitat quality through their impact on prey populations (Winter 1986; Reid 1989; Bull and Henjum 1990; Whitfield and Gaffney 1997). For example, voles inhabit wet areas consisting of thick grass, forbs, and sedge cover (Smolen and Keller 1987; Greene 1995; Sera and Early 2003), whereas pocket gophers select areas of deep soft soils that allow for burrowing (Jones and Baxter 2004). Gophers are found in areas with less vegetative cover than voles, and they tend to avoid saturated soils due to burrow flooding (Greene 1995). More study is needed on the influence of microhabitat features on Great Gray Owl prey.

H. Ecological Considerations

Northern Goshawks and Great Horned Owls frequently prey upon juvenile Great Gray Owls, especially during years when small mammal prey are scarce (Nero 1980; Duncan 1987a; Bull et al. 1989a). In Oregon, Manitoba, and Minnesota, studies have shown that avian predation accounts for most juvenile mortality (Bull and Duncan 1993). In a study in northeastern Oregon, seven juvenile Great Gray Owls were killed by Great Horned Owls, and two died of starvation (Bull et al. 1989a). Common Ravens are known to prey on both eggs and juveniles (Mikkola 1983; Bull and Duncan 1993). Great Horned Owls are occasionally known to prey on adult Great Gray Owls (Duncan 1987a). It is not known if changes in habitat have increased or decreased Great Gray Owls’ vulnerability to predation.

Several raptor species, including Great Horned Owl, Broad-winged Hawk, Red-tailed Hawk, Northern Goshawk, Northern Hawk Owl, Boreal Owl, and Long-eared Owl, are known to nest within 500 m of Great Gray Owl nests (Lane and Duncan 1987; Duncan and Hayward 1994). Great Gray Owls appear to be generally tolerant of other raptors, but they will actively defend the area immediately surrounding the nest site against both conspecifics and other species (Mikkola 1983; Bull and Henjum 1987; Voous 1988). Competition between Great Gray Owls and other raptors is likely low when prey is abundant, but may occur when prey are scarce (Mikkola 1983; Johnsgard 1988). Great Gray Owls are known to demonstrate intraspecific aggression on winter territories (Brunton and Pittaway 1971). Since both Great Gray Owls and Great Horned Owls use abandoned nests of other raptors, it is likely that they compete for nest sites (Nero 1980; Voous 1988). Since the Great Gray Owls’ body mass is lower than the Great Horned Owl

and other *Bubo* owls, it is likely that these owls outcompete Great Gray Owls for food and nest sites (Voous 1988). Great Gray Owls are often harassed by other birds, including Short-eared Owl, Broad-winged Hawk, and accipiters. Barred Owls have expanded their range in recent decades, and now breed throughout much of western North America, including Oregon, Washington, and Northern California (Livezey 2009). Barred Owls, like Great Gray Owls, prefer mature conifer forests with high canopy closure for nesting (Livezey and Bednarz 2007). Barred Owls are known to outcompete Northern Spotted Owls for nest sites (Hamer et al. 2007). It is possible that Barred Owls may share the same habitats and possibly outcompete Great Gray Owls for food and nest sites, although the extent and nature of interactions between Barred Owls and Great Gray Owls has not been studied.

Known parasites include feather lice (*Kurodaia* spp.) and round worms in the abdominal cavity and small intestinal tract. Known diseases include Coccidiosis, a disease infecting the small intestine, and Aspergillosis, caused by fungus and most often seen in captive birds (Oeming 1964). In California, two wild birds that died during handling were found to have heavy internal parasite loads (Godwin pers. comm. 2011).

West Nile Virus is cause for concern for Great Gray Owls. Although no infections have been recorded in the wild, Gancz et al. (2004) reported a 91.3% mortality rate in a captive colony of Great Gray Owls in Ontario, Canada. The incidence of West Nile virus is of particular concern to the Yosemite National Park population due to its geographic and genetic isolation (Hull et al. 2010).

IV. Conservation

A. Threats to Species

Management activities over the past 100 years have had both positive and negative effects on Great Gray Owl habitat quality (Huff 1996). Timber harvest likely has the greatest impact on habitat quality and availability range-wide. Intensive timber harvest reduces the number of standing large-diameter trees and the dense canopy used for nesting and roosting, as well as the number of dead leaning trees and snags used by adults for nesting and foraging and by juveniles for climbing. Timber harvest indirectly affects habitat quality by reducing suitable nest structures for Northern Goshawks and other raptors, which are in turn used by Great Gray Owls for nesting. Bull and Duncan (1993) estimated that forest harvest practices at the time of their study had the potential to affect 75% of the Great Gray Owls' breeding range in North America. Older and mature forest habitats preferred by Great Gray Owls for nesting were frequently selected for timber harvest due to the high value of the trees, and as a result those forest types have declined. For example, Bryan and Forsman (1987) noted that extensive timber harvest in southcentral Oregon caused reductions in suitable Great Gray Owl habitat. Hann et al. (1997) found that old-forest structures, remnant large trees, and medium to large trees in all forest structure classes have been reduced. Quigley et al. (1996) found that the densities of large-diameter snags have likely declined throughout the interior Columbia Basin, thus reducing the availability of nest structure for Great Gray Owls. Because of the extensive loss of mature forest, even small reductions in remaining forests may have long-term impacts on Great Gray Owl habitat availability. This is likely especially true in

Washington, where source habitat has declined significantly in some areas (Wisdom et al. 2000).

The implementation of the Northwest Forest Plan (NWFP) Standards and Guidelines significantly changed forest management practices in the NWFP area. Clearcuts were replaced by regeneration harvests, which significantly reduce canopy but do not remove all trees in a stand. Although clearcutting has been eliminated in the NWFP area, regeneration harvests may pose similar threats to Great Gray Owl habitat quality. Regeneration harvests eliminate the dense, mature forests preferred by Great Gray owls for nesting and roosting. Although some large trees and snags are left, regeneration harvests remove many large trees, snags, and other structural components that are used for nesting and roosting. Similar to clearcuts, regeneration harvests may create temporary foraging habitat, but these habitats are lost with forest succession.

Although clearcuts are no longer used within the Northwest Forest Plan area or on the remainder of FS/BLM lands in Oregon and Washington, it is still important to address their potential impacts on Great Gray Owls, in case of future changes in management and because clearcuts still may be utilized on private lands. Clearcutting can temporarily expand foraging habitat by creating open habitats and possibly boosting the local small mammal population (Sulkava and Huhtala 1997). Foraging habitats created through clearcuts are short-lived compared to the lifetime of a natural meadow, as they are usually lost to succession in ten to 30 years (Habeck 1994). Large clearcuts may not provide suitable foraging habitat, as Great Gray Owls typically catch their prey within 50 m of hunting perches, and longer hunting flights may increase their vulnerability to predation by Great Horned Owls (Duncan 1987a). On the Willamette National Forest in Oregon, Great Gray Owls were found nesting adjacent to young clearcuts but moved to different nest sites as the clearcut areas regenerated (Godwin pers. comm. 2011). Godwin (pers. comm. 2011) noted that regenerating clearcuts provide poor foraging habitat as the dense regrowth shades out the understory vegetation used by small mammals.

Gopher control practices such as strychnine poisoning that are sometimes used to encourage regeneration in clearcuts may offset the increase in local mammal populations. It is unknown whether Great Gray Owls are indirectly poisoned through gopher control practices (Duncan and Hayward 1994).

Both fire suppression and fire alter habitat quality for Great Gray Owls. Low to moderate severity wildfire may improve foraging habitat quality by opening dense forest structure and reducing conifer encroachment into natural forest openings (Habeck 1994; Pilliod et al. 2006). After a fire, snag availability may increase, providing perching, roosting, and nesting sites, although Great Gray Owls may not use these sites due to decreased canopy cover (Winter 1986; Franklin 1988; Atkinson 1989; Whitfield and Gaffney 1997). High-severity or stand replacing fires can remove snags and large-diameter trees, as well as vacated raptor nests and dwarf mistletoe brooms, used for nesting and foraging (Franklin 1988; Voous 1988; Atkinson 1989; Bull and Henjum 1990; Whitfield and Gaffney 1997). After a stand-replacing fire, suitable nesting structures may not be available for 100 years or more. Small mammal populations may be low for the first several years following a

severe fire, but eventually increase (Bull and Henjum 1990; Duncan 1997). Salvage logging may negatively impact Great Gray Owl habitat quality by reducing forest canopy and the number of large trees used for nesting. Fire or timber harvest may cause direct mortality of adult Great Gray Owls; however, the mortality rate from these events is unknown. It is more likely that individuals and populations are indirectly affected by these events through their impacts on habitat.

The encroachment of conifers into meadows resulting from fire suppression and climate change has likely reduced foraging habitat quality and availability for Great Gray Owls in Oregon and Washington. Extensive encroachment of conifers into meadows since the 1940's has been documented in both Oregon and Washington. The extent of encroachment is likely primarily due to fire suppression during this period, although historic grazing and climate change impacts have also likely played a role (Franklin et al. 1971; Takaoka and Swanson 2008; Dailey 2008). Even without active fire suppression, the absence of fire can lead to conifer encroachment into meadows (Habeck 1994). Conversely, fire suppression may contribute to an increase in nesting habitat for Great Gray Owls, as it can lead to higher forested-stand densities and higher canopy closure, which are preferred by Great Gray Owls for nesting. It is likely, however, that the detrimental effects of reduced foraging habitat resulting from conifer encroachment outweigh the potential benefits of increased nesting habitat.

Residential and commercial development has significantly reduced Great Gray Owl habitat in many portions of the species' range including central Oregon, California, and Manitoba (Nero 1980; Winter 1986; Bryan and Forsman 1987).

Insect outbreaks like mountain pine beetle (*Dendroctonus ponderosae*) can impact Great Gray Owl habitat through eliminating mature trees used for nesting. Accelerated harvest of mature and old-growth forests in an attempt to salvage trees killed or weakened by mountain pine beetles can also reduce habitat availability (Bryan and Forsman 1987). Similarly, removal of trees with mistletoe blooms to protect healthy trees from insects and pathogens can eliminate potential nest trees.

It is thought that livestock grazing may negatively impact Great Gray Owl habitat quality through degrading natural meadows and decreasing prey populations (Ulev 2007). A recent study in California, however, found that pocket gopher populations were significantly higher in grazed vs. ungrazed meadows (Powers et al. 2011). More study is needed on the impact of grazing on Great Gray Owl prey populations and habitat quality.

Car strikes are a major source of mortality in some areas, especially in Yosemite National Park (Nero and Copland 1981; Hull et al. 2010). Other sources of direct mortality for Great Gray Owls include entanglement on barbed wire and electrocution on transmission lines.

It is possible that Barred Owls may outcompete Great Gray Owls for food and nest sites, although the extent and nature of interactions between Barred Owls and Great Gray Owls has not been studied.

B. Conservation Status

Studies variously indicate that local and regional populations have remained stable, increased or decreased throughout the Great Gray Owl's range (Collins 1980; Nero 1980; Nero et al. 1984; Winter 1986; Bryan and Forsman 1987; Franklin 1988; Collins and Wendt 1989; Bull and Henjum 1990; Duncan 1992). Because of its widespread range across a variety of habitats, the species appears relatively abundant on a global scale compared to species with a limited range or very specific habitat requirements. Because of this, there is little conservation concern for Great Gray Owls on a global or range-wide scale.

In Oregon, Great Gray Owl populations appear to be relatively secure, with strong breeding populations in southwestern Oregon, and in the Blue and Willowa mountains and surrounding areas of northeastern Oregon. In southwestern Oregon, historic sites that are monitored continue to be occupied (Godwin pers. comm. 2011). Great Gray Owl nest sites have also been located in the western Cascade mountains and foothills, as well as in central Oregon east of the Cascade crest (Table 2, 3) (Figure 3, 4) (ed. Marshall et al. 2006). Because of the relatively high number of nest sites identified in the state, there is currently little conservation concern for Great Gray Owls in Oregon.

In Washington, very few nest sites have been identified, almost all on Forest Service lands. Relatively few detections and even fewer confirmed reproductive sites in the state suggest that populations are insecure and possibly in decline, however, a lack of systematic survey effort in the state makes it difficult to assess the conservation status of Great Gray Owls in Washington. A systematic inventory of Great Gray Owls is a critical step in assessing the conservation status of the species in Washington state.

As discussed in Section III E, "Population Trends," assessments of source habitats for Great Gray Owls can contribute to an understanding of Great Gray Owl population trends and conservation status. Overall, Wisdom et al. (2000) found that source habitats have increased in central, eastern, and portions of central Oregon, while source habitat has declined throughout much of Washington, with the remaining habitat concentrated in the north-central part of the state, mainly on Forest Service lands. These results are largely consistent with known survey results as described in this Section and in Section III D, "Range, Distribution, and Abundance."

C. Known Management Approaches

Current management approaches focus primarily on protecting or enhancing Great Gray Owl nesting habitat and nest sites. Management approaches include restricting activity around nest sites during the breeding season, protecting known nest sites from logging, and installing artificial nest platforms (Winter 1986; Forsman and Bull 1989; Bouchart 1991). In Forest Service Land and Resource Management Plans (LRMPs) and BLM Resource Management Plans (RMPs) in Oregon and Washington, there are provisions for raptor management that may also include specifics for Great Gray owl nests. The standards and guidelines from these plans vary somewhat in their specifics, but in general dictate that raptor (including Great Gray Owl) nests are protected. Currently, under the

Survey and Manage Standards and Guidelines for the Northwest Forest Plan Area, a 30 acre management area is delineated for nests or paired owls, covering the best potential habitat for the species. Within these 30 acres, management treatments are limited to the protection or improvement of nesting habitat. In addition, a ¼ mile protection zone is created around each nest/pair. Within this protection zone, a 300 ft buffer is established around meadows and natural openings greater than 10 acres. Within these buffers, treatments are limited to protection or improvement of nesting habitat. Disturbance from management activities is prohibited from March 1 to July 31, or until fledging, whichever is later.

The placement of artificial nest platforms has improved local breeding success at some sites (Nero et al. 1974; Nero 1982; Bull et al. 1987; Bull et al. 1988b; Bull and Henjum 1990). Artificial platforms, described in detail by Bull and Henjum (1990), are usually wire baskets or wooden platforms with sticks placed on top. Wooden platforms are 60 cm square and 20 cm deep with beveled sides; they are made from 2.5 cm thick boards with drain holes; and chips and sticks are placed in the platforms. Great Gray Owls readily use artificial nest structures, and in some cases prefers them to natural structures. In a study in northeastern Oregon, three females selected artificial structures even though suitable natural structures were nearby (Bull et al. 1988b). In California artificial nest platforms have been used successfully (Beck and Smith 1987; Bull and Henjum 1990). In one study, Great Gray Owls preferred open-style (vs. box) structures within forest stands (vs. adjacent to a clearcut), and preferred structures 15 m vs. 9 m high. In at least one study, nest success was higher at artificial platforms (83%) vs. natural sites (66%). They appear to prefer platforms more than 15 m above the ground, in forested stands rather than at the edge of clearcuts, and on the north side of trees to maximize shade (Bull and Henjum 1990). While the provision of nest structures appears to work well to improve local breeding success, it would be costly and time-intensive to implement on a large scale (Bohm 1985; Bull and Henjum 1990).

D. Management Considerations

Because Great Gray Owl populations appear relatively secure in Oregon, it is recommended that management efforts focus on maintaining or improving habitat in Washington, while retaining adequate habitat in Oregon. Because of the low number of detections, and because changes in distribution may occur over time, it is recommended that managers take a conservative approach to management in Washington state. As part of this conservative approach, consider applying Great Gray Owl management considerations to forested habitats on USFS R6 and BLM lands in Washington whether or not the species has been documented in a particular habitat.

The large home range, movements, and dispersal distances of Great Gray Owls suggest that a landscape scale approach to management is appropriate (Bryan and Forsman 1987; Duncan et al. 1997). Hayward (1994) suggests that management provide a mix of suitable nesting and foraging habitat across a large area. Forest management that encourages a range of successional stages, from early- to mid- to late-seral forests, across the landscape should be suitable. Sufficient mature, late-seral forests should be retained to sustain suitable nest structures across the landscape. The extent of mature forest should be

greater than the extent of stands with nesting Great Gray Owls in any given year to provide for adequate long-term habitat. Overall, management that promotes heterogeneity across the landscape through a mix of late-seral/mature with early seral and meadow stands will likely be most beneficial for Great Gray Owls.

Conifer encroachment into meadows in western Cascades ecosystems has been extensive over the past several decades, and has likely significantly reduced foraging habitat quality and availability for Great Gray Owls. Prescribed fire or thinning may be used to retard the invasion of conifers into meadows and to promote the restoration of open habitats that are used by Great Gray Owls for foraging (Bryan and Forsman 1987). Tree removal or prescribed fire during the early stages of encroachment are most likely to be successful in retarding encroachment and promoting the regrowth of native meadow forbs. Pile burning of slash after tree removal treatments is thought to result in less weedy regrowth than broadcast burning (Halpern and Swanson 2009). Because of their high reproductive rates, small mammal populations are thought to recover rapidly post-fire (Ream 1981; Smith ed. 2000). If prescribed surface burns are performed, some dead woody material on the forest floor should be retained to provide habitat for small mammal prey (Bull, Henjum, and Rohweder 1988b; Franklin 1988; Bull and Henjum 1990). Prescribed burning should be restricted during the breeding season from March through July, or until fledging, whichever is later.

Great Gray Owls appear to be tolerant of some timber harvest (Duncan 1997). In California, Great Gray Owls were detected adjacent to an active logging operation (Knudson 2011). Whitfield and Gaffney (1997), however, observed that Great Gray Owls vacated areas that were severely altered (Bryan and Forsman 1987). As stated in Section IV A, “Threats to Species,” Northwest Forest Plan (NWFP) guidelines significantly changed timber harvest practices in the NWFP area. Clearcuts were replaced by regeneration harvests, which significantly reduce canopy but do not remove all trees in a stand. Over 80% of the land base in the NWFP Area is currently in “reserved” land allocations, with only thinning in younger stands allowed in some of those allocations. Outside of the NWFP area, most harvest is thinning or uneven age management, with large diameter trees and some snags retained (Huff pers. comm. 2011).

The following recommendations apply to both clearcuts and regeneration harvests. Sulkava and Huhtala (1997) suggest cuts of no more than 20 hectares in size, with two to five hectares preferred. Duncan (1992) recommends that cuts not exceed 10 hectares in size and that they occur within a mosaic of multi-sized units across the landscape. A series of smaller cuts across the landscape are preferred to large cuts. Least desirable would be large-scale clearcuts of more than 100 hectares that are circular or square in form, especially if they are treeless and with only small patches of forest between them. Larger cuts should be no more than 400 to 500 m wide, and ideally less than 100 m wide to reduce the distance required to fly while hunting (Duncan 1992; Sulkava and Huhtala 1997). Hayward (1994) suggests that portions of harvest stands over 30 m from an edge or perch are of little value for foraging. Irregularly shaped cuts should be employed to increase forest edge and provide more hunting perches (Sulkava and Huhtala 1997; Duncan 1992). Standing live or dead trees should be left in large cut-over areas to

provide foraging perches (Duncan 1992; Sulkava and Huhtala 1997). In areas of timber harvest, “character” trees may be identified and left to mature into suitable nest trees (Huff pers. comm. 2011). To retain natural nest sites, dead, broken topped trees less than 50 cm (20 inches) dbh should be retained, as well as any tree with old raptor nests, especially Northern Goshawk nests (Bull and Henjum 1990). Leaning trees near potential nest sites should be retained to provide climbing structures for juvenile Great Gray Owls. Dead and downed material should be left to increase cover for prey. Consider retaining forested corridors 50 to 100 m wide, and small forested areas at least 5 to 10 hectares in size, between cut areas (Sulkava and Huhtala 1997). Consider retention of forest corridors along streams. Retaining densely forested stands with at least 60% canopy cover is important for providing cover and protection from heat stress and predators for both juveniles and adults (Duncan and Hayward 1994; Whitfield and Gaffney 1997). Timber harvest could be used to create foraging habitat in areas with few or no natural openings, however, it is important to remember that these habitats are lost to succession in 10 to 30 years without maintenance (Huff pers. comm. 2011).

The protection of known nest sites is an important management consideration, and is especially important in areas where available nesting habitat could be a limiting factor (Huff 1996). It is important to protect known nest sites by limiting timber harvest around nest sites and limiting excessive human activity during the breeding season from March through July, or until fledging, whichever is later. It is recommended that managers continue to implement Forest Service Land and Resource Management Plan (LRMP) and BLM Resource Management Plan (RMP) Standards and Guideline provisions for raptor management (see Section IV C: Known Management Approaches).

Winter (1986) and Bouchart (1991) suggested the retention of a 300 m radius forested area buffer around nest sites, as well as around natural openings in proximity to the nest. In areas where habitat loss has been extensive, a conservative approach to management is recommended. In these areas, it is recommended that managers avoid disturbing any stand in which a potential nest structure is located, and that areas proposed for harvest be thoroughly searched for suitable nest platforms before harvest units are selected (Bryan and Forsman 1987). In heavily managed forests, managers should consider the use of artificial nest structures (Nero et al. 1974; Nero 1980). It has been suggested that in drier regions, the availability of snags may be a limiting factor, and the provision of artificial nest structures may be an important component of management (Huff 1996).

Protection of nest sites alone may not be effective as a long-term management strategy, however, and should be considered a part of landscape-scale management practices designed to maintain viable populations of the species throughout its regional range (Huff 1996). According to Duncan (1992), large corridors of intact forest should be retained to allow for the dispersal of juveniles and adults and to maintain connectivity between populations. A landscape-scale approach could also ensure that alternate foraging sites are maintained during periods of low prey availability (Bryan and Forsman 1987). It is suggested that large spatiotemporal patterns of natural disturbances like fire be retained. The need for landscape scale management will require coordination among administrative units, BLM districts, and National Forests. A panel of biologists reviewing

Northwest Forest Plan recommendations for the Great Gray Owl recommended coordinated watershed-, basin-, province- and regional-level analyses and planning (Huff 1996).

V. Research, Inventory and Monitoring Opportunities

A systematic state-wide inventory of Great Gray Owls and their habitat in Washington is the highest current inventory priority, and should be undertaken before other research or monitoring priorities are addressed. Understanding the distribution and population status of Great Gray Owls in Washington is critical to conservation of the species in that state.

The following actions for Washington are recommended (Huff pers. comm. 2011):

1. Systematic determination of Great Gray Owl habitat and habitat model development
2. Strategic broad-scale surveys
3. Opportunistic project level surveys
4. Longer term monitoring of occupied sites

In implementing broad-scale or project level surveys in Washington, land managers are encouraged to use the guidelines published in the Northwest Forest Plan survey protocol. Although the current protocol specifies one year of pre-disturbance surveys, two years of surveys are recommended in Washington due to high conservation concern and few detections for the species in the state. It is also advised that periodic occupancy surveys for Great Gray Owls continue to be carried out in Oregon, especially at nest sites.

Until systematic surveys are conducted in Washington, the following research and monitoring priorities should be considered as secondary. For information purposes, however, they are included here. In Oregon and Washington, Great Gray Owl movements and habitat use, including juvenile dispersal movements, have been identified as an information gap. Duncan (1992) recommends a thorough review of historic site-specific occurrence information (e.g., literature, specimen data and personal communications) to better understand Great Gray Owl habitat use. Hayward (1994b) recommends several intensive, experimental studies conducted in association with National Forest System commercial forest management, to better understand factors influencing habitat use. The goal of these studies should be a system to rank habitat quality within a management area for different functional uses (nesting, roosting, foraging). Hayward (1994b) also recommends several short-term, relatively small observational studies of Great Gray Owls in new geographic settings representing forest types not covered in past studies. Quintana-Coyer et al. (2004) recommends a study of constraints to reproductive success and critical habitat needs in different vegetation types, landscape settings, and physiographic provinces.

The relationships between primary prey species, habitat features and Great Gray owl distribution and abundance deserve further study on USFS R6 and OR/WA BLM lands. Hayward (1994b) suggests studies of the relationship between primary prey species and microhabitat, as well as prey species' responses to forest management practices

(Hayward 1994b). The author suggests that studies of Great Gray Owl responses to management practices in areas where studies of small mammal dynamics are already occurring can help inform the management of Great Gray Owls at low cost. Great Gray Owl territoriality and spacing, especially as they relate to prey abundance, need further study, as does the effects of grazing on Great Gray Owl prey populations (Hayward 1994b). Other information gaps identified in published literature include studies of the dynamics of nest site production, in order to determine the area of forest necessary to sustain sufficient nest sites (Hayward 1994b); the effects of fire exclusion on foraging and nesting habitat (Quintana-Coyer et al. 2004); and Great Gray Owl metapopulation dynamics (Hayward 1994b).

Definitions of Terms Used

Apteria

On a bird, regions of naked skin between contour feather tracts.

Barrier

Anything that holds apart, separates, hinders movement, or could prevent the mixing of individuals of the same species. A consideration of time should be taken into account in the context of the barriers potential effects to genetic drift or isolation.

Buffer

An area, which is managed to conserve a site, can be undisturbed or managed. The buffer is meant to maintain and/or improve the habitat conditions of the site and provide life requisites for the species.

Connectivity

The linkage of similar but separated suitable habitat patches, by corridors or “stepping stones” of like habitat that permits interaction between individuals or populations over time. Connectivity must consider time in the context of its potential effects to genetic drift or isolation. (See also “barrier”)

Dispersal

The process by which groups of living organisms expand the space or range within which they live.

Corridor

An area of habitat connecting wildlife populations separated by human activities (such as roads, development, or logging).

Documented Occurrence

Generically, it is the location of an individual of a species. Multiple occurrences may equal a site.

When used in context of Special Status/Sensitive Species lists, a physical record exists to indicate that the species either occurred historically or currently exists in the area defined.

Fragmentation

The loss, division, or isolation of patches of similar habitats at a scale relevant for the species being addressed.

GeoBOB (Geographic Biotic Observations Database)

An upgraded version of the ISMS database developed in 2004 but used solely by OR/WA BLM (and NWFP CA BLM), designed to store existing Survey and Manage data as well as BLM Special Status/Sensitive Species data. GeoBOB holds spatial representations of species observations and survey effort using ArcGIS, ArcSDE, and Oracle technologies.

Habitat disturbance

Natural or human caused disturbances that likely may have impacts on the species habitat, its life cycle, microclimate, or life support requirements.

Holarctic

Of, relating to, or being the zoogeographic region that includes the northern areas of the earth and is divided into Nearctic and Palearctic regions.

Home Range

The area to which an animal confines its normal daily activities.

Irruption

A rapid and irregular increase in number.

ISMS database (Interagency Species Management System)

An interagency database containing information about Survey and Manage species, in the Northwest Forest Plan area. ISMS includes; data for surveys, species locations, and their associated habitats/environmental conditions. This database is now defunct, replaced by GeoBOB for BLM and NRIS for Forest Service.

Management Considerations

Potential management activities designed to achieve the conservation of a species at a site. Management considerations are not mandatory.

Microhabitat

A small, localized habitat within a larger ecosystem, as a decomposing log in a forest, having conditions that sustain a limited range of animals and plants

Monitoring

The collection of information used to determine if management actions are meeting objectives of standards and guidelines and if they comply with laws and management policy. Monitoring is used to determine if standards and guidelines are being followed (implementation monitoring), if they are achieving the desired results (effectiveness monitoring), and if underlying assumptions are sound (validation monitoring). Monitoring usually collects information on a sampling basis, provides standardized data, and occurs at multiple levels and scales.

NRIS (Natural Resource Information System)

A set of standard corporate databases and computer applications used by the Forest Service nation-wide to record basic natural resource data. NRIS Fauna and NRIS TES Plants will be the primary repositories for Forest Service Sensitive Species information.

Nidicolous

Animals that remain in the nest or birthplace for a long time after birth, due to their dependence on the parents for feeding, protection and learning survival skills.

Persistence

The likelihood that a species will continue to exist, or occur, within a geographic area of interest over a defined period of time. Includes the concept that the species is a functioning member of the ecological community of the area.

Range

The limits of the geographic distribution of a species.

Site (Occupied)

The location where an individual or population of the target species (taxonomic entity) was located, observed, or presumed to exist and represents individual detections, reproductive sites, or local populations. This term also refers to those located in the future. (USDA, USDI 1994) Other terms such as known site, species location, and element occurrence are included in this definition.

Snag

A standing dead tree.

Species Habitat Area

The geographic area managed to provide for the continued persistence of the species at the site; may include occupied and unoccupied habitats.

Subspecies

A taxonomic subdivision of a species consisting of an interbreeding, usually geographically isolated population of organisms.

Suitable habitat

Abiotic and biotic environmental conditions within which an organism is known to carry out all life history aspects.

Territory

An area occupied by a single animal, mating pair, or group and often vigorously defended against intruders, especially those of the same species.

Viability

Ability of a wildlife or plant population to maintain sufficient size to persist over time in spite of normal fluctuation in numbers; usually expressed as a probability of maintaining a specified population for a specified period. (USDA, USDI 1994)

Viable populations

A wildlife or plant population that contains an adequate number of reproductive individuals appropriately distributed on the planning area to ensure the long-term existence of the species (USDA, USDI 1994).

Well-distributed

Distribution of the species is sufficient to permit normal biological function and species interactions. This distribution considers life history characteristics of the species and the habitats for which it is specifically adapted.

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Tables

Table 1. Partners in Flight Great Gray Owl population estimates by state.^{a b}

U.S. State	Population Estimate	Estimated % of Global Population	Area of Region (km²)
Alaska	10,000	15.3	1,506,156
California	200	0.4	410,232
Idaho	400	0.6	215,495
Montana	300	0.5	379,291
Nevada	4	0	286,367
Oregon	1,200	1.9	250,309
Washington ^b	N/A	N/A	N/A
Totals	12,104	18.7	3,047,850

^aSource: Partners in Flight Landbird Population Estimates Database
(www.rmbo.org/pif_db/laped/)

^bNo data available for Washington

Table 2. Great Gray Owl detections on USFS R6 lands in Oregon and Washington, 1974-2010.^{a,b}

State	USFS Unit Name	Reproductive Status	# of Records
Oregon	DESCHUTES NATIONAL FOREST	Unknown	171
Oregon	DESCHUTES NATIONAL FOREST	Reproducing	9
Oregon	DESCHUTES NATIONAL FOREST	Not Applicable	2
Oregon	FREMONT-WINEMA NATIONAL FORESTS	Unknown	362
Oregon	FREMONT-WINEMA NATIONAL FORESTS	Reproducing	1
Oregon	MALHEUR NATIONAL FOREST	Reproducing	4
Oregon	MALHEUR NATIONAL FOREST	Unknown	2
Oregon	MALHEUR NATIONAL FOREST	Not Applicable	1
Oregon	MT HOOD NATIONAL FOREST	Unknown	6
Oregon	OCHOCO NATIONAL FOREST	Unknown	2
Oregon	ROGUE RIVER-SISKIYOU NATIONAL FORESTS	Unknown	100
Oregon	ROGUE RIVER-SISKIYOU NATIONAL FORESTS	Reproducing	12
Oregon	UMATILLA NATIONAL FOREST	Unknown	10
Oregon	UMATILLA NATIONAL FOREST	Reproducing	2
Oregon	UMPQUA NATIONAL FOREST	Unknown	96
Oregon	UMPQUA NATIONAL FOREST	Reproducing	2
Oregon	UMPQUA NATIONAL FOREST	Not Applicable	1
Oregon	WILLAMETTE NATIONAL FOREST	Unknown	315
Oregon	WILLAMETTE NATIONAL FOREST	Reproducing	24
Oregon	WILLAMETTE NATIONAL FOREST	Non-Reproducing	1
Oregon		Total	1123
Washingto	COLVILLE NATIONAL FOREST	Unknown	12
Washingto	GIFFORD PINCHOT NATIONAL FOREST	Unknown	9
Washingto	MT BAKER-SNOQUALMIE NATIONAL FOREST	Unknown	13
Washingto	OKANOGAN-WENATCHEE NATIONAL FORESTS	Unknown	96
Washingto	OKANOGAN-WENATCHEE NATIONAL FORESTS	Reproducing	9
Washingto	OKANOGAN-WENATCHEE NATIONAL FORESTS	Not Applicable	6
Washingto	OKANOGAN-WENATCHEE NATIONAL FORESTS	Non-Reproducing	1
Washingto	OLYMPIC NATIONAL FOREST	Unknown	1
Washington		Total	147
		Total OR/WA	1270

^aSource USFS R6 NRIS Wildlife Database

^b The species has been detected with breeding confirmed on the Wallowa-Whitman National Forest, but data are not currently available.

Table 3. Great Gray Owl Detections on OR/WA BLM Lands in Oregon, 1998-2011. ^{a b}

State	BLM District	Reproductive Status	# Records
Oregon	LAKEVIEW DISTRICT	Repro	4
Oregon	LAKEVIEW DISTRICT	Unknown	4
Oregon	MEDFORD DISTRICT	Non-Repro	10
Oregon	MEDFORD DISTRICT	Not Applicable	1
Oregon	MEDFORD DISTRICT	Repro	271
Oregon	MEDFORD DISTRICT	Unknown	487
Oregon	ROSEBURG DISTRICT	Non-Repro	1
Oregon	ROSEBURG DISTRICT	Repro	13
Oregon	ROSEBURG DISTRICT	Unknown	9
		Total	800

^aNo recorded detections on OR/WA BLM lands in Washington

^bSource: USDI BLM GeoBOB Database

Figures

Figure 1. Adult Great Gray Owl.^a



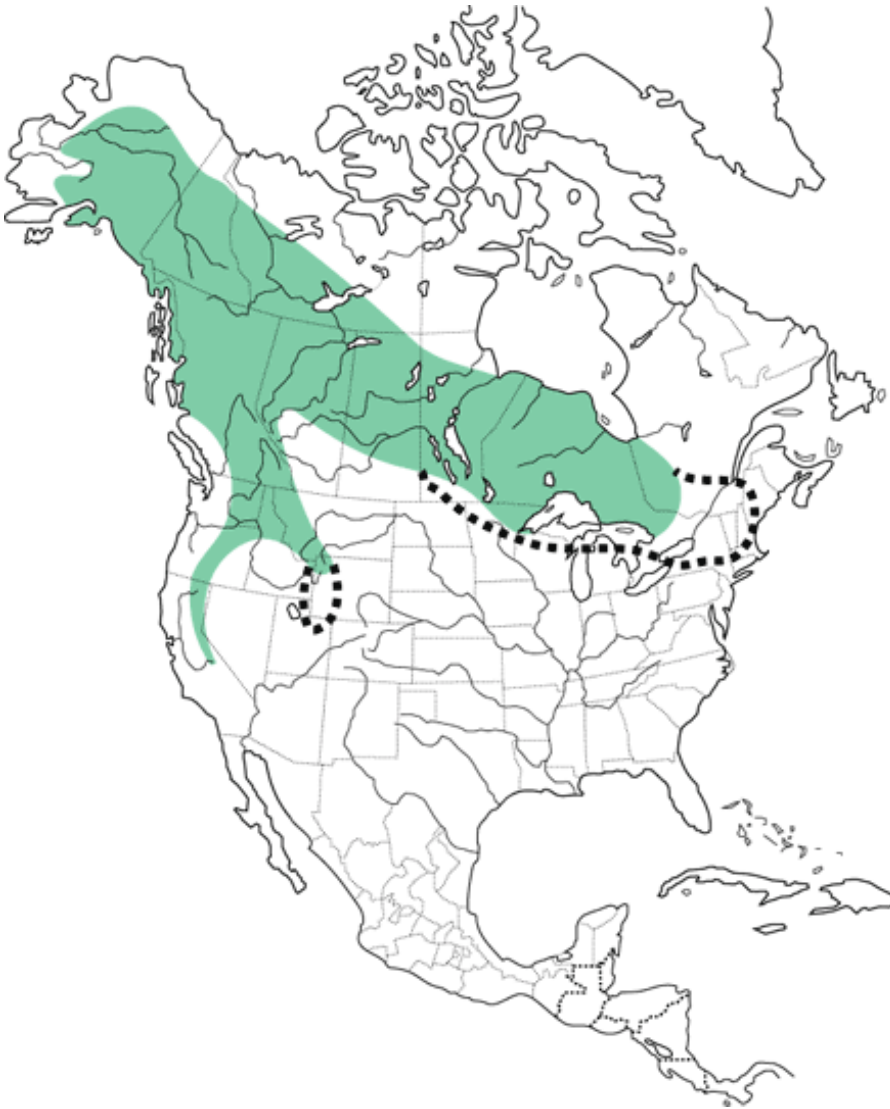
^aPhoto © Jim Livaudais, 2011.

Figure 2. Juvenile Great Gray Owl.^a



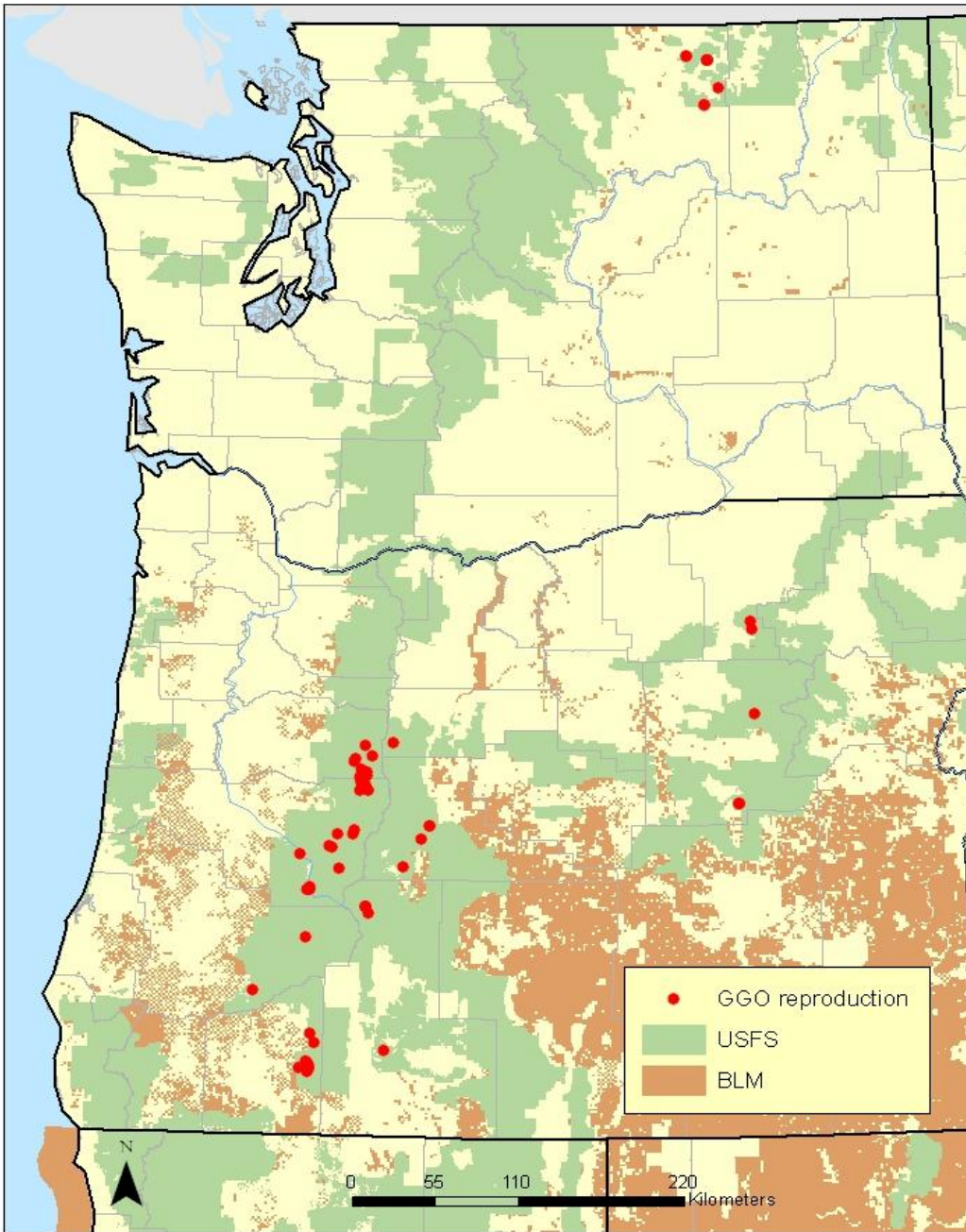
^aPhoto © Andy Yarusso, California Department of Fish and Game, 2011.

Figure 3. Great Gray Owl North America Distribution. ^a



^aImage courtesy Cornell Lab of Ornithology.

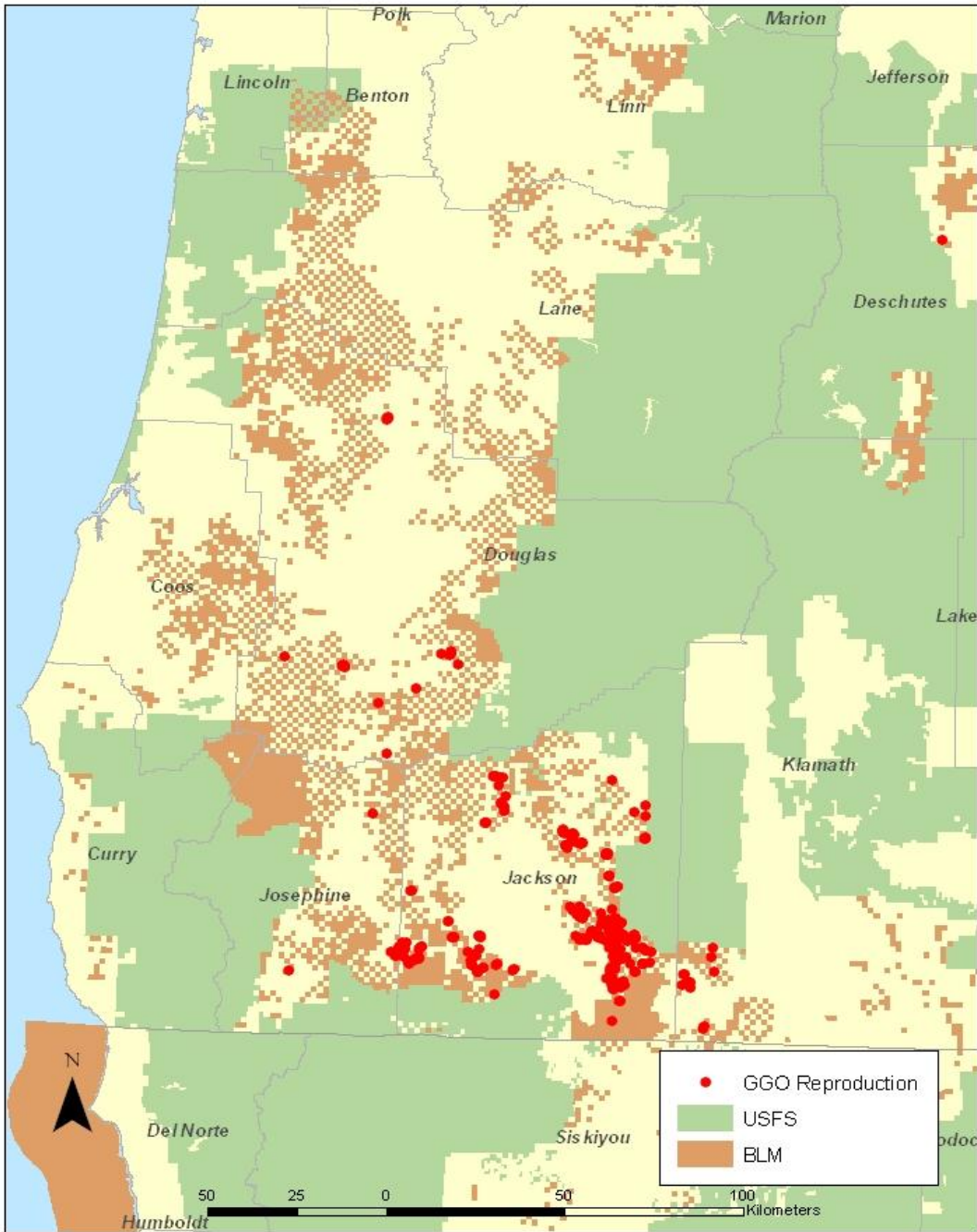
Figure 4. Great Gray Owl reproduction on USFS R6 lands.^a



^aUSFS R6 NRIS Wildlife Database

This map does not include all known GGO nest sites on FS lands, particularly in NE Oregon.

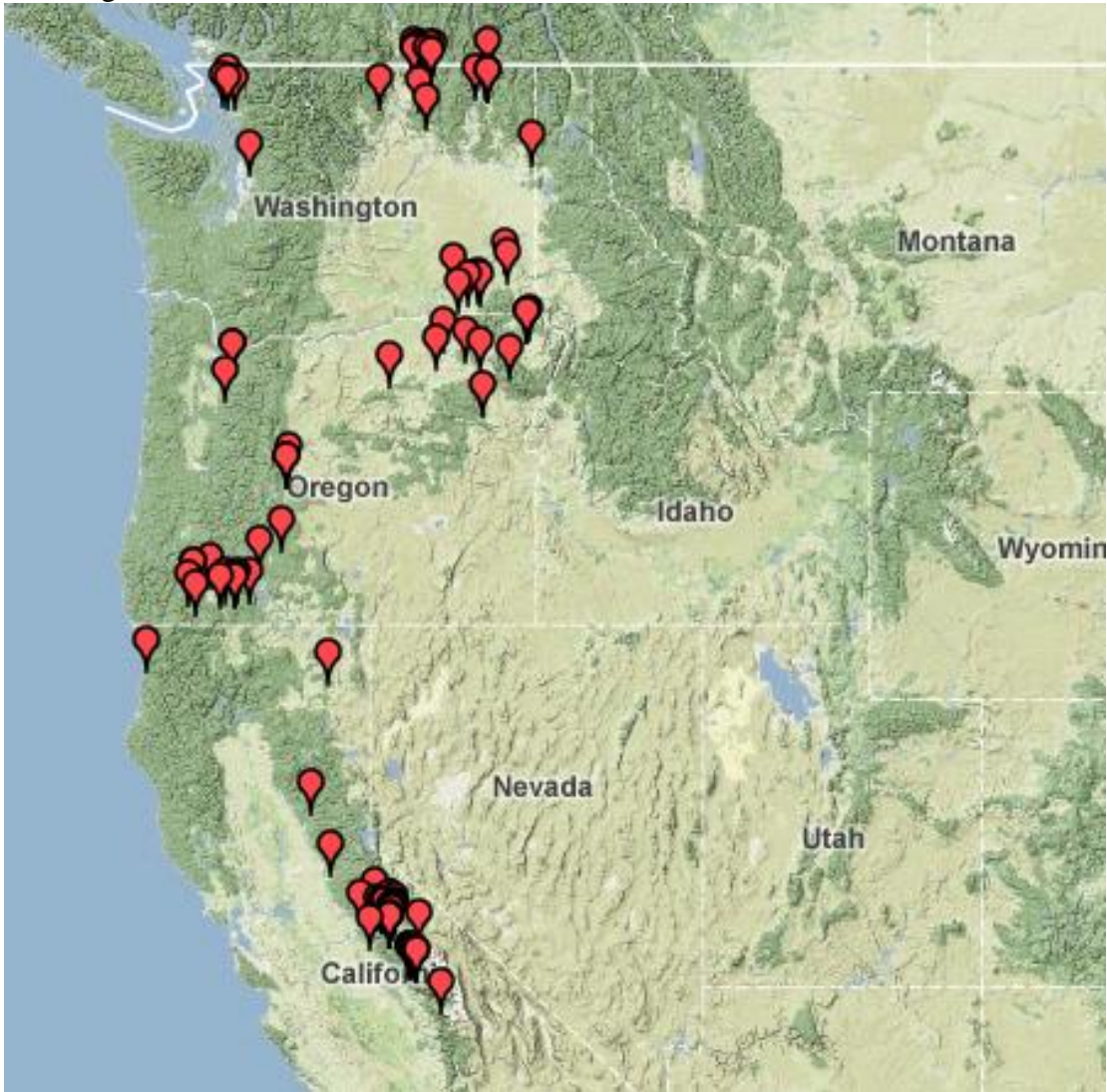
Figure 4. Great Gray Owl reproduction on OR/WA BLM lands.^a



^a No known reproduction on BLM lands in Washington

^bSource: USDI BLM GeoBOB Database

Figure 5. eBird observations of Great Gray Owls in Oregon, Washington, and California, 1900-2011.^a



^aImage provided by eBird (www.ebird.org) and created 9/16/2011.

Figure 6. Adult Great Gray Owl on nest.^a



^a Photo © Ronan Donovan, 2011.