Petition to list the California spotted owl (*Strix occidentalis occidentalis*) as a threatened or endangered species

Center for Biological Diversity

Sierra Nevada Forest Protection Campaign

April 2000

April 3, 2000

Mr. Bruce Babbitt
Secretary of the Interior
Office of the Secretary
Department of the Interior
18th and "C" Street, N.W.
Washington, D.C. 20240

The Center For Biological Diversity, Sierra Nevada Forest Protection Campaign, John Muir Project and Noah Greenwald hereby formally petition to list the California spotted owl *(Strix occidentalis occidentalis)* as threatened or endangered pursuant to the Endangered Species Act, 16 U.S.C. 1531 et seq. (hereafter referred to as "ESA"). This petition is filed under 5 U.S.C. 553(e) and 50 CFR 424.14 (1990), which grants interested parties the right to petition for issue of a rule from the Assistant Secretary of the Interior.

Petitioners also request that Critical Habitat be designated concurrent with the listing, as required by 16 U.S.C. § 1533(b)(6)(C) and 50 CFR 424.12, and pursuant to the Administrative Procedures Act (5 U.S.C. 553).

Petitioners understand that this petition action sets in motion a specific process placing definite response requirements on the U.S. Fish and Wildlife Service and very specific time constraints upon those responses. See 16 U.S.C. § 1533(b).

Due to the fact that California spotted owl populations are in steep decline rangewide, existing regulations are inadequate and that the Forest Service is in the process of developing new management guidelines that will affect the California spotted owl potentially for a decade or more, we appeal for emergency listing and emergency critical habitat pursuant to 16 U.S.C. § 1533(b)(7) and 50 CFR 424.20 in order to ensure that the species' habitat is managed in the immediate future to stabilize declining populations.

Petitioners

Center For Biological Diversity is a non-profit public interest organization dedicated to protecting the diverse life forms of western North America. It has offices in New Mexico, Arizona, and California

Sierra Nevada Forest Protection Campaign is a coalition of grassroots, regional, and national conservation groups dedicated to the protection of the Sierra Nevada's magnificent nationals forests.

And fourteen other petitioners

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Executive Summary

The three subspecies of the spotted owl—northern, California and Mexican—possess nearly every characteristic of a species at risk of extinction. They are large-bodied predators with slow reproduction and specialized habitat requirements. Because of threats to their habitat, primarily from logging, both the northern and Mexican subspecies are listed as threatened under the Endangered Species Act (ESA). Despite similar threats, the California spotted owl has not received Federal protection. An abundance of information now indicates such protection is warranted. Forests of the Sierra Nevada have been severely altered by over a century of logging, resulting in drastic declines in owl habitat. Further, four demography studies of the California spotted owl demonstrate the owl is declining by seven to ten percent annually. Though loss and fragmentation of habitat, climate, low prey density or a combination of all of these are all possible causes for these declines, compelling evidence indicates that habitat loss due to logging plays a significant role in the observed declines. Finally, existing regulations on both federal and private lands are inadequate to protect owl habitat and populations. Thus the California spotted owl meets several criteria for determination as a threatened or endangered species under the Endangered Species Act:

A. The present or threatened destruction, modification, or curtailment of the owl's habitat or range:

- Over a century of logging in the Sierra Nevada has resulted in the loss and reduction of several key attributes of owl habitat from a majority of the landscape, including large trees, snags, downed logs, high total canopy cover, and multi-layered canopies.

- Logging has resulted in extensive habitat fragmentation. Beardsley et al. (1999) and Franklin and Fites-Kaufmann (1996) estimate old-growth has declined by approximately 80% in the Sierra Nevada with large, contiguous blocks primarily limited to national parks.

- Logging under the Forest Service's Interim Guidelines has resulted in numerous adverse effects to owl habitat and owls, including effects to home ranges surrounding Protected Activity Centers (PACs) in 971 instances, Spotted Owl Habitat Areas (SOHAs) in 185 instances and individual owl territories in 183 instances.

- On private lands, over 12,000 logging operations have occurred near owl sites in the past decade.

- Differences in the status of owls in Sequoia/Kings Canyon National Park, where owl populations are nearly stable, and the Sierra National Forest, where owls are in steep decline, strongly suggests that habitat loss due to logging is a determining factor in owl declines.

- Urban development has resulted in significant loss of habitat, particularly at low elevations in the Sierra Nevada and southern California. In southern California, development has heightened natural isolation of California spotted owl metapopulations and has destroyed habitat of the critical San Bernardino Mountains population.

- Other human actions, including livestock grazing, mining, recreation and road construction, have contributed to the past and present loss and degradation of owl habitat.

B. Disease or predation.

- The spotted owl is subject to predation by great horned owls, goshawks and red tailed hawks. Because great horned owls and red-tailed hawks occur in more open areas than spotted owls, logging may increase their abundance and the likelihood that they will take spotted owls.

C. Other natural or human caused factors:

- Logging, livestock grazing and fire suppression have altered fire regimes over much of the Sierra Nevada by eliminating the conditions that allowed frequent fires to burn at low intensities. Resulting changes in forest structure and build-up of fuels has put some stands at increased risk of stand-replacing fire, though to date this risk has not been quantified.

- Short-term climate fluctuations, which have been correlated with lowered fecundity, (Franklin et al. in press and Verner 1999) may be exacerbating owl population declines.

D. Inadequacy of existing regulations to protect the owl and its habitat

Continued loss and degradation of habitat and numerous instances of effects to owl home ranges relate directly to inadequacies in existing regulations, including the Forest Service's Interim Guidelines and the California State Forest Practices Code.

- The Forest Service's Interim Guidelines in part rely on a network of small reserves comprised of "Spotted Owl Habitat Areas" (SOHAs) and 300-acre "Protected Activity Centers" (PACs). These reserves are clearly inadequate. SOHAs have been widely rejected as a viable strategy by the scientific community, and the acreage protected in PACs is far below the minimum amount of habitat required by owl pairs.

- In lands outside of reserves, protection for large trees, high canopy closure, multiple canopy layers and snags and downed wood in the Interim Guidelines fall short of the owl's documented habitat requirements, allowing for continued loss of nesting, roosting and foraging habitat.

- The Guidelines provide no limits on the proportion of the landscape that can be degraded, allowing for increased habitat fragmentation—a major threat to the long-term viability of the owl.

- Hazard sales are exempt from the Guidelines and the prohibition on cutting trees >30" dbh applies only to live trees, both allowing further loss of nesting, roosting and foraging habitat and increased habitat fragmentation.

- On private lands, California's Forest Practices Code provides almost no specific protections for the California spotted owl, essentially allowing any amount and type of logging regardless of the presence of owl habitat or owls.

I. Species Description

A. Non technical

The spotted owl is a medium sized owl, lacking ear-tufts. Unlike most owls, which have yellow eyes, it has dark brown eyes. Coloring is mottled brown and white. The back is brown with white spots, contrasting lighter underparts also with white spots. Facial disk is pale brown, surrounded by a dark brown ring of feathers. Light colored "eyebrows" and "whiskers" form a distinctive X between the eyes. The bill is horn colored to light yellow. Claws are dark brown to black. Legs and toes are covered by buff colored feathers. Size 16-19 inches; wingspan 42-45 inches. Sexes mostly similar.

B. Technical

Average wing length, male 12.6 inches, female 12.9 inches; tail, males 8.5 inches, female 8.9 inches (in Johnsgard 1988); average weight of 46 central Sierra males 19.6 ounces, of 48 central Sierra females 22.2 ounces (Verner et al. 1992a); upperparts brown with irregular white spots, which are larger and more transverse on exterior scapulars and some wing coverts; secondaries with six or seven light brown bands; outer parts of primaries with lighter spots; tail barred with about ten narrow light brown bands; postocular and auricular regions of facial disk light brown, concentrically barred with darker brown; feathers bordering facial disk dark brown; superciliary "eyebrows" and lores white; feathers above and beside eyes dark sooty brown; middle throat pale brown; lower throat dull white; underparts buff with large white spots; legs buff, spotted brown; bill horn colored to dull yellow; claws brown to black (Johnsgard 1988, Gutiérrez et al. 1995). Sexes appear similar; females heavier and generally larger (Blakesley et al. 1990). Late-year juveniles distinguished by clear, white pointed rectrices (Forsman 1981, Moen et al. 1991). Coloration is progressively lighter brown and spots are progressively larger from northern to California to Mexican spotted owl (Gutiérrez et. al. 1995).

C. Taxonomy

There are three recognized subspecies of the spotted owl (*Strix occidentalis*) (AOU 1957), including the California spotted owl (*S.o. occidentalis*) (Xantus 1859), northern spotted owl (*S.o. caurina*) (Merriam 1898), and Mexican spotted owl (*S.o. lucida)* (Nelson 1903). The northern subspecies is found from southwestern British Columbia to central California in the coast ranges, intersecting with the California spotted owl's range in the southern Cascades at the Pit River. The California subspecies ranges from the southern Cascades through the Sierra Nevada and southern California ranges. The Mexican spotted owl is disjunct from the two other subspecies and is found from southern Utah and Colorado, through Arizona, New Mexico and western Texas, and south through the Mexican Plateau (Johnsgard 1988).

Barrowclough et al. (1999), using mitochondrial DNA sequencing to assess gene flow, genetic structure and biogeographic relationships within and among the three subspecies of spotted owl, found that they are phylogenetic species that have been reproductively isolated for "at least tens of thousands of years." They also found evidence of recent gene flow between the California and northern subspecies, but hypothesized that such events are "uncommon." Interestingly, they found that the northern subspecies first split from the combined Mexican and Californian spotted owls, which later split into two separate subspecies. Lastly, they found that the California spotted owl had an order of magnitude lower nucleotide diversity than either the Mexican or northern spotted owls and speculated that this was either because of a past population bottleneck or a mutant haplotype had swept through the population. It is unknown at this time whether reduced diversity in the California subspecies affects its conservation status.

II. Natural History

A. Diet

The diet of the California spotted owl is highly varied, including dusky-footed woodrats (*Neotoma fuscipes*), northern flying squirrels (*Glaucomys sabrinus*), deer mice (*Peromyscus maniculatus*), brush mice (*Peromyscus boylii*), California mice (*Peromyscus californicus*), pocket gophers (*Thomomys bottae*), bats (*Myotis sp.* and *Lasirus cinereus*), crickets and other insects, amphibians, screech owls (*Otus asio*), and Steller's jays (*Cyanocitta stellari*) (Barrows 1980, Hedlund 1996, Marshall 1942, Smith et. al. 1999, Thrailkill and Bias 1989). In terms of number of individuals taken and proportional biomass of selected prey, however, the California spotted owl is a conservative forager, primarily selecting relatively few prey species, probably based on size and ease of capture; others are taken only opportunistically (Hedlund 1996, Thrailkill and Bias 1989). Hedlund (1996), for example, documented that 80% of all pellets in the San Gabriel Mountains, southern California contained remains of dusky-footed woodrats. Trapping, however, revealed that woodrats only made up 30% of small mammal fauna, less than the California mouse (Hedlund 1996). Thus, woodrats were preferentially selected over their abundance. This is probably because of their large size, which increases foraging efficiency (Hedlund 1996, Thrailkill and Bias 1989, Smith et al. 1999). Thrailkill and Bias (1989) demonstrated breeding spotted owls select larger prey than non-breeding owls, indicating availability of large prey may affect breeding success. In support of this conclusion, Smith et. al. (1999) documented that successful nesting spotted owls consumed a greater percent biomass of woodrats than either unsuccessful or non-nesting spotted owls in southern California.

Diets differ between spotted owls at mid-elevations in the Sierra, and the Sierran foothills and southern California. In the former, flying squirrels are the primary component of owl diets, whereas in the latter dusky-footed woodrats are the primary prey and flying squirrels are only a minor constituent of owl diets (Hedlund 1996, Thrailkill and Bias 1989, Verner et al. 1992).

B. Foraging

Spotted owls capture prey by perching on elevated tree limbs or other substrate and silently pouncing on prey (Forsman 1976). They also are adept at "hawking"—capturing birds and insects on the wing (Verner et al. 1992). Spotted owls hunt both by sight and sound and are able to capture prey on the ground, on shrubs or on trees (Verner et al. 1992). If needed, they will move to a better perch before pouncing and sometimes will hop across the ground in pursuit of prey. Because of their use of perches and because nearly all their prey items are found in forested habitats, spotted owls rarely forage in open areas (Barrows 1980, Call et al. 1992).

Spotted owls are primarily night foragers. Forsman et al. (1984) found northern spotted owls on average left their roosts 14 minutes after sunset and stopped foraging 21 minutes before sunrise. During the day, spotted owls spend most of their time roosting, but are known to take prey opportunistically. Laymon (1991) observed California spotted owls in the western Sierra Nevada regularly foraging during the day when they were feeding young, but not otherwise.

C. Vocalizations

The spotted owl uses a variety of calls, including various hoots, barks and whistles. Forsman et al. (1984) defined 13 primary types of vocalizations. The most common of these is the "four-note location call", which is used in territorial disputes and for location between paired owls. It is characterized by a single hoot followed by a short pause, two closely spaced hoots, another short pause, and then a final hoot. Forsman et al. (1984) represented this phonetically as: hoo - - - hoo-hoo - - - - hooo. Others include a "bark series" characterized by three-seven loud barking notes at the rate of two-three notes per second, used mostly by females during territorial disputes; "series location calls," which is a sequence of 7-15 hoots used mostly during territorial disputes; "contact call," which is a "hollow whistled note ending in an upward inflection" used mostly by females to alert the male or young of her location for delivery of food or copulation, and "juvenile begging call," which is a high pitched whistle used to indicate hunger (Forsman et al. 1984). Juveniles develop most adult calls in the fall or winter of their first year (Ibid.). Females generally have a higher pitched call, allowing for identification of sex (Blakesley et al. 1990).

D. Reproduction

Spotted owls are monogamous with both members of a pair remaining in the same home range throughout the year, though often not roosting together during the non-breeding season (Forsman et. al. 1984, Verner et al. 1992). The breeding season begins in mid-February and lasts until as late as early October with considerable variation depending on elevation and latitude (Verner et. al. 1992). Birds in the foothills of both southern California and the Sierra Nevada, for example, are thought to begin breeding about two weeks earlier than birds in mixed conifer forests of their respective ranges and birds in southern California mixed conifer forests are thought to begin breeding about four days before birds in Sierra Nevada mixed conifer forests (Verner et. al. 1992). Pairs begin regularly roosting together about two-three weeks before laying. During this time, the male begins feeding the female and they engage in mutual preening and copulation (Verner et. al. 1992). Once egg laying begins (one-six days), continuing through incubation (28-32 days), and until the nestlings are two to three weeks old, the female receives all of her food from the male. Peak egg laying is from about April 7 to 21 in the San Bernardino Mountains and from about April 11 to 25 in the Sierra Nevada (Verner et al. 1992). Clutch sizes of the spotted owl are small with most containing one or two eggs, infrequently three and very rarely four eggs (LaHaye 1997, Verner et al. 1992). During incubation, female owls develop a distinctive brood patch, where feathers are absent and the skin is thickened. All incubation is done by the female (Johnsgard 1988). Nestlings are semialtricial and remain in the nest for 34-36 days (Forsman et al. 1984). For the first week following fledging, the young are clumsy fliers and thus are often restricted to a single perch or even the ground for several days at a time. After the first week, they can generally fly between trees. The parents continue to feed the fledglings until late September or early October (Verner et al. 1992).

Rather than constructing their own nests, spotted owls use tree cavities, mistletoe brooms, depressions in broken-top trees or snags, or platform nests constructed by other species, such as goshawks, ravens or tree squirrels (Gutiérrez et al. 1992, Gutiérrez et al. 1995). Platform nests are more common in southern California, whereas cavities are more common in the Sierra Nevada (Gutiérrez et al. 1992, Gutiérrez et al. 1995). Similarly, snags are more often used in southern California and the southern Sierra Nevada than in the northern Sierra Nevada, but still less than live trees. Nests occurred in a variety of species, including ten species of conifer and seven species of hardwood. Use of hardwoods for nesting primarily occurs in riparian hardwood forests (Gutiérrez et al. 1992). Nests are almost universally found in larger trees. Gutiérrez et al. (1992) compiled data from 1986-1991 on all National Forests in the range of the California spotted owl and found mean nest trees of approximately 45" dbh in Sierra Nevada mixed conifer, 37" dbh in southern California mixed conifer and 29.5" dbh in riparian hardwood forests. Nest trees are also typically old, frequently ranging from 200-350+ years in age (Gutiérrez et al. 1992, North et al. In press, LaHaye and Gutiérrez 1999). This is probably because old trees are more likely to have large cavities, broken tops or other deformities used for nesting by the spotted owl. A century and a half of logging in the Sierra Nevada, focusing on large trees that take several centuries to grow, has drastically reduced the quantity and distribution of trees used by the owl for nesting (Verner et al. 1992). Gutiérrez et al. (1992) state: "it is reasonable to hypothesize large-diameter trees as a current or potentially limiting factor sometime in the future."

E. The range and distribution of the California spotted owl

The range of the California spotted owl is the smallest of the three subspecies, encompassing approximately one quarter or less the area of the northern or Mexican spotted owl's range (Gutiérrez and Harrison 1996). In the Sierra Nevada, the spotted owl's historic range was probably continuous. Today, it remains largely so, but because of a combination of natural and anthropogenic habitat fragmentation has several discontinuities (Beck and Gould 1992, see below). The spotted owl's range in southern California was historically discontinuous. However, this discontinuity likely has been heightened by loss of low elevation dispersal habitat because of development and other factors (Noon and McKelvey 1992).

Sierra Nevada. The California spotted owl's range in the Sierra Nevada includes the entire western side of the Sierra Nevada from the Pit River in the southern Cascades south to Tehachapi Pass (Gould 1977, Verner et al. 1992). At the Pit River, the California spotted owl's range connects with the range of the northern spotted owl, where the two subspecies probably interbreed (, Borrowclough et al. 1999, Verner et al. 1992). At the southern end of the range, it is likely that birds historically crossed Tehachapi Pass, allowing interchange between the two population groups of California spotted owls. A small number of territories have also been found in the eastern Sierra Nevada in both red fir and eastside pine forests.

In the Sierra Nevada, the California spotted owl occurs in mixed conifer, red fir, ponderosa pine and foothill riparian forests. Verner et al. (1992) calculated that 81.5% of territories were in mixed conifer, 9.7% in red fir, 6.7% in pine-oak, 1.6% in foothill riparian hardwood and .5% in eastside pine. Sierra Nevada mixed conifer not only harbors the majority of birds within the mountain range, but also rangewide with 62.4% of all territories known in 1992 (Verner et al. 1992). Though only slightly less than 7% of all territories are found in pine-oak, this habitat type also provides winter habitat for an unknown number of owls. Laymon (1988) and Verner et al. (1991) found that owls migrated during the winter from mixed conifer forests to low elevation (<3,900 ft.) pine-oak woodlands, comprised of either ponderosa or gray pine. Conversely, Call et al. (1992) did not observe migration in their study of owls on the Tahoe National Forest, indicating only a portion of California spotted owls migrate.

Sierran mixed conifer forests occupy a mid elevation belt on the westside of the Sierra Nevada, roughly 10-70, but mostly less than 30, miles wide and approximately 400 miles long (Langley

1996). In total, Sierran mixed conifer forests occupy approximately 6,546 km^2 (Davis and Stoms 1996). Primary tree species in this zone include Douglas-fir, sugar pine, ponderosa pine, white fir, incense cedar, black oak and red fir (Verner et al. 1992). Davis and Stoms (1996) estimate that Sierran mixed conifer forests are approximately 68% publicly and 32% privately owned. Verner et al. (1992) state “most of the best forest-growing lands in the Sierra Nevada are owned by commercial timber companies in the mixed-conifer zone,” indicating private lands may have historically played a greater role in supporting California spotted owls in mixed conifer forests than they do today (see below). The narrowness of the owl’s prime habitat causes it to be highly subject to discontinuity from habitat fragmentation and indeed there are currently several discontinuities in its distribution (see below).

Red fir forests occur directly above mixed conifer forests, occupying roughly 4,550 km^2 (Davis and Stoms 1996). Though red fir is the predominant tree species, white fir is common in stands at lower elevations and lodgepole pine and quaking aspen are common in stands at higher elevations (Verner et al. 1992). Over 90% of all red fir forests in the Sierra Nevada are publicly owned and nearly 25% are managed by the National Park Service (Davis and Stoms 1996).

Westside ponderosa pine forests occur below the mixed conifer zone in the Sierra Nevada and occupy roughly 4,402 km^2 (Davis and Stoms 1996). Ponderosa pine is the dominant overstory species, mixing with incense cedar and white fir at higher elevations (Verner et al. 1992). Several species of oak are common under- or mid-story species. Approximately 65% is publicly owned (Davis and Stoms 1996). Along with eastside ponderosa pine forests, this is one of the most heavily logged forest types (Franklin and Fites-Kaufmann 1996).

Riparian hardwood forests occupy a relatively small portion of the landscape in the foothills of the Sierra Nevada (Davis and Stoms 1996). Primary tree species include cottonwood, sycamore, interior live oak, Oregon ash and buckeye (Verner et al. 1992). The majority of these forests are privately owned (>70%)(Davis and Stoms 1996) and many areas are threatened with development or have already been developed.

Eastside pine forests occupy roughly 1,614 km^2 (Davis and Stoms 1996) east of the Sierra Nevada crest. Ponderosa and Jeffrey pine are the major tree species. Eighty percent of eastside ponderosa pine forests are publicly owned (Davis and Stoms 1996). Though historical occupancy of eastside ponderosa pine is unknown, the current limited distribution of owls is likely at least in part due to heavy logging of this forest type dating back to the late nineteenth century and continuing to the present. Franklin and Fites-Kaufmann (1996), for example, found that 78% of eastside pine forests lacked significant traits of late successional forests.

Of the 1476 reliable owl locations (observed after 1990) in the Sierra Nevada, the vast majority (85%) of known territories are found on National Forest Lands (Gould unpublished data) with a lesser amount found on private lands (10%), National Parks (4%), Bureau of Land Management lands (.8%), state (.3%) and Native American lands (one territory) (Table 1). Given that approximately 30-40% of potential, suitable habitat is found on private lands (Davis and Stoms 1996, Verner et al. 1992), however, it is likely that historically a larger percentage of territories occurred on these lands. This potential shift in distribution likely reflects the degree to which habitat on private lands has been degraded and fragmented.

Table 1, numbers and percent in parentheses of reliable territories related to ownership and management agency.

	USFS	Private	NPS	BLM	State	Native	Total
Sierra Nevada	1248 (85)	146 (10)	64 (4)	12 (.8)	5 (.3)	1	1476
S. California	281 (85)	37 (13)	0	2 (.7)	6 (2)	4 (1.4)	329

Southern California. The California spotted owl occurs in all major mountain ranges of southern California, including the San Bernardino, San Gabriel, Tehachapi, Santa Lucia, Santa Ana, Cuyamaca/Laguna, Liebre/Sawmill Mountain, Mount San Jacinto, Palomar Mountain and the Los Padres Ranges (Noon and McKelvey 1992). These ranges form isolated habitat islands, surrounded primarily by low elevation desert scrub and chaparral, which is unsuitable for the owl (Noon and McKelvey 1992). Habitat islands vary in size and proximity to other ranges and thus differ widely in the number of owl sites they support (e.g. MacArthur and Wilson 1967). For example, the Santa Ana Mountains, which are fairly small and 30-40 miles from other mountain ranges, only supported two owl sites in 1992 (Noon and McKelvey 1992). Whereas, the San Bernardino Mountains, one of the larger ranges and within 12 miles of two other ranges, have a total of 132 sites (Gutiérrez et al. 1999). Noon and McKelvey (1992) characterized the distribution of the California spotted owl in southern California as:

> "an insular population structure characterized by large (about 200 pair sites) to small (about 2-4 pair sites) local populations distributed among discrete mountain ranges. The distribution of habitat "islands" is discontinuous across the landscape, reflecting natural discontinuities in vegetation structure and composition, in topographic conditions and in the effects of extensive human-induced habitat disturbance and fragmentation."

Isolation of southern California spotted owl populations is likely greater today than it was historically because of loss of low elevation habitats, such as riparian forests, that may have facilitated dispersal. Historically, California spotted owls were found in riparian canyons of San Diego, Riverside and Los Angeles Counties (Bandier 1892, Dawson 1923, Sechrist 1938, Heller 1893, Cole 1908, Payton and Nokes 1925, Payton 1909). For example, spotted owl eggs were collected in Fish Canyon in Los Angeles County, where a nest was found in a "hole in a rocky cliff" (Paytan and Nokes 1925), near Riverside, California, where a nest was located in a cottonwood tree (Heller 1893), and Fanita Ranch, San Diego, California, where a nest was found in a sycamore in a dense stand of live oaks (Sechrist 1938). Low elevation riparian forests in all likelihood formed a network that allowed dispersal between the various isolated mountain ranges (LaHaye personal communication). Presently, nearly this entire habitat has been lost to development, water consumption, dams and livestock grazing (GAO 1988). Additionally, many low elevation areas between mountain ranges occupied by spotted owls have been converted to urban areas possibly further reducing the likelihood of dispersal.

The owl primarily occurs in three vegetation community types in southern California, including live oak/bigcone Douglas-fir (40.8% of sites), riparian/hardwood (32.2% of sites) and mixed conifer (26.4% of sites) forests (Verner et al. 1992). A small number of owl sites have also been found in coast redwood/California-laurel forests (Verner et al. 1992). Live oak/bigcone Douglas-fir forests are dominated by coast and canyon live oak and bigcone Douglas-fir and occur in a narrow band at mid elevations. Riparian/hardwood forests occur in riparian canyons of the various ranges and are dominated by a variety of tree species, including coast and canyon live oak, cottonwood, sycamore, white alder and California laurel (Verner et al. 1992). Southern California mixed conifer forests are found at 6,000-9,000' in elevation in the larger ranges and consist of ponderosa pine, white fir, Coulter pine, bigcone Douglas-fir, sugar pine and incense cedar. Verner et al. (1992) estimated that there are 573,000 acres of suitable habitat in southern California, mostly under Forest Service management (94%), but stated "we still cannot characterize the full range of conditions that comprise suitable habitat there."

There are approximately 329 reliably documented owl locations in southern California. Of these, National Forest lands harbor the majority (85%), followed by private lands (11%), state lands (2%), Native American lands (1%) and Bureau of Land Management lands (<1%)(Gould unpublished data).

III. Habitat Requirements

Every study on the habitat use and requirements of the California spotted owl conclude that it is a habitat specialist, which selects stand characteristics associated with old-growth or mature forests for nesting, roosting and foraging. These include large trees, high canopy closure, decadent stand traits, such as snags and broken tops, and at least a two-layered canopy (e.g. Bias and Gutiérrez 1992, Moen and Gutiérrez 1997, LaHaye et al. 1997, Gutiérrez et al. 1992). Significantly, these results are consistent with findings for both the northern and Mexican spotted owls (e.g. Gutiérrez et al. 1998, LaHaye and Gutiérrez 1999, Peery et al. 1999). Below, we present the current evidence concerning habitat attributes required by the owl.

A. Study Methodologies

Determining some general habitat characteristics of roosting and nesting owls has been straightforward. Spotted owls readily respond to imitations or recordings of their call, allowing researchers to easily locate them while nesting or roosting and then measure the characteristics of the surrounding stand (e.g. Bias and Gutiérrez 1992, Gould 1977, Laymon 1988, Moen and Gutiérrez 1997, LaHaye et al. 1997, Verner et al. 1991). Documenting the habitat requirements of foraging owls, however, is more difficult because owls forage at night and are less stationary than when roosting and nesting. Two approaches have been taken. Call (1990) and Laymon (1988) located radio-marked owls at night, when they were assumed to be foraging, and then returned during the day to measure various stand attributes. Zabel et al. (1992) and Verner et al. (1991) similarly located radio-marked owls, but instead of directly measuring stand attributes, estimated them based on aerial and ortho-photos and remote sensing. The difference in methodologies resulted in significantly different findings, particularly between Zabel et al. and Call and Laymon. Whereas Call and Laymon found significant selection for old-growth stand characteristics, Zabel et al. found inconclusive selection for some old-growth traits, but not others. Because Call and Laymon directly measured stand traits, however, their results are considered more conclusive. Gutiérrez et al. (1992) conclude:

> "Results of Call's (1990) and Laymon's (1988) studies reported earlier in this Chapter, tend to show stronger selection for habitat attributes by foraging owls than suggested by studies reported in Chapter 6 [Zabel et al. 1992]. We believe this resulted from differences between studies in their scale of measurements. Call and Laymon sampled habitats at or very near actual locations where owls foraged. Studies reported in Chapter 6, on the other hand, characterized the entire stand in which a given owl foraged, thus lacking the localized scale used by Call and Laymon."

And Zabel et al. (1992) state:

> "We can differentiate habitat selection only at the level of the entire polygon. Consequently, evidence of habitat selection given in this chapter is likely to be less conclusive than that given in Chapter 5."

Based on the above statements, Laymon and Call should be considered more conclusive than Zabel et al. (1992) for characterizing foraging habitat.

B. Large trees

Roosting and nesting requirements. Every study that has quantified the nesting and roosting characteristics of the California spotted owl has demonstrated significant selection for stands with trees larger than 20-24" dbh (table 2). In the first of these studies, Gould (1977) described stand characteristics at 192 California and northern spotted owl territories throughout California. Of these 192 sites, 83% were dominated by trees larger than 33" dbh. More recently and in a study specific to the California spotted owl, Bias and Gutiérrez (1992) measured stand traits at eleven nest sites in the Central Sierra Nevada, in combined variable radius and .04 ha. plots, and found greater basal area of medium (12-24" dbh), mature (24-40" dbh) and old-growth (>40" dbh) trees than found in random plots. Eight of the eleven nests were in stands with dominant trees >24" diameter at breast height (dbh), whereas the remaining three were in stands with dominant trees 12-24" dbh. All eleven nest stands, however, had one or more residual old-growth trees. Similarly, Moen and Gutiérrez (1997), in a study of 25 owl "activity centers," found that nest stands contain significantly more and larger trees (>24")($P = .0033$) and more residual old-growth trees (>40") than random stands ($P = .0018$). Large trees are required by California spotted owls in the southern portion of their range, as well. In a study of 103 owl territories in the San Bernardino Mountains, LaHaye et al. (1997) documented that owls selected nesting stands, measured in variable radius plots, with significantly higher basal areas of conifer trees 20-30" and >30" dbh and hardwood trees 12-18" and >18" dbh than random stands ($p < .05$).

Results were nearly identical for roost sites. Moen and Gutiérrez (1997) documented that 97% of all roosts located had residual old-growth trees (>40" dbh), including many that were found in stands the Forest Service had classed via remote sensing as mixed conifer, pole stage (12-24" dbh)[1]. Similarly, Laymon (1988), using data from 12 radio-marked birds, demonstrated that owls select roosting stands with significantly greater densities of trees >24" diameter in both summer and fall than in random plots. Indeed, summer roosts had 80% more large trees (>24") than random plots, leading Laymon to conclude: "thus, summer roost sites exhibited many more characteristics of dense, mature forest than did the forest in the home ranges at large."

Foraging requirements. Similar to nesting and roosting habitat, foraging owls select stands with large trees (Table 2). In a study of 12 radio-marked owls on the Eldorado National Forest, for example, Laymon (1988) documented that a majority of foraging locations were in stands with trees >24" dbh and that owls used stands with trees >24" dbh significantly more than expected based on their availability on the landscape, whereas stands with trees 11-24" dbh were used significantly less than expected based on availability. Similarly, in a study of seven radio

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[1] Despite the inability of remote sensing to identify stands with residual old-growth trees characteristic of owl habitat, the Forest Service has continued to use remote sensing for determining management of spotted owl habitat. As a result, some owl habitat likely has been classified as non-owl habitat and received less protection.

marked owls on the Tahoe National Forest, Call (1990) found owls use clearcuts and other openings less than expected based on availability, stands with trees 11-20" dbh in proportion to their availability and stands with trees 20-35" dbh significantly more than expected based on availability. Both studies indicate owls select stands with large trees (>20" dbh) while foraging.

Conversely, Zabel et al. (1992) found that cumulatively over three study areas, including both roosting and foraging sites, the owls used all tree-size classes in proportion to availability. There were significant differences in habitat between the various study areas, however. Only ten and 21% (breeding and nonbreeding season, respectively) of locations were in stands with trees >21" dbh in their study area in mixed conifer forests of the Sierra National Forest (S-CON). By contrast, 91 and 99% of locations were in stands with trees >21" dbh in their study area in riparian oak woodland of the Sierra National Forest (S-OAK); and 82 and 70% of locations were in stands with trees >21" dbh in their study area in mixed conifer forests of the Lassen National Forest (L-CON). These differences indicate that lack of available habitat in the S-CON study area skewed results against selection for tree size. This is significant because habitat selection by the owls in the S-CON study area may reflect the quality of the habitat available to the owls, more than preference. Zabel et al. (1992) conclude:

> "The data suggest, however, that the habitat available to spotted owls on the Sierra NF may be less adequate than that on the Lassen NF. Indeed, it may be that spotted owls on the Sierra NF cannot maintain their numbers, and that perhaps they are maintained by immigration from populations in the neighboring NPs. Note that the Sierra NF shares its northern border with Yosemite NP and its southern border with Sequoia/Kings Canyon NPs."

Thus, the weight of evidence indicates foraging owls select stands with trees >20-24" dbh, likely including the work of Zabel et al. (1992) in two of three study areas.

Table 2. Size of trees in stands selected for nesting, roosting and foraging by California spotted owls.

study	size of trees: nesting and roosting (dbh inches)	size of trees: foraging (dbh inches)
Gould 1977	>33"*	
Bias and Gutiérrez 1992	>24"	
Moen and Gutiérrez 1997	>24"	
LaHaye et al. 1997	>20"	
Laymon 1988	>24"	>24"
Call 1990		>20"
Zabel et al. 1992		>21"**

*Both California and northern spotted owls
**Both roosting and foraging locations

C. Canopy closure

Nesting and roosting requirements. All studies demonstrate that the California spotted owl selects stands with high canopy closure, generally ≥70%. Of the eleven nest sites measured by Bias and Gutiérrez (1992), ten had canopy closure >70% and all had significantly higher canopy closure than found in randomly selected plots. In southern California, LaHaye et al. (1997)

documented a mean canopy closure of 79.3% for nest stands compared to 52.4% for random plots. Canopy closure was also significantly higher at roost sites than random plots. Moen and Gutiérrez (1997) found 99% of all roosts had canopy closure >40%, failing, however, to specify how many were over 70%. Laymon (1988) documented 99% of all roosts had canopy closure between 60-100% in summer with a 26% higher mean than random plots. A majority of fall and winter roosts (73 and 66% respectively) also had canopy closure between 60-100% . Finally, 29 of 29 roost sites measured by Bias and Gitierrez (1992) had canopy closure >70%. Thus, evidence indicates California spotted owls require >70% canopy closure for nesting and roosting.

Foraging requirements. Existing studies provide conflicting information about the minimum amount of canopy closure required by foraging owls, with some studies indicating 40% canopy closure is required and others indicating as much as 70% canopy closure may be required. Laymon (1988) documented that a majority of foraging locations had canopy closure between 60-100% and that stands with 60-100% canopy closure and trees 11-24” dbh were selected in greater proportion to their availability. In addition, owls selected stands with canopy closure between 40-59% and large trees, and avoided stands with 10-39% canopy closure regardless of tree size, indicating that stands with both 40-69% and >70% canopy closure were selected. Similarly, Call (1990) in a study of radio-marked owls on the Tahoe National Forest documented a mean canopy closure of 91.8% at foraging sites, which was significantly different than random sites (mean canopy closure of 85.2%), and that stands with both 40-69% and >70% canopy closure were used in greater proportion than their availability. Verner et al. (1991), however, in a study of radio-marked owls in the Sierra National Forest and Sequoia/Kings Canyon National Parks found that owls use, including both foraging and roosting locations, stands with >70% canopy closure more than expected based on availability, whereas stands with canopy closure 40-69% were used in proportion to their availability. Further, Call et al. (1992) documented that owl home ranges contained more stands with >70% canopy closure than available on the landscape and that stands with 40-69% canopy closure were found in proportion to their availability. Zabel et al. (1992) located more owls in stands with canopy closure >40% and these stands were used more than expected by the owls based on their availability on the landscape, whereas stands with <40% canopy cover were used less than expected. Unfortunately, Zabel et al. (1992) did not separate stands with >70% canopy closure from stands with 40-69% canopy closure for analysis of selection. More foraging and roosting locations documented by Zabel et al. (1992), however, were found in stands with >70% canopy closure on the Lassen National Forest and Sierra National Forest riparian oak study areas than in stands with canopy closure 40-69% and the mean proportion of locations in stands with >70% canopy closure was higher than the mean proportion of these stands within the home ranges on all of the three study areas (Table 3). Conversely, the mean proportion of locations in stands with canopy closure 40-69% was in most cases nearly equal to or less than the mean proportion of these stands in the home ranges (Table 3). Thus, while it is clear that owls select against stands with <40% canopy closure, it is unclear whether owls show a stronger preference for stands with >70% or 40-69% canopy closure for foraging. Until this can be tested further, a conservative approach would be to assume that stands with >70% canopy closure provide better foraging habitat than ones with 40-69% canopy closure, particularly given the limited quantity of such stands and the extent of documented population declines.

Table 3. Comparison of use and availability of stands with >70% and 40-69% total canopy closure. Though it appears that selection for >70% canopy closure may be more significant than selection for 40-69% canopy closure, Zabel et al. (1992) lumped >70% with 40-69% canopy closure for analysis of preference by the owls (reprinted from Zabel et al. 1992).

		Breeding season		Nonbreeding season	
National Forest	total canopy closure	mean % area within home ranges by canopy closure	mean % of locations	mean % area within home ranges by canopy closure	mean % of locations
Sierra NF mixed conifer	40-69%	67.7	68.5	59.8	64.4
	>70%	13.2	22.2	16.4	22.2
Sierra NF riparian oak	40-69%	50.1	41.6	34.7	38.5
	>70%	27.3	48.8	31.6	47.4
Lassen NF	40-69%	26.3	20.4	25.7	18.5
	>70%	41.1	64.7	39.6	67.5

D. Multi-layered dense stands

Nesting and roosting requirements. Gould (1977) observed that of 192 northern and California spotted owl territories: "the quality of the forest was quite similar: a multi-layered forest with a diversity of tree species." This initial observation of selection for multi-layered stands, typically associated with old-growth or mature forests, is supported by later studies. Bias and Gutiérrez (1992), for example, found greater variation in tree size in nest stands compared to random plots, and Moen and Gutiérrez (1997) found higher structural diversity in roosting and nesting stands compared to random plots, features indicative of multi-layered stands. Similarly, in southern California, LaHaye et al. (1997) found owls select multi-layered stands often with a conifer overstory and hardwood understory.

Several studies also found that owls select stands with greater numbers of trees than random plots when nesting and roosting. Moen and Gutiérrez (1997), for example, found more live trees in nest stands than random plots and Bias and Gutiérrez (1992) documented greater basal area of medium, mature and old-growth trees in nest stands and of medium and old-growth trees in roost stands than in random plots, indicating denser stands.

Foraging requirements. Both of the primary studies on foraging habitat found selection for stands with a multi-layered canopy (Call 1990, Laymon 1988). Call (1990) documented that foraging owls select stands with multiple vegetation strata (canopy layers) and Laymon (1988) found that foraging owls prefer stands with little vegetation between the ground and 33' and higher foliage volume between 33-130', which is produced by a multi-layered canopy. This attribute is likely selected because it affords owls a range of heights to perch and locate prey.

E. Large snags and downed woody debris

Nesting and roosting requirements. Spotted owls have been documented to select stands for nesting and roosting with greater numbers and basal area of snags (standing dead trees) than random plots (Bias and Gutiérrez 1992, Laymon 1988, LaHaye et al. 1997). Snags provide nesting and perching sites for the owl and potentially increase prey abundance. For example, the flying squirrel, the owl's main prey item in the northern Sierra Nevada, requires large snags with cavities for denning and as a result may be more common in stands with a greater abundance of snags (Carey 1991, Carey 1995, Weigl and Osgood 1974). Snags also likely attract woodpeckers and secondary cavity nesting birds, minor prey items of the owl (Rosenberg et al. 1996).

Foraging requirements. California spotted owls chose stands for foraging with higher basal area of snags than random sites in both Call's and Laymon's studies. Additionally, Laymon (1988) found that owls select stands with more and larger snags. Both studies indicate that large snags are a critical component of owl foraging habitat. These studies also documented that owls select stands for foraging with more downed woody debris. Call (1990) found significantly greater amounts of downed woody debris 1-11.8" and >11.8" diameter in stands used by owls for foraging compared to random plots and Laymon (1988) documented that optimal foraging habitat contains moderate levels of small dead and down material. Similar to snags, downed wood likely increases prey abundance (Maser et al. 1978).

F. Selection for other features

Gould (1977) documented that 89% of northern and California spotted owl territories occurred on the lower slopes of canyons, 90% had water courses within .3 km, and more occurred on slopes with a north aspect. More recent studies have either not quantified these variables, or in the case of aspect did not find a statistical difference (Bias and Gutiérrez 1992, LaHaye et al. 1997). All of these observations require more data to make definitive conclusions or may be factors that co-vary with other characteristics selected by the owl. It is also possible that the observations of Gould (1977) indicate selection for a cooler micro-climate by the owl.

G. Home range size and landscape scale habitat requirements

Using radio-telemetry, several studies have estimated home range size of the California spotted owl in the Sierra Nevada (Call 1990, Laymon 1988, Zabel et al. 1992). For example, estimates of mean breeding season home range size from three studies in mixed conifer forests, using the 100% minimum convex polygon (MCP) method, were 2,114 acres based on 12 radio-marked owls on the Eldorado National Forest (Laymon 1988), 3,137 acres based on five radio-marked owls on the Tahoe National Forest (Call 1990), 5,423 acres based on nine radio-marked owls on the Lassen National Forest and 1,799 acres based on 24 radio-marked owls on the Sierra National Forest (Zabel et al. 1992) (Table 4). Though there is a wide range of variability in this data, these studies indicate that breeding season home ranges are generally larger in the northern Sierra Nevada than either the central or southern Sierra Nevada.

Zabel et al. (1992) found that home ranges were considerably larger during the nonbreeding season than the breeding season with a mean of 14,677 acres for seven owls in the Lassen National Forest and 5,943 acres for 18 owls in mixed conifer forests of the Sierra National Forest (Table 4). Conversely, both Call (1990) and Laymon (1988) found similar home range sizes during the breeding and nonbreeding seasons. Both Call (1990) and Zabel et al. (1992) found larger home ranges when the breeding and nonbreeding seasons were combined, however. The

Table 4, estimated home range size from three studies, using the 100% MCP method.

Mean Home Range Size (acres)	**Call 1990**	**Laymon 1988**	**Zabel et al. 1992**

			Lassen NF mixed con.	Sierra NF mixed con.	Sierra NF Oak
Individual birds breeding season	3,137 +/- 450	2,114	5,423 +/- 5,194	1,799 +/- 787	715 +/- 624
Individual birds nonbreeding season	2,969 +/- 417	2,074	14,677 +/- 8,252	5,943 +/- 4,530	762 +/- 469
Individual birds combined	4,085 +/- 492		12,927 +/- 10,132	5,969 +/- 4,640	1,043 +/- 866
Pairs breeding Season			3,014	2,515 +/- 874	457 +/- 274
Pairs nonbreeding season			17,292	7,201 +/- 6,901	819 +/- 251
Pairs combined				7,709 +/- 7,184	876 +/- 304

former documented a mean of 4,085 acres for five birds on the Tahoe National Forest and the latter found a mean of 12,927 acre on the Lassen National Forest and 5,969 on the Sierra National Forest. Based on Zabel et al. (1992) alone, combined home ranges, like breeding season home ranges, were larger in the northern Sierra Nevada than the southern, but if Call (1990) is also considered, this pattern no longer holds true. Breeding, nonbreeding and combined home ranges of owls in Sierra National Forest riparian oak habitats were consistently smaller than home ranges of owls in mixed conifer forests, regardless of latitude. Mean home ranges in these habitats ranged from 700-1,000 acres (Zabel et al. 1992). Overall, these studies indicate there is a wide range of variability in home range size of the California spotted owl, ranging from a mean of 4,000 to 13,000 acres for combined breeding and non-breeding season owls in mixed conifer forests of the Sierra Nevada.

Regardless of the variability in home range size, the above findings indicate the owl may require large areas of suitable habitat (e.g. stands dominated by large trees, with high canopy closure (>70%), multi-layered canopies and large numbers of snags). What is unknown, however, is what proportion of each California spotted owl home range must be suitable for them to remain viable; nor is it known what proportion of the landscape as a whole must be in a suitable condition to support a viable number of owl pairs in close enough proximity to each other to facilitate reproduction and genetic exchange and avoid extinction from demographic stochasticity. These questions are inherently difficult to answer for several reasons. First, it is difficult to measure the specific characteristics of forest stands over a large area. Thus, although studies have measured the characteristics of stands occupied by owls, they have not been able to perform these same measurements within all forested stands in a home range[2]. Second, even if it were possible to measure all stands in a home range or even many home ranges, then we would

[2] As noted above, Forest Service vegetation maps based on remote sensing fail to adequately characterize spotted owl habitat at the landscape scale (Moen and Gutiérez 1997).

still need to know if owls were surviving and reproducing in these home ranges. We cannot assume that just because an owl occurs in a home range that it is suitable for owls to survive and reproduce within that home range in the long-term. Lastly, there is a lack of information on the requirements of dispersing juveniles or floaters and thus it is difficult to determine the necessary quantity and distribution of habitat to support dispersal.

To date, two studies have made crude attempts at describing habitat within California spotted owl home ranges (Zabel et al. 1992, Call et al. 1992). Zabel et al. (1992) classified forest stands within home ranges of three study areas into one of five tree size classes and canopy closure classes both for total and dominant canopy cover, using aerial photographs, USGS topographic maps and orthoquads. This analysis shows that, excluding home ranges in mixed conifer forests of the Sierra National Forest, a majority of stands in the home ranges were dominated by trees over 21" and that in all three study areas a majority of stands had a total canopy closure over 40% (Table 5). Call et al. (1992) found that owl home ranges had less clearcut, shrub or plantation areas, more medium trees (11-20" dbh) and more stands with >70% canopy closure than available on the landscape. Whereas, both large trees and stands with 40-69% canopy cover occurred in the home ranges in proportion to their availability on the landscape. Because the stand descriptions were rather coarse, sample sizes fairly small and we have no information on how owls were doing in the studied home ranges, however, we cannot easily draw conclusions from these studies about the quantity of habitat required on the landscape to support viable populations.

Table 5, mean tree size and dominant and total canopy closure classes of owl home ranges on three study areas from Zabel et al. (1992).

Tree size class (d.b.h inches)	**Sierra NF mixed conifer**	**Sierra NF oak**	**Lassen NF mixed conifer**
11- 20	83.9%	8.3%	30%
21-35	9.5%	91.2%	25.1%
>35	3.2%	0%	37.7%
Dominant canopy closure (percent)			
40-69	35.4%	54.2%	25.1%
>70	.2%	19.4%	7.6%
Total canopy closure (percent)			
40-69	67.7%	50.1%	26.3%
>70	13.2%	27.3%	41.1%

In the absence of knowledge of the specific quantity and distribution of habitat required by the California spotted owl within individual home ranges and on the landscape, the safest course is to not degrade or destroy existing suitable habitat and to allow recovery of currently un-suitable habitat to a suitable condition, particularly considering that owl populations are declining. The "Working Group on Late-Successional Conservation Strategies"(WGLSCS) (1996) determined that 67% of mixed conifer forest in the three main National Parks of the Sierra Nevada are high-quality old-growth (LSOG 4, 5) and that 23% are moderate quality old-growth (LSOG 3). These figures represent a best guess at the proportion of forested acres in the Sierra Nevada that were in an old-growth condition prior to European settlement. Thus, allowing recovery of an old growth condition to 75% or more of each home range would approximate conditions that likely supported spotted owls for thousands of years. In addition, in order to facilitate dispersal of juveniles, reproduction and genetic exchange and avoid loss of distinct population segments from demographic or environmental stochasticity, the safest approach would be to configure this habitat to ensure overlapping home ranges throughout the owl's range with no gaps, excluding those created by natural fragmentation.

IV. Population Status

A. Sierra Nevada

Population Distribution. Based on surveys since the 1970s, there are a total of 1726 spotted owl locations in the Sierra Nevada, of which 1476 are considered reliably extant, meaning they have been confirmed since 1990 (Gould unpublished database). Of the 250 unreliable territories, 19 (7.6%) have been surveyed to protocol (six visits over two years) and determined to be likely extirpated and 32 (12.8%) have been visited at least once, but not to protocol, without detection of owls, indicating they may no longer be active territories. Of the 1476 reliable territories, 40 (2.7%) have been surveyed to protocol without detection of owls, indicating they are likely extirpated, and 82 (5.6%) have been surveyed at least once, but not to protocol, without detection, indicating they are potentially extirpated. One thousand and seven of the reliable territories have been occupied by a pair in one or more years, 268 have only been occupied by a territorial single, confirmed by a protocol survey, and 201 have only been occupied by a single bird, but were not surveyed to protocol.

Gould (unpublished database) incorporated detailed information about every owl territory in the Sierra Nevada, including location, year last detected, reproductive status and other information, into a Geographic Information Systems (GIS) database. We have used this database to explore the distribution properties of the California spotted owl in the Sierra Nevada. Several authors have asserted that the California spotted owl's distribution is continuous in the Sierra Nevada, but failed to state the methodologies or assumptions used in making this determination (e.g. Beck and Gould 1992). We used the GIS database produced by Gould (unpublished) to determine whether the distribution is in fact continuous, based on different assumptions of what distance constitutes continuous territories. This was accomplished by placing circles of two and 3.5 mile radii around each territory and then visually determining whether there were breaks in the distribution. Circles were placed around both all reliable territories and reliable pairs. The smaller radius was chosen in order to approximate the size of owl home ranges (two miles represents about an 8,000 acre home range), which range from a mean of roughly 4,000 acres to 13,000 acres, excluding riparian home ranges (Call 1990, Zabel et al. 1992). We approximated home range size because interconnected home ranges represent the greatest degree of continuity possible for a population and provide the highest likelihood that dispersing juveniles and adults will locate vacant territories. The larger radius was chosen to approximate the known dispersal distances of juvenile northern spotted owls. Thomas et al. (1990) found that of all radio-marked juveniles in several studies about 75% traveled at least seven miles. Our rationale was that if territories are within the approximate distance traveled by dispersing juveniles than there is some chance that they will be colonized should they become vacant.

Similar to Beck and Gould (1992), we defined "Areas of Concern" (AOC) as places where the overall owl distribution was broken, narrow or characterized by low owl densities. We have labeled each AOC numerically from north to south (Figure 1). AOC were first identified using reliable pairs with the two mile radius because this combination produced the strongest patterns.

We do, however, discuss all the combinations in relation to each AOC and population continuity as a whole. In order to determine if gaps in the owl distribution or low owl densities related to forest cover type, we consulted maps of forest type and late successional ranking found in Langley (1996) and developed by Franklin and Fites-Kaufmann (1996). The following paragraphs describe each AOC identified by our analysis, many of which, but not all, were also identified by Beck and Gould (1992).

1. Most of this AOC was also described by Beck and Gould (1992). It includes a significant portion of the Lassen National Forest, which Beck and Gould described as being:

> "characterized by habitat fragmentation that decreases the density of owl pairs, makes successful dispersal more difficult, and reduces the quick replacement of owls in vacated habitat."

Habitat fragmentation in this AOC stems from both natural and anthropogenic (logging) factors. We have expanded the boundary of the AOC compared to Beck and Gould (1992) to the northwest to include an area that they labeled Area A, which could serve as the connection between the California and northern subspecies. Owl densities in this AOC are generally lower than in other portions of the range. A number of both reliable pairs and territories (figures 1 and 2) appear to be isolated from other territories by more than four miles, indicated by the two mile radius circles. Fewer reliable pairs or territories are isolated when the 3.5 mile radius is considered (figures 3 and 4).

2. This AOC covers portions of the western and southern Lassen National Forest into the northern part of the Plumas National Forest, where there is a nearly complete break in owl distribution from east to west. Beck and Gould (1992) also identified this AOC, stating:

> "Area 2 is a gap in the known distribution of spotted owls from the western to the eastern edge of the owl's range in the northern Sierra Nevada. If few birds and little habitat exist in this area, north-south dispersal could be impeded. This area and others where few surveys have been done are, however, capable of producing owl habitat and may not be breaks in distribution."

To date, there is no information to indicate owls fill this gap. We included a somewhat larger area in this AOC, using the gap in the distribution of reliable pairs and the two mile radius. The gap is less apparent when the 3.5 mile radius is considered, particularly in combination with all reliable territories.

Beck and Gould (1992) did not explore possible causes for this gap, but did state the area is capable of supporting owl habitat. Figures in Langley (1996) show a mix of private lands and mixed conifer habitat on Forest Service lands in this area. Portions of the mixed conifer habitat were characterized as Rank zero or one in terms of their contribution to late successional forest function by Franklin and Fites-Kaufmann (1996), indicating that habitat loss and fragmentation may in part be responsible for this gap.

3. This AOC is a large gap in owl distribution covering the central potion of the Tahoe National Forest down into the American River, nearly creating another east to west gap in distribution. Beck and Gould (1992) also included this area, minus the American River portion, in their AOC list because of checkerboard ownership, granite outcroppings and red fir forests. This gap

remains quite apparent when all reliable territories are considered with the two mile radius. At the 3.5 mile radius for both all reliable pairs and territories, the American River portion is no longer apparent and it becomes less of a complete gap. According to Franklin and Fites-Kaufmann (1996), this AOC makes a fairly minimal (rank 1 or 2) contribution to late successional forest function. Because of the checkerboard ownership and the fact that this AOC occurs in an area with the longest history of intensive logging in the Sierra Nevada (see below), it seems likely that, in addition to natural habitat fragmentation from granite outcroppings, fragmentation related to logging is at least in part responsible for this gap in owl distribution.

4. Beck and Gould (1992) identified this AOC based on habitat fragmentation and checkerboard ownership with very low owl densities on private inholdings. According to our analysis, the owl distribution is fairly continuous in this area, but we have left it as an AOC because of the identified habitat fragmentation and low owl densities on private lands. Part of this AOC is within the Eldorado demography study area.

5. This AOC is found in the northern portion of the Stanislaus National Forest, extending beyond its western boundary. Beck and Gould (1992) also identified this area as an AOC because of habitat fragmentation from unspecified causes and private land inholdings. The analysis of all reliable pairs with the two mile radius circle shows that this area also has low owl densities and nearly forms a third gap in the distribution. This gap is not apparent when either the 3.5 mile radius is used or when all reliable territories are considered. Based on maps in Langley (1996), the area is dominated by westside mixed conifer, indicating logging and not natural factors, is the cause of habitat fragmentation.

6. A combination of Areas 6 and 7 identified by Beck and Gould (1992), this AOC is found west of Yosemite National Park in the Stanislaus and Sierra National Forests. According to Beck and Gould (1992), the northern portion (their Area 6) has little remaining habitat because of extensive, recent fires and the southern portion (their Area 7) has a high degree of natural habitat fragmentation that has been accentuated by logging. The area is classified as having predominantly low ranks (1 and 2) for contribution to late successional forest function (Franklin and Fites-Kaufmann 1996). In contrast, forests in the adjacent Yosemite National Park have high ranks for contribution to late successional forest function. Apparently, the fires in the northern portion of the AOC did not affect the Park to the same degree, perhaps because of their longstanding prescribed burning program and lack of interrelated effects of logging and fire. Similarly, in the southern portion of the AOC, the Park does not have the compounding effect of logging overlaid on natural fragmentation.

7. This AOC is found at the southern end of the Sierra National Forest near the Kings River Canyon and adjacent to the Sierra demography study area, where there is an almost complete west to east gap in owl distribution. It was not identified by Beck and Gould (1992). Though we do not know what the cutting history is for this particular area, Franklin and Fites-Kaufmann (1996) characterized it as mixed conifer with a low rank for contribution to late successional forest function.

8. Beck and Gould (1992) identified this area as a point where the distribution of owl habitat is particularly narrow and indeed figures in Langley (1996) show that the area of forest types utilized by the owl is very narrow. Within the bounds of Sequoia National Park, this AOC has never been logged. Franklin and Fites-Kaufmann (1996) characterized the area as having a high rank (5) for contribution to late-successional forest function. Our analysis shows the area as a

break in the owl distribution, but this is likely because it was last surveyed in 1988 and 1989. At that time, several territories were found which are no longer considered reliable. It should be a priority to conduct surveys in this area and confirm that continuity remains.

9. Also identified as an AOC by Beck and Gould (1992), this area is the southern terminus of the California spotted owl's range in the Sierra Nevada and is characterized by low owl densities and habitat fragmentation. Much of the AOC is low elevation foothills gray pine with scattered ponderosa pine and oak, as well as eastside pine and is mostly classified as making a low (0-2) contribution to late-successional forest function (Franklin and Fites-Kaufmann 1996, Langley 1996). This area is critical because it links populations in the Sierra Nevada and southern California.

Besides these obvious AOCs, a couple of other facets of the known owl distribution are of interest. First, the distribution of reliable owl pairs in the Tahoe and Plumas National Forests is generally fragmented when the two-mile radius circle is considered. Though there are no landscape scale descriptions of habitat of a high enough quality to correlate this distribution with habitat variables, it seems likely that the owl distribution in these forests as well as elsewhere in the Sierra Nevada is at least in part determined by habitat fragmentation and loss due to logging. This is based on the fact that the Tahoe and Plumas have large private land inholdings, where logging has been and is currently largely unrestricted and intensive and that both forests occur in the portion of the range with the longest history of logging. Second, the known distribution of owls in the Sierra Nevada is for the most part limited to the bounds of the National Forest system, including private land inholdings. Because survey efforts outside National Forests have been limited, there is no way to prove or disprove lack of owls outside national forest boundaries, but given the lack of regulation outside national forest boundaries, it remains a distinct possibility that the owl has been largely eliminated from many private lands.

In sum, our analysis of the spatial distribution of owl territories and pairs in the Sierra Nevada indicates that there are a number of discontinuities and areas of low owl density that likely relate to a combination of natural and anthropogenic habitat fragmentation. Given that there is no indication that owl habitat is increasing in the Sierra Nevada and that owl populations are declining, it is likely that the owl distribution will become increasingly fragmented without additional protection under the Endangered Species Act.

Population demography. In 1992, when the Technical Team reviewed the status of the owl and recommended the Interim Guidelines, lack of statistically significant declines on all three Sierra Nevada demographic studies was a primary justification for not enacting stronger measures and not listing the species as threatened (Verner et al. 1992). In a discussion of whether the owl was declining in the Sierra Nevada, for example, Verner et al. (1992) state:

> "Selective logging of the largest trees from the most productive sites in the Sierra Nevada has resulted in significant changes in the diameter distributions of trees, leaving relatively few very old, large trees that are clearly selected by the owls for nesting. Consequently, we are far from comforted by results from the demographic studies. Before reaching a final conclusion on this matter, we need to continue these studies until the power of the tests on lambda is greatly increased."

Since then, all three studies have collected seven additional years of data and are now able to reliably estimate the finite rate of population change (λ) (Gutiérrez et al 1998, Noon and Blakesley 1999, Steger et al. 1999). Results from these studies show substantial population decline. Additionally, because these studies were conducted in the north, central and southern Sierra, they strongly suggest that declines are occurring over the entire range of the California spotted owl, excluding perhaps Sequoia/Kings Canyon National Parks. Although the ESA does not require definitive evidence that a species is declining to determine if it merits Federal protection, the fact that studies indicate such declines are occurring provides strong evidence that owl populations are being affected by past and present logging, climate and other factors and thus require listing.

Lassen National Forest Study Area. Beginning in 1990, researchers from the Pacific Southwest Research Station of the Forest Service initiated a study of California spotted owls on 500 square miles of the Lassen National Forest in northeastern California, including capture of 191 sub-adult and adult owls (Noon and Blakesley 1999). For the ten years of study, Noon (2000) estimates a λ of .922, indicating an average decline of 7.8% per year from 1990-1999 in the study area. This value is significantly different from one (i.e. a stable population) with a confidence interval that the true value lies between .890-.954 at 95% probability. These numbers include the 1999 field season even though Noon and Blakesely did not produce a report of their 1999 findings. Instead, we received a letter with new estimates of survival, fecundity and λ, which states:

> "These results may be considered an addendum to the 1999 report as we do not intend to rewrite the report this year. Our methods and conclusions have not changed since writing the 1999 report." (Noon 2000)

Thus, the following comments and analysis rely on Noon and Blakesley (1999). The quality of any model, including λ, is only as good as the estimates of parameters entered into the model. Noon and Blakesley (1999) used a three-stage projection matrix model to calculate λ, incorporating estimates of juvenile (≤1 year) and adult (≥1 year) survivorship and sub-adult and adult fecundity. They addressed several possible problems with estimation of these parameters and λ. Estimation of juvenile survivorship can be negatively biased if significant numbers of juveniles emigrate from the study area and survive to ≥ 1 year, but are not recaptured. Noon and Blakesley (1999), however, reason that their estimation (juvenile survival, .354 (CI = .249-.459 with a 95% probability) is likely not biased low because it is higher than estimates of the same parameter for the northern spotted owl from long-term studies. Even if juvenile survival were biased low, however, it would not likely mask a stable population (i.e. λ = 1) because population models of spotted owls are not highly sensitive to changes in juvenile survivorship (Noon and Biles 1990). Noon and Blakesley (1999) calculated that for the Lassen population to have had a stable population from 1990-1998 (λ = 1), juvenile survival would have to have been .697 with an annual emigration of .49. Both are significantly higher than all recorded values for the spotted owl.

Survival rates of sub-adults and adults also can be negatively biased by emigration out of the study area. Because adult owls are highly territorial, however, the risk of enough owls emigrating to significantly alter estimates of adult survivorship and provide false indication of a decline is considered "very low" (Burnham et al. 1996, Noon and Blakesley 1999). Adult survival would have to have been ≥ .87, compared to .81 measured to produce a stable population, which is not within the estimated confidence intervals (CI = .786-.844 with a 95% probability) and thus highly unlikely. Finally, the researchers note that if their study area differs somehow from the regional landscape, then the declines they observed could be unique to their area. Contrary to this, Noon and Blakesley (1999) conclude:

> "[W]e believe our sample to be representative of the regional population, and that reliable inference can be made to the dynamics of the resident, territorial population of owls occupying public lands within the southern Cascades/northern Sierra Province for the period 1990-1998."

The fact that two other studies in the Sierra Nevada came to similar conclusions as Noon and Blakesley (1999) provides further evidence that their findings are not isolated to the study area in question. Based on the severity of the observed declines, Noon and Blakesley (1999) make strong recommendations for the protection of the California spotted owl:

> "The results of our demography study, coupled with strong evidence that California spotted owls select stands dominated by trees >24 inches dbh [note the emphasis on 24" rather than 30"] and with at least 40% canopy closure (Verner et al. 1992b, Gutiérrez et al. 1992, Zabel et al. 1992) suggest that interim measures to retain spotted owl habitat should be no less than those proposed by Verner et al. (1992a)."

Significantly, they also call for the U.S. Fish and Wildlife Service to review the status of the species for Federal listing as a threatened species:

> "Both the northern and Mexican subspecies of spotted owls are currently listed as threatened subspecies under the Federal Endangered Species Act. Both these subspecies were listed on evidence of population declines that was less extensive and less reliable than that for the California subspecies… Because levels of timber harvest are likely to increase in the near-term, we believe the U.S. Fish and Wildlife Service should thoroughly evaluate the status and trend of the California spotted owl to determine if it warrants listing as a threatened species."

Sierra National Forest and Sequoia/Kings Canyon National Parks Study Areas. From 1990-1999, the demography of California spotted owls was investigated on three study areas, including one in relatively pristine habitats of Sequoia/Kings Canyon National Parks (SNP) and two others in the Sierra National Forest (SNF and NS) (Steger et al. 1999). One of the latter studies (NS) was initiated in 1994 to increase the size and power of the studies. In total, they encountered over 200 individual owls between the three study areas. Of primary interest is any differences in the status of populations between the National Forest and National Parks. These differences are likely to be directly related to degradation, destruction and fragmentation of the owl's habitat in the Sierra National Forest due to logging or other management actions, since other factors that could potentially impact owl populations in the study areas, such as climate or prey fluctuations, would likely affect both the parks and National Forest.

As expected given vastly different management of the two study areas, there were differences in the status of populations in the Parks compared to the Forest. The finite rate of population change (λ) for SNP was .971 compared to .906 for the SNF and NS combined. Furthermore, λ in SNP was not significantly different than one, indicating the possibility of a stable population.

Whereas, λ in SNF and NS was significantly different than one, making it highly unlikely that the population is actually stable.

These differences are likely due to a difference in adult survivorship, which is the parameter that most influences λ (Noon and Biles 1990). Adult survivorship was .8822 in SNP compared to .8250 in SNF and NS combined. Steger et al. (1999) conclude:

> "The difference between the SNF and SNP is largely attributable to the higher adult survival rate (return rate) observed in SNP, as λ is most sensitive to this value (Noon et al. 1992). Over the life of the study, adult survival rates were almost 7% higher in SNP than in SNF."

Differences in adult survivorship between SNP, where there is no logging and SNF and NS, where there has been substantial habitat degradation, supports the conclusion of Noon and Blakesley (1999) that to produce a stable age population requires a reduction in adult mortality, which can be accomplished through habitat maintenance and restoration:

> "If the remaining demographic parameters were to remain constant, the survival rate of female owls would have to increase to ≥.87 [this is an increase of .06, which is similar to the difference between the parks and the National Forest] to have a stationary population. Such an increase would require a reduction in adult female mortality. To the extent that survival rates are affected by habitat loss and fragmentation, changes in management may lead to increases in survival."

This is also consistent with the findings of Franklin et al. (In press), who found in a study of the northern spotted owl that larger blocks of suitable habitat produce higher adult survival. Discussing the differences in adult survival between the two study areas, Verner (1999) states:

> "Although none of these differences is significantly different, the general results are consistent with those of Alan Franklin (In press) from his demographic study of the northern spotted owl on the Willow Creek site in the Klamath National Forest. Alan found that with access to larger blocks of suitable habitat owls had slightly lower mortality rates, but those whose home ranges were more patchy had slightly higher fecundity."

Thus, habitat loss and fragmentation by likely causing higher adult mortality is directly implicated in differences in λ between SNP and SNF and NS. This is significant because the owl's life history is based on a bet hedging strategy, where low, highly variable fecundity is compensated by a long reproductive lifespan (Franklin et al. In press, Noon and Biles 1990, Noon et al. 1992). Noon et al. (1992) conclude:

> "The life history pattern of the spotted owl suggests that it must have evolved in an environment stable with respect to adult survivorship. The much greater sensitivity of λ to variation in adult than preadult survival rates indicates strong natural selection to maintain low adult mortality rates. Further, the low fecundity rate suggests that recruitment may always have been variable. In spite of this, high adult survivorship has allowed the spotted owl to persist through long periods of low reproductive output. A consequence of this trade-off is of great concern when considering management for

> spotted owls. Namely, low fecundity precludes rapid recovery from a population decline. Any management action that lowers adult survival rate, particularly when coupled with a reduction in population size, markedly increases the likelihood of local extinction."

In addition to determining that high quality habitat with large blocks of interior old-growth forest likely increases adult survival, Franklin et al. (In press) also found that such habitat potentially acts as a buffer against short-term declines related to climate, stating:

> "Habitat quality, as defined by fitness, appeared to buffer variation in annual survival but did not buffer reproductive output. We postulated that the magnitude of λ was determined by habitat quality whereas variation of λ was influenced by recruitment and reproductive output. As habitat quality declines, variation in λ should become more pronounced" (Franklin et al. in press).

Therefore, large blocks of habitat likely result in a more stable population at lower risk of extinction (Schaffer 1987). A comparison of trends in crude densities between SNP and SNF and NS reflects the increased stability probably related to superior habitat quality in SNP[3]. Both SNP and SNF experienced good reproduction in 1992 leading to an increasing trend in the real number of owls (Figure 5). However, for SNF this trend only lasted until 1994, when a downward trend in owl numbers began. Whereas, in SNP the upward trend lasted until 1995, when it too began declining. The latter declines in territory numbers on both study areas were speculated to be the result of climate effects on fecundity (Steger et al. 1998). These effects apparently had a less serious impact on SNP than SNF because owls in the former declined only by 28% below the peak of 1995 compared to a 33% decline from the peak in 1994 on the latter. Thus, less serious declines in real owl numbers on SNP compared to SNF and NS are likely related to the buffering effect of large blocks of interior, old-growth forest against the deleterious effects of climate. Franklin et al. (In press) conclude:

> "This also suggested that habitat maintenance is essential when considered on landscape scales because excessive loss of key landscape habitat components, such as mature and old-growth forest, can exacerbate the effects of unfavorable climatic conditions on survival."

[3] These are crude rather than ecological densities and thus the difference in trend between the two study areas is of more interest than any differences in density between the two. Crude density is the number of owls divided by the total study area, whereas ecological density is the number of owls divided by the area of potential habitat within the study area. A comparison of the latter is more valid because it takes into consideration differences in the amount of naturally occurring areas that were never suitable for owls.

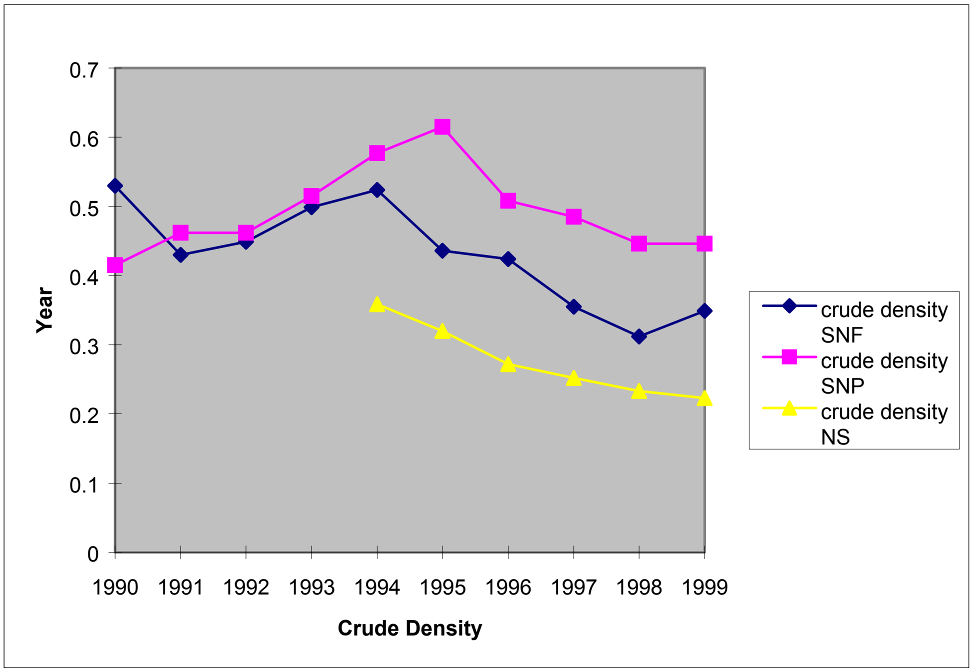

Figure 5. Crude densities of owls on Sierra National Forest (SNF) and Sequoia/Kings Canyon National Park (SNP).

Both SNP and SNF, but not NS, have stopped declining in real owl numbers due to good reproduction in 1998 and in fact SNF increased some in 1999. This increase, however, does not mean that λ is likely to increase substantially, as poor adult survival continues on SNF. This was reflected in the fact that eight banded owls were confirmed missing, and six were replaced on SNF, compared to three missing owls and two replacements on SNP.

Overall, differences in λ values, adult survivorship, and timing and extent of decline all indicate differences in the status of owls in Sequoia/Kings Canyon National Parks and Sierra National Forest. The most obvious explanation for these differences is the substantial habitat loss and fragmentation that has occurred and continues to occur on the Sierra National Forest. Thus, evidence supports a hypothesis that Forest Service logging programs past and present are implicated in declines of California spotted owls.

Central Sierra Nevada Demography Study Area. Gutiérrez et al. (1998) studied a population of owls on the Eldorado and Tahoe National Forests in the central Sierra Nevada for 13 years (1986-1998), including 780 captures plus resights of owls. The finite rate of population change (λ) was .93 for the 13 years of study and was significantly different from a stationary population (z =2.56, p=.005). This value indicates a 7% annual decline over the 12 years of study. Adult survival rates were similar to the other studies at .7942 for females and .862 for males. Thus, the longest study of owl demography in the Sierra Nevada also shows continued population decline.

This decline could be due to several factors, including regional climate, habitat degradation or other factors. Of these, however, there is strong indication that habitat degradation is a determining factor in the observed declines. Much of the study area is a checkerboard of private and Forest Service lands. In general, forests have been more heavily impacted on private lands. Bias and Gutiérrez (1992) showed that within the study area owls almost exclusively relied on Forest Service lands for nesting and roosting, primarily because private forestlands had fewer stands with attributes required by owls, including large trees, high canopy closure and large numbers of snags. Essentially, private lands were unusable to the owls, reducing overall habitat and fragmenting remaining habitat. That habitat fragmentation has been documented in the study area and is known to potentially reduce adult survival thereby causing declines (Franklin et al. In press), suggests that habitat loss is at least in part responsible for the observed decline.

Furthermore, it is unlikely that climactic factors alone are responsible for the declines on this study and others because the demography studies have spanned both favorable and poor weather conditions. In the late 1980s and early 1990s it was speculated that drought was negatively affecting the owl (Verner et al. 1992). Since then, rainfall has been above average in the Sierra Nevada, yet the owl has continued to decline.

B. Southern California

In total, there are approximately 412 owl sites in southern California (Gould unpublished data). Of these, 329 territories are considered reliable, including 305 pairs, 93 single owls and 14 territorial singles (Gould unpublished data). As stated above, the spotted owl in southern California occurs in a discontinuous distribution within at least eight mountain ranges. Stephenson (1991) surveyed these ranges from 1987-1991, providing an estimate of sites per mountain range. The estimated number of owl sites in each range varies from 2-148 and the distance between each range varies from 6-45 miles (table 6, LaHaye et al. 1994, Noon and McKelvey 1992, Stephenson 1991).

Table 6, Mountain ranges, numbers of owls and distance between ranges in southern California from Noon and McKelvey (1992)

Mountain Range	Total owl sites	Nearest Neighbor Distance (miles)
Palomar Mountain	18	18-33
Central San Diego County	9	18-33
Cuyamaca/Laguna Mountains	10	18-33
Santa Ana Mountains	2	30-40
San Jacinto Ranges	20	11-18
San Bernardino Mountains	148*	6-11
San Gabriel Mountains	54	6-20
Liebre/Sawmill Mountains	14	12-20
Tehachapi Mountains	4	unknown
Tecuya Mountains	5	9-12
Los Padres Ranges	65	8-12
So. Santa Lucia Mountains	12	32-45
No. Santa Lucia Mountains	39	45
Total	400**	

* From Gutiérrez et al. (1999)
** Does not represent all sites in Gould (unpublished data)

Noon and McKelvey (1992) reviewed existing literature on population structure, dynamics and modeling and constructed a spatially explicit, simulation model to "explore the stability properties of the southern California metapopulation." The primary finding of this exercise was that owl populations in the San Bernardino and San Gabriel Mountains are critical to the long-term survival of the southern California population of spotted owls. They state:

> "Simulation results suggested that the San Gabriel/San Bernardino owl population plays a pivotal role in maintaining the southern California metapopulation."

These populations are critical because they support sufficient owl sites to remain stable and to possibly act as a source population. According to both there simulation and past modeling results, if population clusters have "moderate connectivity", they must have >20 sites to have locally stable populations. In contrast, their simulation showed that if their were "moderate to strong risks to dispersing birds", then only clusters with > 40 sites and contiguous habitat remained stable. Thus, the San Bernardino and San Gabriel populations with over 100 owl sites form not only the most stable population, but perhaps have historically acted as a source for other smaller and less stable populations. Noon and McKelvey (1992) state:

> "Simulation results suggest that, in those parts of the species' range where suitable habitat constitutes only a small fraction of the landscape, populations are unstable and have low occupancy rates. The pattern is improved if the metapopulation contains a large source population."

Given this knowledge, two serious concerns arise regarding the spotted owl population in southern California. First, large-scale population growth and development may be a major impediment to dispersal from large, source populations to smaller, isolated populations. For example, for birds to emigrate from the San Bernardino to the Santa Ana Mountains, they would have to cross 30 miles of the Los Angeles Basin. Second, over ten years of demographic data from the San Bernardino Mountains indicate this population is in sharp decline. Noon and McKelvey (1992) conclude:

> "Unfortunately, the resident territorial population of spotted owls in the San Bernardino Mountains has declined precipitously since 1987. If the territorial population is in some sort of dynamic balance with a nonterritorial (floater) population, then these sorts of declines may be accommodated over the short-term and pose no long-term threat. If these trends also characterize the other local populations, however, and were to persist for another 5-10 years, we believe the persistence of the entire metapopulation would be at risk."

Since this statement was written, the San Bernardino Mountains population has continued to decline for six additional years.

The San Bernardino Mountains Study Area. A demography study of owls in the San Bernardino Mountains was begun in 1987 and was expanded to include the whole range in 1989. This range harbors the largest population in southern California with a total of 148 historic sites documented since the study began (LaHaye et al. 1999). Because the San Bernardino population is insular, researchers have been able to monitor the entire population from year to year. In addition, most owls in both the San Bernardino and adjacent Mount San Jacinto (11 air miles distance) were banded between 1988-1992. During this time, no owls were found to move between ranges, suggesting that estimates of both juvenile and adult survival are likely not biased by emigration from the study area.

In 1998, owls were found at 81 sites with 51 vacant (LaHaye et al. 1999). Survival of juveniles (age 0-1) and subadults (age 1-2) were constant throughout the study at .32 and .89, respectively.

Adult (>3 years) survivorship ranged from .71 to .83 and was .79 in 1998 (LaHaye et al. 1999). The finite rate of population change (λ) was .91 for all years of study, indicating that the owl population has declined by 9% annually. This estimate was found to be constant over the duration of the study and significantly less than one ($z = 6.85$, $P < .01$). Furthermore, a declining owl population is supported by declines in real numbers of owls. LaHaye et al. (1999) conclude:

> "Over the course of the study, the total number of vacancies created by turnovers was nearly twice the number of vacancies filled by replacements. These numbers were consistent with the hypothesis that the spotted owl population in the San Bernardino Mountains was declining."

Based on existing data, the cause of this decline is difficult to determine. LaHaye et al. (1999) speculate that climate may be a factor, stating:

> "After an initial decline during the early 1990's occupancy rate remained relatively stable during the mid 1990's, then declined again from 1996 to the present. Although we have not determined the cause of the initial decline in territory occupancy, we suspected poor environmental conditions associated with a series of drought years in the mid and late 1980's."

LaHaye et al. (1994), in a detailed examination of the population dynamics of spotted owls in southern California, used linear regression to explore the relationship between precipitation and fecundity in the San Bernardino Mountains owl population. They found that there was a positive linear relationship ($P<.1$ level) and that precipitation explained 52% of the variability in fecundity. Because climate influences fecundity, however, does not necessarily indicate that it is the cause of decline, particularly since estimates of λ are relatively insensitive to changes in this parameter (Noon and Biles 1990). Even if climate is responsible for short-term decline, this does not rule out the possibility that owl populations in southern California might also be experiencing long-term declines because of human caused habitat loss and fragmentation or other factors. LaHaye et al. (1994) conclude:

> "Distinguishing natural population fluctuations from human-induced declines can be difficult and require long-term demographic data."

There are several indications that human activities may be causing long-term declines in addition to any short-term fluctuations related to climate. First, we know that habitat loss has occurred and is continuing to occur. Noon and McKelvey (1992) state:

> "The human population in southern California continues to expand into the forested mountain habitats of the spotted owl. In the San Bernardino Mountains, for example, the human population has grown from about 19,000 in 1970 to over 40,000 in 1992, with 5 million annual visitors. Accompanying this growth is a reduction in the quality and amount of forested habitat for spotted owls—a consequence of urbanization, highways and smaller roads, and recreational developments. Although we lack earlier estimates of spotted owl population sizes or densities, we nonetheless consider it likely that spotted owls have declined in both number and distribution from historic levels."

Habitat loss to human encroachment and other factors such as catastrophic fire is likely ongoing in all of the southern California mountain ranges. For example, Gould (1977) noted that three historical sites in Los Angeles County no longer supported owls likely because of habitat loss to unknown factors. Similarly, Gutiérrez and Pritchard (1990) failed to locate any owls in 6,478 ha of forest that burned in 1987 on Palomar Mountain, nor did they find owls in a previously documented site that had burned in 1975. Second, if the population were stable and just experiencing a short-term fluctuation then we might expect to see growth and recovery in the population during favorable climate, balancing temporary decline. LaHaye et al. (1994) state:

> "If the long-term growth rate is 1.0, one would have been as likely to observe an increase similar in magnitude to the observed decline."

Yet, during the favorable years of the mid 1990's, the finite rate of population change for the San Bernardino Mountains population of spotted owls continued to indicate sharp decline. Third, as already noted, climate is thought to influence fecundity, but adult survival is what most influences population stability and this has consistently ranged around 75-85%, even during favorable years of the mid 1990's (Gutiérrez et al. 1999). Finally, if in fact habitat loss and other factors are resulting in long-term decline, environmental fluctuation will only serve to increase risk for the southern California metapopulation. LaHaye et al. (1994) state:

> "We assessed the effect of correlated growth rates among populations and found that increased correlations lead to increased risk of declining. This effect was quite large under the environmental fluctuations hypothesis."

LaHaye et al. (1994) used a spatially structured metapopulation model, demographic data from the San Bernardino study and data on the size and distribution of other spotted owl populations in the region to asses risk of decline for spotted owls in southern California. Based on this analysis, they conclude:

> "Our results show that the spotted owl metapopulation in southern California faces a serious threat of decline if the current demographic trends continue. The SBM spotted owl population has declined dramatically in the last five years. If the current demographic trends continue and are representative of the other populations in the region, our analysis indicates that the southern California metapopulation could become extinct within 40 years. Even the more optimistic scenario that the decline is temporary, would result in a substantial decline in this metapopulation before a recovery period begins."

As noted above, the California spotted owl has continued to decline to the present, leading LaHaye et al. (1999) to conclude:

> "Thus, we feel that there should be continued concern for this spotted owl population."

In sum, four demography studies of the California spotted owl indicate it has been declining by 7-10% annually for the past 6-12 years. The precise cause of these declines has not been determined, but given the extent of habitat loss and the observed differences between the Sierra National Forest and Sequoia/Kings Canyon National Parks, it is highly likely that habitat fragmentation and loss is at least in part responsible. This information in combination with the fact that habitat destruction continues to the present, clearly demonstrates the California spotted owl requires listing under the Endangered Species Act.

C. The California spotted owl's status is comparable or worse than the status of the northern or Mexican spotted owls were when they were listed.

A review of the final rules listing the northern and Mexican subspecies shows that both were listed as threatened based on similar conditions as now exist for the California spotted owl. Like the California spotted owl, the two subspecies require stand characteristics associated with old-growth forest, including large trees, high canopy closure, multi-layered stands and large numbers of snags. Neither were listed because they were absent from large portions of their historic range. Indeed, both subspecies were thought to have a present range mostly identical to their past range, according to the final rules. Instead, they were listed because of habitat loss within their range caused by logging that was ongoing at the time of listing. Similarly, the California spotted owl is thought to occupy most of its former range, but has lost considerable habitat within that range to past and present logging. At the time of listing it was estimated the northern spotted owl had lost 60% of its former habitat within its range and when the Mexican spotted owl was listed there were no reliable estimates of habitat loss, but it was thought to have been considerable. As noted above, the California spotted owl has also lost a significant amount of habitat, including likely most of 2.4 million acres of potential habitat on private lands (Bias and Gutiérrez 1992 and Gould unpublished). On Federal lands, old-growth forests are believed to have declined by approximately 70-80% (Beardsley et al. 1999, WGSCLS 1996), which indicates similar or potentially greater declines in habitat than experienced by the northern spotted owl.

The final rule for the northern spotted owl identified clearcut logging as the primary cause of habitat loss in the Northwest. Conversely, shelterwood cutting and thinning were identified as the main causes of habitat loss for the Mexican spotted owl. The California spotted owl is threatened by the latter, like the Mexican spotted owl. Though the two types of logging differ considerably, the eventual outcome is the same—replacement of older forests with younger ones less suitable to the owl. Verner et al. (1992) state:

> "Clearcut, seed-tree, and shelterwood cutting techniques all have the same goal: produce even-aged stands. In this regard, seed-tree and shelterwood systems can generally be thought of as two-stage (sometimes three-stage) clearcuts"… "In terms of owl biology, the primary impact of traditional, even aged harvesting practices lies in the creation of simple stand structures and, probably more importantly, the removal of all large trees from vast areas of the forest."

As documented in the EAs and BEs for the seven major owl forests in the Sierra Nevada, salvage logging and commercial thinning are currently the predominant cutting methods in the range of the California spotted owl (see below). Though Interim Guidelines provide protection for some old-growth attributes required by the owl, these prescriptions will result in simple stand structures, lacking the necessary snags, multiple canopy layers and canopy closure to support California spotted owls. Indeed, the Forest Service recently admitted this in the ROD for the Herger-Feinstein Quincy Library Group Forest Recovery Act (QLGFRA), concluding:

> "The interim direction guidelines provide protection measures for the maintenance of the old forest characteristics upon which spotted owls depend. However, the guidelines permit the manipulation, and partial degradation, of suitable owl habitat. Specifically, the

> interim direction guidelines permit timber harvesting that reduces the quality of suitable nesting and foraging habitat."

Thus, like the northern and Mexican subspecies, the California spotted owl is threatened with continued loss of an already much-reduced habitat base.

Likely in part because of continued degradation, destruction and fragmentation of habitat, California spotted owl populations are declining. These declines are far more reliably documented than was the case for the northern or Mexican spotted owls. In fact, the rule listing the Mexican spotted owl did not even cite demography studies as a justification and instead relied entirely on present and predicted loss of habitat. The final rule for the northern spotted owl, however, did rely on predictions of decline from demography studies, but only two of several studies were considered to reliably show decline because they were longer than four years and because they covered a sufficient area (113 and 1200 mi^2). Predicted λ values from these studies were .9524 and .8588 with corresponding adult survival rates of .903 and .802, respectively. Currently, there are four demography studies on the California spotted owl, all conducted for over nine years on areas larger than the smaller of the two northern spotted owl study areas, indicating they are reliable. All of these studies show significant declines comparable to, or lower than, the values listed above for the northern spotted owl.

V. Present or threatened destruction, modification, or curtailment of the California spotted owl's habitat or range

A. Logging in the Sierra Nevada

Logging in the Sierra Nevada has resulted and is continuing to result in loss of key components of spotted owl habitat over large portions of the landscape. Specifically, logging has resulted in the loss of large trees, snags, multi-layered canopies and a reduction in canopy closure, all defining characteristics of both quality owl habitat and old-growth condition (Beardsley et al. 1999, Bias and Gutiérrez 1992, Gutiérrez 1994, McKelvey and Johnston 1992, Verner et al. 1992). Loss of these components from Sierra Nevada forests has resulted in a drastic decline in nesting, roosting and foraging habitat of the spotted owl (Bias and Gutiérrez 1992, Moen and Gutiérrez 1997). The following paragraphs discuss the history, extent and effect on the California spotted owl of over a century of logging in the Sierra Nevada.

Historic extent and method of logging in the Sierra Nevada. Logging in the Sierra Nevada began with the onset of the California Goldrush in 1849, but until early in the twentieth century was mostly limited to areas surrounding mining and other towns, and major railroads (Beesley 1996, Leiberg 1902, McKelvey and Johnston 1992, Sudworth 1900). Beesley (1996), for example, states:

> "Logging before 1900 affected many parts of the Sierra Nevada. This industry developed primarily in support of mining activities near newly created camps and towns located on the western and eastern slopes on the northern and central portions of the range."

Though limited in extent, a number of areas were heavily logged prior to the turn of the century, particularly the Tahoe-Truckee Basin and other parts of the northern and central Sierra Nevada. McKelvey and Johnston (1992) state:

> "In particular, areas north of Nevada City and the Truckee Basin were heavily cut. Again, access was key and the presence of the Southern Pacific Railroad allowed transportation to more distant markets. Lake Tahoe also provided convenient access, allowing large quantities of timber to be taken from areas adjacent to the lake. In addition, a 4 mile wide strip following the railroad between Reno and Sacramento was heavily logged for locomotive fuel."

Logging occurred in both the American and Yuba River Basins, and in portions of Nevada, Sierra, Placer and Mariposa Counties (Beesley 1996, Leiberg 1902, McKelvey and Johnston 1992, Sudworth 1900). Leiberg (1902) documented that in the northern Sierra Nevada, including portions of what are now the Tahoe, Eldorado and Plumas National Forests and the Lake Tahoe Basin Management Unit, a total of 1,386,890 acres had been cut for milling and mine timber, leaving 2,337,930 acres uncut. Of these, the Tahoe was the most heavily impacted prior to 1900, with about 50% of the Forest entered for logging (Leiberg 1902, McKelvey and Johnston 1992).

Early logging practices ranged from complete removal to light high grading. Leiberg (1902) noted that anywhere from five to 99% of the stand was removed. Heavy timber removal was for the most part restricted to low elevations, near rail lines, such as the Southern Pacific Railroad, and areas surrounding mines and mills (Beesley 1996, Leiberg 1902, McKelvey and Johnston 1992, Sudworth 1900). Sudworth (1900) reported that "a common practice of mill operators is to consume all saw timber in a radius from the plant of from 2.5 to 3 miles, and then move to another site." Culling of large trees occurred in a wider area, including low and mid elevations throughout the northern and central Sierra. Large sugar pine were particularly sought after for the shake market, but yellow pine were also heavily cut. Beesley (1996) summarized:

> "The reproduction of certain species such as sugar pine was reported to be imperiled by the wasteful high grading practices of shake makers who took only the best parts of the large trees, leaving the rest as waste. Yellow pines were reported to have been taken in great numbers, especially in areas adjacent to mining operations, and brush and other noncommercial plant species were reported to be replacing them (Sudworth 1900; Leiberg 1902)."

Though primarily sugar and yellow pine were cut, Sudworth (1900) reported that "in some localities, however, 25 to 40 per cent of the cut consists of white fir, red fir, sugar pine and Jeffrey pine."

In sum, logging before the turn of the century began the process of removing and reducing large trees and stand structural complexity from the landscape, but was primarily limited to the northern Sierra at low elevations and near mines, mills and rail-lines. Though we have no way of knowing the direct effects of early logging on the California spotted owl, a reasonable hypothesis is that some areas formally serving as owl habitat were made unsuitable and others were degraded.

The period from 1900 to 1940 saw both the formation of National Forests in 1907 and a major expansion in logging, particularly on private lands. The Southern Pacific Railroad facilitated the shipment of lumber from the Sierra Nevada to distant markets. This fact combined with new railroad logging techniques led to large increases in logging. Beesley (1996) states:

> “Much of the most accessible Sierran timberland by 1900 was in private hands. Application of railroad logging techniques permitted greater amounts of lumber to be brought to market and allowed more distant areas to be logged economically… The railroad lumber industry of the Sierra Nevada grew most between 1890 and the 1920s, and more than eighty rail logging companies were created. Logging rail systems opened formerly inaccessible privately held timberlands to intense development until the 1930s.”

Similar to before the turn of the century, logging was concentrated in the northern and central Sierra, primarily affecting areas within and near the Eldorado and Stanislaus National Forests, and the Tahoe-Truckee Basin and South Yuba River drainage. In the southern Sierra, logging still primarily served local markets, affecting areas near the Sequoia National Forest and elsewhere (Beesley 1996). Beesley (1996) reports that:

> “By 1934 more than half of the mixed conifer forestland in the north-central Sierra Nevada had been entered for harvesting, although logging was restricted primarily to ponderosa, Jeffrey, and sugar pines.”

Private lands, in particular, were heavily impacted by logging prior to 1940 with more than 90% of remaining pristine stands occurring on federal lands (Beesley 1996). Cutting during this period primarily focused on taking the largest sugar and yellow pines, often resulting in complete removal of large trees of these species from stands. Beesley (1996), for example, concludes:

> “A report issued by S.B. Show for the Forest Service in 1926 warned that if the pine forestland in California, 80% of which was in private hands, continued to be cut at currently existing cutting rates, most of the companies involved would soon be in the cut-over land business… The most significant effect of logging before 1940 was the removal of the largest yellow and sugar pines.”

Overall, the period from the turn of the century to the start of World War II saw a major increase in logging. Harvest on lands in the Sierra Nevada increased from below .4 billion board feet in 1900 to over 1.2 billion board feet in the late 1920s (McKelvey and Johnston 1992). During the Great Depression, harvest levels dropped sharply, but only until the start of WWII when they increased dramatically (Beesley 1996, McKelvey and Johnston 1992). Again, we have no direct data on the effects of this increased logging on the California spotted owl, but given that it focused on the largest trees and covered fairly extensive portions of the landscape, a reasonable hypothesis is that logging prior to 1940 contributed to a declining trend in the amount and quality of owl habitat.

During and after World War II, logging in the Sierra Nevada grew at a nearly exponential rate (Beesley 1996, McKelvey and Johnston 1992), fueled by increased demand for lumber and facilitated by new technologies, including the chainsaw, the tractor and later cable logging systems (Hirt 1994). McKelvey and Johnston (1992) report that logging increased from nearly 1.2 billion board feet in1940 to over 1.8 billion board feet in the mid 1950s. Logging levels declined to around 1.4 billion board feet in the late 1950s, remaining fairly constant until a brief decline during the 1982 recession, after which they rose sharply to nearly 1.8 billion board feet in 1990 (McKelvey and Johnston 1992). Beesley (1996) concluded that the Forest Service had “moved from a custodial role into a production mode,” further stating:

> "As an example, between 1902 and 1940, the total timber harvested on the Eldorado National Forest was 148.9 million board feet. From 1941 to 1945 it totaled 175.4 million board feet, reflecting wartime demand. Between 1946 and 1956, the harvest total stood at 728.9 million board feet, meaning that in thirteen years more than twice as much timber was harvested on the Eldorado than in the preceding forty-three years."

In order to carry out this immense increase in logging, Beesley (1996) states that "both public and private forestry in the postwar period moved toward 'intensive timber management practices' ". Logging practices shifted to either heavy selection for most or all large trees in a stand or even aged practices, such as shelterwood, overstory removal, seed tree, and clearcutting (Helms and Tappeiner 1996). On Forest Service lands, clearcutting was rarely used prior to 1970, when there was a policy shift emphasizing this practice (McKelvey and Johnston 1992). Because of this shift, clearcutting was common on Forest Service lands throughout the 1980s and accounted for most of the volume harvested from 1983 to 1987 (Ibid.). Regardless of logging method, however, the effects were often very similar, Verner et al. (1992) conclude:

> "Clearcut, seed-tree, and shelterwood cutting techniques all have the same goal: produce even-aged stands. In this regard seed-tree and shelterwood systems can generally be thought of as two-stage (sometimes three-stage) clearcuts. In all of these cutting systems, the original stand will be totally removed before the new stand is scheduled to be cut."

Similarly, on past selective cutting, Verner et al. (1992) conclude:

> " 'Selective' harvest in the Sierra Nevada has, in the past, primarily targeted the large trees. This system sometimes called 'pick and pluck,' will not produce the simple, even-aged structures that characterize clearcutting techniques, but its effect on the presence of large, old trees is similar."

On private lands, the California Forest Practices Act of 1943 emphasized seed tree logging as the preferred silvicultural method (Helms and Tappeiner 1996). Removal of most of the overstory was also encouraged by the state constitution, which gave a tax subsidy to landowners who harvested at least 70% of the volume on their land. Helms and Tappeiner (1996) state:

> "A major force shaping timber harvesting and regeneration on private lands in California was section 12 ¾ of the state constitution. This section enabled landowners who harvested at least 70% of the volume of trees on a unit of land to pay taxes only on the land, rather than on the land and timber, for forty years or until another harvest was made. This form of tax relief on private lands resulted in heavy selective cutting and discouraged more modest thinnings."

Both of these policies resulted in removal of most large trees from private lands during this period.

Forest practices were not only more intensive after 1940, but also were expanded to include all National Forests of the Sierra Nevada. This means that forests in the southern Sierra Nevada, which up until 1940 were relatively lightly harvested, now became major producers of timber. For example, annual timber production in Fresno County, in the southern Sierra, rose from roughly 37 million board feet in 1947 to a peak in 1975 of 136 million board feet (Bolsinger 1978). Additionally, areas previously unpractical to log were now under production. Beesley

(1996) states “many of the areas opened had previously been considered too remote or steep to log.”

Thus from 1940 through the early 1990s most mixed conifer and ponderosa pine forests of the Sierra Nevada on both public and private lands were utilized primarily for the production of lumber. This combined with previous logging has resulted in the loss and degradation of California spotted owl habitat across the majority of the Sierra Nevada.

Forest Condition prior to logging. By all accounts, the majority of mixed-conifer forests in the Sierra Nevada at the turn of the century were characterized by exceedingly large trees and a high degree of structural complexity (Franklin and Fites-Kaufmann 1996, Leiberg 1902, McKelvey and Johnston 1992, Sudworth 1900). Franklin and Fites-Kaufmann (1996), for example, state:

> “The collective inference from all lines of evidence is that stands with moderate to high levels of LS/OG [late successional/old-growth]-related structural complexity occupied the majority of the commercial forestlands in the Sierra Nevada in presettlement times.”

And McKelvey and Johnston (1992) conclude:

> “Stands described by Sudworth (1900) were very large and very old. The average yellow pine, for instance, was reportedly 150-180 feet tall, 3-4 feet in d.b.h., and 250-350 years old… Most stems exceeded 25 inches in d.b.h., and many extremely large specimens were measured. Of the major timber species, sugar pine, Douglas-fir, and white fir occurred only as very large trees.”

Sudworth (1900) quantified the number, species and size of all trees over 11 inches diameter on 22 one-quarter acre plots, of which three were sub-alpine types and thus not of interest in relation to the owl. The average diameter of trees on the remaining 19 plots was 40.9 inches with the average diameter in individual plots ranging from 25.6 to 52.7 inches. Given the predominance of large trees in most Sierran stands, it is likely that there were also considerably more large snags and downed logs than exist on the present landscape (Franklin and Fites-Kaufman 1996).

Sudworth (1900) described presettlement forests in the Sierra Nevada as “open”, but with areas of dense forest. Speaking of the “middle timber belt,” Sudworth states:

> “As a rule the growth is continuous but rather open; there are, however, areas of considerable extent on broad benches where the forest is dense. The trees are usually of large dimensions.”

The average number of trees over 11 inches diameter in the 19 plots measured by Sudworth (1900) was 24 trees/quarter acre with individual plots ranging from 15 to 43 trees/quarter acre, indicating fairly dense stands. Considering the number and size of trees found in turn of the century Sierran forests as measured by Sudworth (1900) and that according to Beardsley et al. (1999) “the crowns of the species found in mixed conifer are generally broader, thereby resulting in dense canopy cover,” it is likely that most presettlement Sierran mixed conifer forests had fairly high canopy closure, but were described as open because understory vegetation and tree regeneration were sparse or patchy.

There is no way to know the proportion of the presettlement forest landscape that was in an old-growth condition, but based on descriptions it seems likely that it was the majority (Leiberg 1902, Sudworth 1900). WGLSCS (1996) determined that within the national parks high- and mid- quality old-growth mixed conifer occupies approximately 90% of the forested area, further indicating most of the forested landscape was in an old-growth condition prior to logging.

Extent of habitat loss and degradation from logging on Forest Service and private lands. Primarily because of logging, present day Sierran forests are drastically different from those described at the turn of the century. Perhaps most obvious is that forests once dominated by trees well over 25 inches diameter are now dominated by trees under 20 inches. McKelvey and Johnston (1992), for example, conclude:

> "A comparison of that distribution [Sudworth (1900)] with the largest diameter stands in Sierran forests of today shows that far more of the stand basal area in the forests of 1900 was concentrated in very large trees… To various degrees, the forest system has been changed from one dominated by large, old, widely spaced trees to one characterized by dense, fairly even-aged stands in which most of the larger trees are 80-100 years old."

Other changes include reduction and loss of large snags and logs and multi-layered canopies, reduced total canopy cover, and habitat fragmentation. Franklin and Fites-Kaufmann (1996) conclude:

> "A logical inference from both the rankings and the tabulated characterizations of the patches developed in the mapping exercise is that large-diameter decadent trees and their derivatives—large snags and logs—are generally absent or at greatly reduced levels in accessible, unreserved forest areas throughout the Sierra Nevada. This reflects the selective removal of the large trees in past timber harvest programs as well as the removal of snags and logs to reduce forest fuels due to wildfire concerns. Snag removal programs have been underway on both public and private lands for over 60 years and log reduction programs have been underway for about half that period… Key structural features of LS/OG forests—such as large diameter trees, snags and logs—are generally at low levels… While forest continuity is high in the Sierra Nevada, as noted above, the forest structure has been greatly simplified relative to presettlement conditions so that these forests do not produce the same level of wildlife habitat and ecological functions, characteristic of high-quality LS/OG forests."

Overall declines in old-growth forests have been substantial. Two studies have tried to determine the extent of these declines. Based on a comparison of 2,455 ground plots measured in 1991-1993 with data from a 1940s era mapping project, Beardsley et al. (1999) estimated old-growth forests declined from 45% of the landscape in the mixed conifer, true fir and pine types to 11 % of the landscape between 1945 and 1993. Considered alone, however, mixed conifer old-growth declined from 50% to 8% of the landscape, indicating old-growth mixed conifer forests have declined by approximately 84% since 1945. Remaining old-growth was found to occur primarily on federal lands, reflecting the substantial degradation of private lands. The authors state that by 1993:

> "Of the 4.8 million acres of mixed-conifer forests in the Sierra Nevada, 371 thousand acres (8 percent) were old-growth. Almost all the old-growth was in Federal ownership, mostly National Forests and National Parks. Surprisingly, most of the old-growth in

> National Forests was outside designated wildernesses. Less than 2 percent of the 3 million acres of privately owned coniferous forests was old-growth."

Beardsley et al. (1999) note that though many stands do not qualify as old-growth, they have one or more large trees. Presumably a portion of these stands provide nesting and roosting habitat for the owl. Even these stands, however, are highly limited. The study found only eight percent of the landscape is occupied by stands with three or more trees greater than 40" dbh and only 21% of the landscape was found to have one or more trees greater than 40" dbh. Such trees are documented to be a crucial part of owl nesting and roosting habitat (Moen and Gutiérrez 1992).

With similar results, the "Working Group on Late Successional Conservation Strategies" (1996) compared the amount of late-successional habitats (Ranks 4 and 5) in National Parks and National Forests in the Sierra Nevada to approximate decline and found that in the former, high quality late successional habitats occupy 67% of mixed conifer forests, compared to 12% in the latter, indicating a decline of 82%. Similarly, old-growth red fir forests have declined by roughly 72%, old-growth white fir and eastside mixed conifer forests have declined by 79%, and old-growth eastside pine forests have declined by an astounding 99%. Further, much of the old-growth remaining on national forests has been degraded by some selective cutting, occurs in less valuable timber types, such as red fir, or is highly fragmented (Franklin and Fites-Kaufmann 1996).

Effects of habitat degradation and loss on the California spotted owl. Logging of Sierra Nevada forests has resulted in a drastic reduction in nesting, roosting, and foraging habitat across the landscape. This is based on studies demonstrating that spotted owls select stands with large trees, snags and downed logs, high canopy closure, and multi-layered canopies for nesting, roosting and foraging (Bias and Gutiérrez 1992, Call 1990, Gutiérrez et al. 1992, Laymon 1988, Moen and Gutiérrez 1997), and that stands with these attributes have declined substantially (Beardsley et al. 1999, Franklin and Fites-Kaufmann 1996, McKelvey and Johnston 1992). Verner et al. (1992) state:

> "Having concluded that California spotted owls are not habitat generalists, particularly for nest stands, we must determine whether any evidence indicates a decline in the amount of habitat used more than expected by the owl."

Clearly, such decline has occurred and indeed, Verner et al. (1992) conclude:

> "Are key habitat elements declining in the Sierra Nevada? Yes. Of greatest concern to us at this time is the rapid disappearance of the large, old, and generally decadent trees that are the focus of nesting by spotted owls."

Based on several lines of evidence, loss and degradation of habitat has likely resulted in reductions in owl density in parts of the Sierra Nevada. Two studies documented that owls were substantially reduced in degraded forests compared to similar, but less degraded, areas (Bias and Gutiérrez 1992, Gutiérrez et al. 1992). Bias and Gutiérrez (1992) found that 26 of 29 roost sites and 11 of 11 nest sites were on public lands in an area of checkerboard ownership, primarily because of the effects of greater amounts and intensity of logging on private lands. The authors state:

> "*Fewer ($P \leq 0.001$) owls were detected on private lands than expected from its relative land area [emphasis added]*. Slope; total canopy closure; number of possible nest trees; maximum shrub height; basal areas of old-growth, medium, pole, and live trees; percent ground cover by litter; and small and large dead or dying woody vegetation were different ($P \leq .05$) between public and private land. Habitat types of mixed-conifer, large tree successional stage, with ≥70% total canopy closure were most abundant (38.1%) on public land; whereas mixed-conifer, pole-medium successional stage with ≥70% total canopy closure habitat types dominated private land (44.1%). Roost sites occurred in habitats with relatively greater canopy closure, and basal area of snags, medium and old-growth trees than the abundance of habitat."

Similarly, Gutiérrez et al. (1992) documented that owl densities on USGS quadrangles were significantly correlated with the proportion of mixed conifer forests having medium sized and larger trees and high canopy closure, stating:

> "We interpreted these relations cautiously, however, because survey effort was not uniform among the survey units and error exists in the type of mapping of mixed-conifer habitat by the FS (Call 1990, Bias and Gutiérrez 1992, G.N. Steger pers. observ.). Nevertheless, this analysis suggested that, as with nest stands, owl densities were higher in areas with a higher proportion of dense stands and large trees."

Further, both our analysis of owl distribution and one of Beck and Gould (1992) show several areas where owl densities are low because of loss of suitable habitat. In addition, several known historical owl sites have been decimated by logging and no longer exist. Gould (1977) states:

> "Logging and other forest cutting practices appear to be the major causes making forest habitat unsuitable for Spotted Owls. Two adjacent sites reported occupied in 1960 and 1961 were unoccupied in 1974. Since originally reported, both sites had been logged, removing approximately 80% of the canopy over 80% of the area around the sites. The destruction of habitat apparently caused the owls to abandon the territories. Habitat destruction, usually involving logging, was the major cause believed responsible for the absence of Spotted Owls at five historical sites checked." [At least two of these and possibly a third are in the range of the California subspecies.]

These few sites provide an example for perhaps hundreds of owl sites that have been decimated by logging, but were not visited prior to the beginning of intensive survey for owls.

There is also reason to believe that owl densities may be substantially reduced on private lands in the Sierra Nevada. In total, only 176 territories, of which 146 are considered reliably extant, have been documented on private lands in the Sierra Nevada (Gould unpublished data), despite the fact that such lands occupy 2.4 million acres of some of the most productive forestlands in the range (Verner et al. 1992). Though this is in part due to lack of survey, the findings of Bias and Gutiérrez (1992) combined with knowledge that private lands have been more intensively logged for a longer period of time and that only two percent of all private lands can be classified as old-growth (Beardsley et al. 1999) suggests that large areas of private land may have been made unsuitable for the owl, thereby reducing owl densities and potentially resulting in loss of range.

Conversely, Verner et al. (1992) assert that the: "current distribution and abundance" of owls "do not suggest that they have declined either in their overall distribution in the Sierra Nevada or that they have declined markedly in abundance within any forest type," and add that "spotted owls may be more abundant in some areas of the Sierra Nevada today than they were 100 years ago." Although it is true that California spotted owls do occur over the length of the Sierra Nevada, without historical data this conclusion is highly speculative at best. First, given that there is very limited information about the historic or current distribution of spotted owls in eastside and Pacific ponderosa pine habitats, foothill riparian-oak habitats or on private lands in general and that these forests have been severely altered by logging and other factors (Beardsley et al. 1999, Franklin and Fites-Kaufmann 1996), there is a distinct possibility that owls have been eliminated from portions of these areas and thus it is premature to state that there has been no range contraction. Second, because spotted owls occur over the length of the Sierra Nevada does not mean that they have not declined in density. Indeed, evidence provided above suggests this has likely occurred. Finally, justification for the statement that spotted owls may have increased is supported by little to no data. This statement is based on a theory that rampant sheep grazing may have caused a decline in flying squirrel numbers, reducing owl populations, which have presumably now rebounded. The authors state:

> "Late last century, sheep and sheep herders so depleted the understory vegetation and the supply of dead-and-downed wood at some locations in the Sierra Nevada that flying squirrel populations may have been depressed. We would expect owl numbers to decline proportional to the decline in numbers of flying squirrels, unless the owls preyed mainly on other species in the latter part of last century."

The authors fail to provide any references or data for the above assertion and indeed, there is no data from the turn of the century on squirrel populations, or levels of dead-and-downed wood. There are historic accounts stating that sheepherders burned to remove dead wood (see McKelvey and Johnston 1992), but it is unknown how often or to what extent they burned and what effect this had on downed wood. Many early authors (e.g. Sudworth 1900 and Leiberg 1902) tended to underestimate the frequency of natural fires, believing that most fires were human caused. This fact combined with a recognized prejudice against sheepherders probably resulted in accounts of their burning being exaggerated (McKelvey and Johnston 1992, Vankat 1977). It is likely that sheep had a devastating effect on understory vegetation and that sheepherders did do some burning, but the effects of this on flying squirrel populations are unknown and the authors failed to cite a current study showing a relationship between grazing and flying squirrel populations. Thus the above assertion is based on several interrelated and complex hypotheses without supporting evidence. Even if it were true that owls declined because of sheep-herding, however, it would not indicate owl populations were secure, but instead suggests that they had recovered from the effects of grazing at the turn of the century. If such a hypothetical recovery occurred, we have no way of assessing the extent of recovery or whether continued impacts from logging and other factors had hampered it.

In conclusion, widespread logging in the Sierra Nevada over the last century and a half has severely depleted important components of spotted owl habitat, such as large trees, snags and downed logs, and multi-layered dense canopies, resulting in drastic declines in old-growth forests used by the owl for nesting, roosting and foraging. Such declines have likely resulted in reduced owl densities and population viability. Despite protections enacted in 1993 under the Interim Guidelines, logging has continued to negatively affect the owl to the present day.

B. Current logging on Forest Service lands has resulted in numerous effects to California spotted owls.

Logging on Forest Service lands is currently regulated under Interim Guidelines developed by a team of Forest Service, state and university biologists and presented in a report entitled *The California Spotted Owl: A Technical Assessment of Its Current Status* (Verner et al. 1992). In order to comprehensively analyze the effects of logging on the owl under these Guidelines, we requested through the Freedom of Information Act, all Biological Evaluations (BEs), Environmental Assessments (EAs) and other decision documents for Forest Service projects where the agency concluded "may affect individual owls, but *is not likely* to lead to a trend towards listing" or "may affect individual owls and *is likely* to lead to a trend towards listing" from 1990 to July 1998. Only those post-1993 when the Interim Guidelines were enacted were analyzed in this report. This analysis indicates Forest Service logging and other projects are having dramatic effects on the California spotted owl, which clearly put the owl in jeopardy.

Lassen National Forest. The Lassen National Forest has determined actions "may affect individual owls, but are not likely to lead to a trend towards listing" 54 times since 1993. Of these, only five were non-timber sale projects, including three recreation projects, construction of a new road and one general project, meaning the Lassen has planned or carried out 49 timber sales between 1993 and 1998 that affect the California spotted owl. Forty of these were planned under the Interim Guidelines and nine were exempted from the Guidelines primarily because they were sold prior to the Guidelines being established. Effects to individual PACs were identified in 66 instances, to SOHAs in 48 instances and to owl territories in six instances (effects determinations are in most cases based on actions within estimated owl home ranges, rather than within the PACs and SOHAs themselves). Based on the number of PACs, SOHAs and individual territories affected, it is likely the majority of PACs and SOHAs on the forest were affected with some likely also affected more than once, as there are only 85 PACS and 40 SOHAs on the entire forest.

Timber sales resulted in the most instances of effects to owl home ranges, accounting for 57 (86%) of the PACs, 32 (67%) of the SOHAs and 3 (50%) of the owl territories. An additional five instances of effects to PACs, twelve to SOHAs and two to territories were caused by timber sales exempt from the Interim Guidelines. Under the Interim Guidelines, salvage logging and/or hazard tree removal were the most commonly identified prescriptions (28), followed by commercial thinning (9), shelterwood (6), sanitation (4), and fuels treatments (7), which usually involves thinning. Many sales included more than one prescription, hence there are more prescriptions than sales. Though these prescriptions were modified to meet the Interim Guidelines, they retain many of the same characteristics of the prescriptions prior to the Guidelines and have many of the same effects on owls. In total, these timber sales were slated to remove 195 million board feet from approximately 85,676 acres or 9% of productive forest lands on the Lassen.

Salvage and hazard tree logging were not only the most common prescriptions, but likely also some of the more damaging timber sales on owl habitat. Hazard sales, which remove trees near roads or in campgrounds that can be considered a risk to motorists or campers, are exempt from the Interim Guidelines because of the Highway Safety Act. This allows cutting of trees >30" dbh and reduction of canopy closure below minimum standards, resulting in further fragmentation of owl habitat across the landscape. The Lassen planned 11 timber sales that either entirely or partially involved removal of "hazard" trees. While, unlike hazard cutting, salvage sales must follow the Guidelines for retention of the canopy and basal area, they are partially exempt from restrictions on cutting large trees because the Guidelines only require complete retention of *live* trees >30" dbh. Thus, the Forests are allowed to remove dead or dying trees that are larger than 30" dbh, despite the fact that these trees are utilized by nesting spotted owls.

Sierra National Forest. Since 1993 when the Interim Guidelines were established, the Sierra National Forest has concluded a project "may affect individual owls, but is not likely to lead to a trend towards Federal Listing" 88 times and "may affect and [is] likely to adversely affect the California spotted owl" once. In total, the BEs identified negative effects to PACs in 127 instances, SOHAs in six instances and owl territories not identified as being associated with either protected area in 22 instances. An additional nine timber sales that occurred since the Guidelines were established, but were exempted for various reasons resulted in identification of negative effects to PACs in 4 instances, SOHAs in two instances and territories in ten instances. Given that there are only 200 PACs on the entire forest, this analysis indicates that either a majority of them were affected or some were affected more than once. These determinations are just for one six-year period. Combine this with the past century of logging and it is easy to see why the owl is declining by 10% annually on the Sierra National Forest. Indeed, Zabel et al. (1992) in the Technical Assessment for the owl identified lack of habitat as a seriously limiting factor for owls on the Sierra:

> "The data suggest, however, that the habitat available to spotted owls on the Sierra NF may be less adequate than that on the Lassen NF. Indeed, it may be that spotted owls on the Sierra NF cannot maintain their numbers, and that perhaps they are maintained by immigration from populations in the neighboring NPs. Note that the Sierra NF shares its northern border with Yosemite NP and its southern border with Sequoia/Kings Canyon NPs."

The majority of projects (39) were timber sales, 24 were general projects, which were mostly construction projects of various scale, 13 were recreation related, including trail construction and maintenance and off-road vehicle races, six were prescribed burns, four were road construction or maintenance, and three were issuance of grazing permits.

Timber sales, including ones that either did or did not comply with the Interim Guidelines, comprised not only the majority of the projects, but also affected the largest number of PACs and territories. Sixty-nine (53%) of the 131 PACs, five (63%) of the eight SOHAs and 14 (45%) of the 31 territories where effects to individual owls were noted were due to timber sales. This is not including a forest-wide BE for cutting of hazard trees, which determined a "may affect" for all 200 PACs and 29 SOHAs on the forest. Besides negatively affecting a large proportion of the Sierra National Forest owls, these timber sales directly impacted approximately 40,631 acres, which comprises five percent of the productive forest area on the Sierra National Forest, and removed 95 million board feet. Countless more acres of habitat were likely affected indirectly by habitat fragmentation.

Logging prescriptions under the Interim Guidelines included commercial thinning (10), salvage (6), hazard tree removal (5), shelterwood (2), sanitation (3), thinning from below (2), and overstory removal (1). Salvage sales covered the largest areas, with two sales covering 18,950 acres combined. All prescriptions, however, had the effect of reducing canopy cover, and numbers of large trees (20-30") and snags, thereby degrading or destroying owl habitat. For example, the Biological Evaluation for the “Owl Thinning” timber sale concludes that even though the Interim Guidelines are being followed: "The harvest will reduce the basal area and canopy cover on 600 acres.” Only three of the prescriptions were identified as being specifically designed to remove fuels by thinning from below, which, though still harmful to the owl, was the expressed purpose of allowing continued cutting within owl habitat.

We received cruise reports for 19 of the above timber sales, 17 of which included tables with the size and species of trees marked for cutting. We randomly sampled 9 of these sales for analysis (Table 7). The average diameter of all trees cut in these 9 sales is 26.1” dbh, with roughly 61% of the trees harvested having diameters >20” dbh and 35% having diameters >30” dbh. These figures suggest that larger trees were targeted for removal with many of them exceeding 30” dbh. This is counter to the stated intent of the Interim Guidelines, which was to begin to reduce fuels, while at the same time preserving large trees used by the owl for nesting (Verner et al. 1992).

Removal of the overstory in a stand has been shown to be less effective in reducing fire risk compared to surface and ladder fuel treatments (Scott 1998, Van Wagtendonk 1996) van Wagtendonk (1996) demonstrated that treatment of surface and ladder fuels up to six feet in height through prescribed burning and thinning of small diameter trees, resulted in the greatest improvement to fire resiliency in the modeled stands. Consequently, timber harvest that focuses on the removal of medium to large diameter trees, as represented by the nine cruise reports that we reviewed, likely fail to substantially reduce fire danger. Rather, the timber harvests we reviewed negatively affect the owl by reducing the quantity of medium and large trees used by the owl and by reducing canopy cover (Bias and Gutiérrez 1992).

Disputed discussion of 10S18

Table 7, average, range and numbers of trees >30” dbh cut in ten timber sales on the Sierra National Forest.

Sale Name	Average dbh (inches)	Range (inches)	Trees >30” cut
10S18 Fuels Reduction*	31.4	9.8-50	337
Douglas Station	16.9	4.8-36.7	10
Fifth Timber Sale	22.9	10.1-49.4	57
Horse Hazard	29	21.7-45.5	4
North Fork Fuelbreak*	20.4	7.3-41.5	14
Pack Hazard	27.6	7.7-62.6	42
Squaw Hazard	28.1	10.8-59.3	58
Stumpface	20.2	6-41.6	9
Teakettle	28.6	10.1-75	105
Total	**26.1**		**658**

*smaller trees removed mechanically, but not listed in cruise report.

Other projects had serious impacts, as well, particularly when considered cumulatively. General projects came in a distant second to timber harvesting in effects on owls. Projects such as a resort expansion, poisoning of gophers and construction of a radio tower resulted in effects to PACs in 19 instances, SOHAs in two instances and individual territories in nine instances. Recreation-related projects, which resulted in effects to PACs in 18 instances and owl territories in seven instances, mostly had minimal impacts. In one case, however, serious effects resulted.

The effects of an off-road vehicle race were so severe that the Forest Service concluded it "was likely to adversely affect the owl," primarily because it occurred within 1.3 miles of six pairs during the breeding season. Despite this determination, they still approved the race. Road construction and maintenance resulted in effects to only two PACs and one SOHA, but combined with the high densities of roads already in existence, any further construction compounds existing fragmentation. Burning was estimated to affect PACs in 18 instances and individual territories in one instance. While burning can remove needed snags and coarse woody debris, its effect on owls is yet to be determined. Spotted owls in New Mexico, for example, have remained on their territories and even reproduced following fires (Stacey and Hodgson unpub.). Three grazing permits were considered to affect owls. The BEs, however, did not identify any PACs and SOHAs on these allotments. Livestock grazing likely affects owl habitat by removing riparian forests used by owls, reducing owl prey and by altering fire regimes through removal of ground fuels (USDI 1995). Effects to habitat rather than owl territories may have been the justification for the effects determination for these permits or the BEs simply failed to identify existing owl territories on the allotments.

Eldorado National Forest. Since 1993, the Eldorado National Forest has proposed approximately 143 projects where the BE concluded "may affect individual owls, but not likely to result in a trend toward Federal listing." These projects negatively affected PACs in an astounding 598 instances, SOHAs in 75 instances, and territories that were not identified as being associated with a PAC or SOHA, in 70 instances. There are only 168 PACs and 31 SOHAs on the Eldorado, indicating the majority were affected and often by more than one project.

Timber sales accounted for 87 (62%) of the projects, 76 under the Interim Guidelines and 11 exempted, and resulted in a majority of the effects determinations on owls. Four hundred forty (73%) of the 598 PACs, 47 (63%) of the 79 SOHAs and 66 (94%) of the 70 territories where effects were noted were because of timber sales. Only 29, 4 and 37 of the instances of effects to PACs, SOHAs and territories, respectively, resulted from timber sales exempt from the Guidelines. Thus, the vast majority of these effects were from logging under the Interim Guidelines. Based on the EAs and BEs, timber sales that negatively affected owls under the Interim Guidelines have removed or will remove 163 million board feet of timber from approximately 73,205 acres (15% of the productive forest area on the Eldorado) with considerably more indirectly impacted due to fragmentation.

Salvage (19) and commercial thinning (18) were the most commonly cited prescriptions under the Interim Guidelines, followed by thinning from below (15), hazard tree removal (6), shelterwood (3) and overstory removal (3). In several cases, we were only provided with a BE and could not identify a prescription, meaning this is only a sample of the prescriptions used by the Forest Service, rather than a complete summary. This sample, however, does indicate that the Eldorado is continuing to propose timber sales that are designed to produce volume and are damaging to the owl.

Other projects included 20 general projects, 17 recreation projects, nine burns, eight road construction and maintenance projects, one mining project and one grazing permit issuance. Of these, recreation projects resulted in the most instances of effects to PACs (58), SOHAs (15) and territories (2), but to varying extents. For example, an off-road motorcycle race during the breeding season or construction of a permanent trail are likely to have more significant effects than an equestrian ride. General projects resulted in the next most instances of effects to PACs (52), SOHAs (7) and territories (2) and ranged from land exchanges to herbicide treatments.

Though burns were thought to affect PACs 26 instances and SOHAs in six instances, we suspect effects were likely minimal in most cases. The most likely negative effect on owl habitat from prescribed burning is removal of snags and coarse woody debris. Loss of snags and coarse woody debris may be short-term, however, because burning likely creates these attributes, as well. The BE for issuance of a grazing permit did not mention any PACs or SOHAs, meaning there might not have been any in the allotment. The one mining project did not affect any PACs or SOHAs directly.

Sequoia National Forest. The Sequoia National Forest has proposed 21 projects where the BE determined that it "may affect individual owls, but not likely lead to a trend towards Federal listing." The majority of these projects (19) were timber sales, including 16 sales that complied with the Interim Guidelines and three that were exempt because the planning process was initiated prior to signing of the Guidelines. Salvage and thinning were the most commonly identified prescriptions accounting for eight and nine, respectively, of 22 total prescriptions. Two additional timber sales had no identified prescription beyond following the Guidelines. In addition, the Sequoia proposed one hazard tree sale. These timber sales harvested a total of approximately 58 million board feet from 23,000 acres. There were also two recreation projects, including a new motorcycle trail and a trail plan for the entire Forest. The latter details plans for 390 miles of new trail with 35 miles of new roads and trails through PACs and SOHAs. In total, projects affected PACs in eight instances, SOHAs in 6 instances and individual territories in 23 instances. Timber sales that were exempted from the Interim Guidelines resulted in five of the instances where PACs were affected, three of the instances where SOHAs were effected and one of the instances where territories were effected. The Sequoia National Forest has a total of 106 PACs and 40 SOHAs, indicating only a portion were affected.

Stanislaus National Forest. The Stanislaus National Forest has proposed 103 projects that were determined in a BE to "may affect individual owls, but not lead to a trend towards Federal listing" since 1993. These projects resulted in effects to PACs in 66 instances, SOHAs in 22 instances and individual territories in 34 instances. Given that the Stanislaus has a total of 135 PACs and 35 SOHAs, this analysis indicates a substantial portion of the PACs and likely a majority of SOHAs were affected by Stanislaus National Forest projects.

Like the other National Forests, the majority of effects determinations resulted from timber sales (52), followed by burns (19), general projects (19), recreation projects (10) and roads (3). Thinning, including commercial, biomass and from below, was the most common prescription (14), followed by Salvage logging (13). Other prescriptions included clearcutting (three sales that were exempted because planning predated the Guidelines), group selection (two similarly exempted), fuelbreak cutting (2), modified shelterwood (1), modified overstory removal (1) and hazard cutting (1). If carried out as planned, these timber sales resulted in removal of approximately 163 million board feet from 95,000 acres.

General projects consisted of herbicide treatments and other brush removal, heliport construction, bridge replacement, erosion control and other activities. Recreation included among other things constructing new OHV trails, building a museum, highway construction for a snow park and permitting of a horse camp. The three road projects involved repair and improvement to existing roads. These projects have had various adverse effects on owls ranging from minor to severe. For example, a project involving moving a trailhead to an area with no identified PACs or SOHAs probably did not significantly affect the owl, whereas building a museum three quarters of a mile from a known PAC, potentially had a much more significant effect.

Tahoe National Forest. The Tahoe National Forest planned 46 projects where it was determined in a BE that it “may affect individual owls, but not likely to lead to a trend towards Federal listing,” and one where they determined “may affect individual owls, and is likely to lead to a trend towards Federal listing,” These projects resulted in effects to PACs in 44 instances, SOHAs in 16 instances and territories in five instances. This indicates that of the 106 PACs and 33 SOHAs on the Tahoe a substantial portion were affected.

Projects that have affected owls include 25 timber sales, one prescribed burn, livestock grazing on 24 allotments, and eight general, nine recreation and three mining projects. Salvage (13) and thinning (13) were the most common prescriptions for the timber sales, followed by sanitation logging (4), hazard tree removal (2), group selection (2), modified shelterwood (1), overstory removal (1), and clearcutting (1). Clearcutting, one of the group selection prescriptions and the overstory removal were in a timber sale exempted from the Guidelines because planning began before they were signed. In total, the 25 timber sales potentially resulted in removal of approximately 123 million board feet from 36,000 acres.

Non-timber sale projects resulted in effects with a range of severity. For example, general projects ranged from pipeline construction near a nest, potentially affecting reproduction and likely only having a minor effect on the population, to two separate land exchanges giving four PACs to private land owners, almost certainly resulting in logging and loss of these owl territories. Recreation projects consisted mostly of trail construction, both non-motorized and motorized, with the latter having a greater potential for effect caused by excessive noise during the breeding season. There was also construction of a hut and a parking lot. The three mining projects involved blasting and underground exploration. One of these (Sapphire Placer Mine) was determined to potentially “result in a trend toward listing” for the California spotted owl because of removal of large trees >30” dbh and blasting in a nest core area. The project was approved anyway. Finally, livestock grazing on 24 allotments was determined to have “only a small potential” for indirect effects on the owl. The basis for this judgement, however, was not supported with evidence.

Plumas National Forest. Since 1993, the Plumas has proposed 48 projects where the BE determined that the project “may affect individual owls, but not likely lead to a trend towards Federal listing.” These projects have resulted in effects to PACs in 58 instances, SOHAs in 10 instances and individual territories not identified as being in a PAC or SOHA in 13 instances. This indicates a substantial portion of the 190 PACs and 54 SOHAs on the Plumas were affected.

Timber sales comprised the majority of projects (39), followed by general projects (4), road construction (3), recreation (1) and mining (1). Eighteen of the timber sales were exempted from the Guidelines, either because planning for the project was initiated prior to enactment of the Guidelines (9) or because the project occurred in eastside pine forests (9). Prescriptions for the 21 timber sales that followed the Guidelines included salvage logging (12), thinning (9), shelterwood (2), sanitation (1) and general (1). Prescriptions for the sales that were exempted included salvage (8) and thinning (7), sanitation (3) and General (1). The exempted sales also included overstory removal (4), DFPZs (4), clearcutting (2) and group selection (2). Combined, these sales potentially resulted in removal of approximately 133 million board feet from 54,000 acres, of which approximately 108 million board feet from 35,000 acres was from exempted sales. This indicates a majority of the Plumas' harvest since 1993 were conducted under exemptions to the Interim Guidelines.

General projects included two cases of removal of hazard trees for powerlines, construction of a fire station and a soil study involving cutting trees on 27 acres. The recreation protect was felling of trees for a snowmobile trail and the three road projects all involved either road improvement or permitted use for logging. Finally, the mining project involved approval of a plan of operation for the Treasure Canyon Lode Mine #1, including cutting a 52" dbh Douglas-fir. These projects had a range of negative effects on the owl.

Summary of effects on all seven National Forests. As demonstrated above, Forest Service actions have resulted in effects to numerous owl sites, including effects to PACs in 971 instances, to SOHAs in 185 instances and individual owl territories not identified with either management area in 183 instances (Table 9). Considered individually, almost none of these projects would lead to a trend towards listing, but the cumulative effect of these actions combined with the past effects of a century of logging has had widespread negative effects on owl habitat and owl populations and is probably a significant factor in owl declines, meriting its protection under the ESA. Furthermore, the Forest Service is continuing to plan multiple timber sales many of which could magnify negative affects to the owl. For example, the most recent National Environmental Policy Act (NEPA) calendars for the seven national forests discussed above indicated planning was underway for 82 timber sales.

Table 9. Summary of effects on California spotted owls from Biological Evaluations on seven national forests.

National Forest	BEs with "may affect"*	# of times PACs affected	# of times SOHAs affected	# of times owl sites affected	Total PACs/NF	Total SOHAs/NF
Lassen	54	66	48	6	85	40
Sierra	89**	131	8	32	200	29
Eldorado	143	598	75	70	168	31
Sequoia	21	8	6	23	106	40
Stanislaus	103	66	22	34	132	35
Tahoe	47**	44	16	5	106	33
Plumas	48	58	10	13	190	54
total	**505**	**971**	**185**	**183**	**987**	**262**

* Number of biological evaluations (BEs) that concluded Forest Service projects "may affect individual owls, but will not lead to a trend toward Federal listing."
** One determination of "likely to adversely affect the California spotted owl."

C. Logging on private lands

As noted above, logging on private lands has been more intensive for a longer period of time than on Federal lands. This has resulted in drastic declines in late-successional habitats utilized by the owl. For example, Beardsley et al. (1999) found that only two percent of the three million acres of private land could be classified as old-growth and Bias and Gutiérrez (1992) found that owls did not use private lands adjacent to Federal lands for nesting or roosting because they were deficient in several attributes of owl habitat. Additionally, very few owls have been found on private lands. Despite the fact that Verner et al. (1992) estimated there are 2.4 million acres of potentially suitable owl habitat on private lands in the Sierra Nevada, to date only 176 owl territories have been documented on private lands with 146 of these considered reliable. Of the latter, 95 have been occupied by a pair in at least one year. While this is in part because of lack of reported surveys, it is unlikely that there are large reserves of spotted owls on private lands because of substantial loss of habitat on private lands (Beardsley et al. 1999). If there are, however, there is cause for serious concern because intensive logging is ongoing on private lands and there are almost no protections for spotted owls on these lands (see below). As is demonstrated in the analysis below, owls are being heavily impacted by logging on private lands.

We assessed the amount and type of logging occurring within two miles of known California spotted owl (CSO) sites. A database of California spotted owl locations maintained by the California Department of Fish and Game (Gould unpublished data) was used to identify sections of private land within two miles of known owl sites. The sections were forwarded to the California Department of Forestry (CDF) from whom we requested harvest planning documents submitted since 1990 that occurred within these sections. This request revealed that more than 12,000 Timber Harvest Plans (THPs) or exempted timber harvests had occurred near owl sites within the past decade.

Because the CDF database lacks a spatial component, however, it was impossible to determine from the available data how many acres of various logging prescriptions occurred within the specific sections we had identified and the large number of THPs made detailed review impossible. Thus we were not able to quantify effects to all owls on or adjacent to private lands in detail. In and of itself, however, the sheer amount of logging that has occurred since 1990 near spotted owl territories in the Sierra Nevada is instructive to the degree of habitat destruction that is occurring on these lands.

To provide more specific information about the level of impacts occurring in and around home ranges of owls located on private lands in the Sierra Nevada, we conducted a detailed analysis of selected owl sites. The purpose of the case studies was to evaluate a representative sample of owl sites as to the level of impacts occurring within 0.5 and 2 miles of owl sites as a result of logging within owl habitat.

This analysis revealed extensive impacts to land within 0.5 and 2 miles of owl sites we reviewed, and almost no mention, analysis, or mitigation of these impacts in the associated timber harvest documents.

1. Analysis Methods

While scattered private lands exist throughout the Sierra Nevada, the CASPO report identified several areas in the Sierra Nevada where concentrations of private lands are located and identified them as "Areas of Concern." (Beck and Gould 1992). We focused our analysis on owls in four of the Areas of Concern (AOC) in which a concern about private lands had been identified in the CASPO report.

Within each of the four AOCs that present concerns due to presence of private lands, we selected five owl locations for further examination. These sites were selected at random, from the set of owl locations on private land that were found within the AOC boundaries. We then prepared a list of all sections of land that were within or were intercepted by a two mile radius circle, the center point of which was the known owl site. The area encompassed by this radius is about 8,000 acres, which is within the size range of documented owl home ranges.

We submitted this list to the CDF, again requesting copies of all THPs that occurred within these sections. These timber harvest plans and all associated maps were then analyzed to determine as accurately as possible the precise nature of impacts within 2 miles of the identified owl sites, and within 0.5 mile of owl sites. The following discussion summarizes the results of this analysis.

2. Results

Most of the timber sales were conducted under exemptions to the THP process (287 out of 416, or 69%). The exemption process is limited to a one-two page application and as a result little information was provided on the intensity and type of cutting to occur under these harvest documents. Even in those cases where more detailed analysis was performed in a THP, such analysis in the vast majority of cases did not focus on effects on the owl or components of its habitat (see below). Thus while impacts from timber harvest have affected numerous acres of potential owl habitat during the review period, the analysis we were able to complete has limitations that are inherent to the data available.

Beck and Gould (1992) identified four Areas of Concern in the Sierra Nevada due to the presence of a large private land component. We assessed impacts to owl sites by the area of concern within which they occur and use the numbering system established by Beck and Gould (1992).

a. Overview

Our analysis revealed extensive impacts to land within one-half and two miles of the owl sites we reviewed for the period 1990 to 1999. A total of 416 documents indicated that harvest units occurred within two miles of the 18 owl sites with 116 documents containing units that occurred partially within one-half mile of an owl site. In total, these 416 timber sales proposed harvest on more than 2.3 million acres both in and out of the two mile radius around known owl sites. This number includes all acres associated with timber harvest operations and fewer acres were actually located within the 2 mile radius circle around owl sites. There was sufficient detail in 310 documents to evaluate if harvest areas were within 2 miles of an owl site. For these cases, a total of 302,339 acres occurred within 2 miles of an owl site.

The majority of the documents were exemptions (254 cases covering 2,366,753 acres) followed by THPs (129 cases covering 81,817 acres) and then emergencies (33 cases covering 23,697 acres) (Table 10). The number of planning documents per AOC varied substantially with a low of 18 for AOC 3 to a high of 204 for AOC 5. AOC 5 also contained the greatest number of documented harvest acres within 2 miles of a nest stand (119,733 acres).

Table 10. Summary of acres affected by the reviewed planning documents.

Area of Concern	Owl sites affected	Number of planning documents	Acres of THPs with units partially w/in 2 miles of owl site	Acres of Exemptions with units partially w/in 2 miles of owl site	Acres of Emergencies with units partially w/in 2 miles of owl site	Total acres of planning documents with units partially w/in 2 miles of owl site	Number of THPs with units w/in 0.5 miles of owl site	Number of Exemptions with units w/in 0.5 miles of owl site	Number of Emergencies with units w/in 0.5 miles of owl site	Documented acres w/in 2 miles of owl site
2	5	58	24,145	870,115	4,925	899,185	2	17	3	85,414
3	3	18	3,143	20,066	20	23,229	0	2	0	13,411
4	5	136	16,582	594,977	0	611,559	14	23	0	80,863
5	5	204	37,947	881,595	18,752	938,294	16	31	8	119,733
TOTAL	**18**	**416**	**81,817**	**2,366,753**	**23,697**	**2,472,267**	**32**	**73**	**11**	**299,421**

The number of THPs and exemptions filed and their respective acreage varied somewhat by year for the period 1990 to 1999 (Table 11). The patterns suggest that harvest operations are not declining over this period and appear to be somewhat stable.

Table 11. Harvest documents proposing activity within 2 miles of 18 selected owl sites.

Year	Number of THPs	THP acreage	Number of Exemptions	Exemption Acreage	Number of Emergencies	Emergency Acreage
1990	15	11,215	17	152,656	17	11,662
1991	19	15,978	16	94,912	5	4,520
1992	14	8,778	26	227,948	0	0
1993	11	4,797	34	263,731	2	1,800
1994	12	5,059	49	299,187	0	0
1995	10	5,357	28	359,962	5	4,925
1996	24	13,263	34	384,097	1	20
1997	8	4,998	29	354,018	1	60
1998	16	12,373	15	229,946	2	710
1999	no data	no data	6	129,814	0	0
TOTAL	**129**	**81818**	**254**	**2496271**	**33**	**23697**

In many cases, THPs were proposed in the same area as exemptions for the period between 1990 and 1999. An estimate of the total number of THPs that occurred within areas that had come under exemptions for the period of review is difficult to determine, nevertheless the following examples illustrate the pattern. In AOC 2, exemptions were filed 5 times on the same 92,634 acre area between 1990 and 1999. During this same period and in this same area, 5 THPs totaling 20,158 acres were filed. In AOC 4, exemptions were filed 7 times on the same 68,382 acre area between 1990 and 1999. During this same period and in this same area, 17 THPs totaling 9,698 acres were filed. In total, numerous exemptions were filed repeatedly on the same 324,840 acres during the period 1990 and 1999. During this same period and in the same area, 81 THPs totaling 70,365 acres were filed. The harvest activities associated with these timber harvests removed habitat elements (i.e. large trees, large snags, multi-layered canopies) required to maintain California spotted owl habitat. Despite the magnitude of effects to California spotted owls, the impacts of these harvest activities are not disclosed or mitigated in the harvest documents.

b. Area of Concern 2

Area of Concern 2 is located in northern Plumas County, within boundary of the Lassen National Forest and adjacent to the Plumas National Forest boundary. Beck and Gould (1992) describe this area of concern as "A gap in known distribution [of the spotted owl], mainly on private lands, extends east-west in a band almost fully across the width of the owl's range."

Within this area of concern, owl sites bearing the following Gould database identification numbers were examined: PL001; PL053; PL306; PL 164; and TE096. These owl sites were affected by 57 timber harvest operations on private lands between 1990 and 1998, impacting a total of 899,185 acres, both within and near likely owl home ranges (Appendix A). The 30 of these timber harvest operations that were accompanied by detailed information as to location of impacts affected 85,414 acres within 2 miles of the five owl sites.

The primary harvest method was harvesting of dead, dying, or diseased trees under a THP exemption, which is not defined in the Forest Practice Rules, but appears to be most similar to the sanitation or salvage logging methods (FPR section 953.3(b)). Given that there are no provisions under the Rules to protect large trees, snags, high canopy closure or other components of owl habitat when conducting this type of harvest, it is certain that owl habitat was lost on many of the acres slated for harvest in the reviewed documents.

Of the 57 timber harvest operations within 2 miles of the five owl sites analyzed, 22 involved impacts that occurred within .5 miles of an owl site (Appendix A). Despite the proximity of logging operations to spotted owl sites, only 7 mention the California spotted owl in any manner. Of these 7 references to the owl, only 1 actually identifies the Gould database owl location; only 3 identify presence of occupied owl habitat, and none identify any anticipated impacts to the nearby owl or its habitat. None identifies the cumulative effects of the numerous timber sales occurring in and around each owl area. Further, of the 57 timber harvest documents, none identifies the presence of late successional forest or impacts to late successional forest. Given this failure to even identify spotted owl locations or habitat, it is clear that no specific actions were taken to protect or limit impacts to owl habitat. Instead, extensive logging appears to have occurred in close proximity to owl sites, in areas that have been identified by Beck and Gould (1992) as important to the owl's long term viability.

c. Area of Concern 3

Area of Concern 3 is located in the Tahoe National Forest, and is described by Beck and Gould (1992) as "an area of checkerboard lands; much dominated by granite outcrops and red fir forests; both features guarantee low owl densities."

Within this area of concern, owl sites bearing the following identification numbers were examined: PC045, SI042, SI043, NV005, and NV 010. No data were available from the CDF for owl sites NV005 and NV010. Thus, the following summary represents only timber harvest operations associated with owl sites PC045, SI042 and SI043.

These three owl sites were affected by 18 timber harvest operations on private lands between 1990 and 1998 (Appendix A). These timber harvest operations impacted a total of 23,229 acres, both within and near likely owl home ranges. Of these, we were able to determine that 13,411 acres were actually within 2 miles of the three owl sites, indicating a substantial amount of the acreage within two miles of these sites was impacted.

Similar to AOC 2, the primary harvest method was harvesting of dead, dying, or diseased trees, which is not defined in the Forest Practice Rules, but appears to be most similar to the sanitation or salvage logging methods (FPR section 953.3(b)). The rules fail to provide restrictions under this type of harvest for retention of large trees or snags, high canopy closure or other components of owl habitat.

Of the 18 timber harvest operations within two miles of the five owl sites analyzed, two involved impacts that occurred within .5 miles of an owl site. Despite the proximity of logging operations to spotted owl sites, none of the timber harvest documents identify owls within the planning area, although seven do mention California spotted owl sites on nearby or adjacent national forest land. None identifies the cumulative effects of the numerous timber sales occurring in and around each owl area. Further, of the 18 timber harvest documents, only one identifies late successional forest acres, and none identifies impacts to late successional forest. In one case, a timber harvest document identifies the affected stand as a "virgin stand," but does not identify a single acre of late successional forest. Given this failure to even identify spotted owl locations or habitat, it is clear that no specific actions were taken to protect or limit impacts to owl habitat and indeed none of the documents identified any action would be taken to minimize or remove effects on spotted owls or their habitat. Instead, extensive logging appears to have occurred in likely owl home range habitat, in an AOC that has been identified by the CASPO report as important to the owl's long term viability.

d. Area of Concern 4.

Area of Concern 4 is located in the northern part of the Eldorado National Forest. Beck and Gould (1992) describe this AOC as characterized by "[c]heckerboard lands and large, private inholdings; owl densities unknown on some private lands and very low on others."

Within this area of concern, owl sites bearing the following Gould database identification numbers were examined: ED014, ED045, ED198, PC037, and PC051.

There were 136 logging operations partially located within 2 miles of the five owl sites assessed in AOC 4 (Appendix A). The total number of acres affected by the harvest documents both within and outside the two mile area totaled 611,559 acres. Detailed information as to the location of impacts was only available for 85 of the plans, and these plans affected approximately 80,863 acres within two miles of owl sites, indicating that potentially a majority of the acres were effected and that definitely some acres were entered more than once.

Of the 136 timber harvest operations within two miles of the five owl sites analyzed, 53 involved impacts that occurred within one-half miles of an owl site. Despite the proximity of logging operations to spotted owl sites, only 27 of the timber harvest documents mention owls, mostly noting owls on adjacent national forest land. Only one of the documents identified an owl site within the planning area. None identifies the cumulative effects of the numerous timber sales occurring in and around each owl area. Further, of the 136 timber harvest documents, only two identify late successional forest acres, one identifies impacts to late successional forest, and none identifies mitigation measures to reduce impacts. Given this failure to even identify spotted owl locations or habitat, it is clear that few specific actions were taken to protect or limit impacts to owl habitat, nor were specific actions mentioned in any of the documents. As with the other AOCs, extensive logging occurred in owl home ranges, in an AOC that has been identified as important to the owl's long term viability.

e. Area of Concern 5

Area of Concern 5 is located in the northwest portion of the Stanislaus National Forest, and is described by Beck and Gould (1992) as having "large private inholdings; owl densities unknown on most private lands."

Within this area of concern, owl sites bearing the following identification numbers were examined: CA011, CA032, TL037, TL 152, and TL201.

There were 204 logging operations partially located within two miles of the five owl sites assessed in AOC 5 (Appendix A). The area affected by the THPs both within and outside the two mile area totaled 938,294 acres. Detailed information as to the location of impacts was only available for 124 of the harvest documents, and these plans affected approximately 119,733 acres within two miles of owl sites.

Of the 204 timber harvest operations within two miles of the five owl sites analyzed, 69 involved impacts that occurred within .5 miles of an owl site (Appendix A). Despite the proximity of logging operations to spotted owl sites, only 42 of the timber harvest documents mention owls, mostly noting owls on adjacent national forest land. Only 6 of the documents identified owl sites within the planning area, and only one document described a mitigation intended to reduce impacts to the located owl. None identifies the cumulative effects of the numerous timber sales occurring in and around each owl area. Further, of the 204 timber harvest documents, only six identify late successional forest acres, and none identifies impacts to late successional forest. Similarly, all except one document failed to propose or carry out any actions to protect or limit impacts to owls or their habitat, despite the fact that the documents propose extensive logging near known owl sites within an AOC.

D. Historical logging in Southern California

Though logging in southern California occurred over a shorter period of time and was less intensive than in the Sierra Nevada, it still has negatively affected spotted owls in southern California. Further, because forests in southern California occur on isolated and relatively small mountain islands and support exceedingly small populations of owls, even limited logging has potentially affected population viability. Logging began in southern California at the turn of the century in the western part of the San Bernardino Mountains and served the growing city of Los Angeles. Minnich et al. (1995) documented that several of 68 vegetation plots first measured in 1929 and then re-measured in 1992 were logged prior to the turn of the century. These plots were recorded as young-growth stands in the 1929 survey and were dominated by large numbers of small trees. These stands remain largely in the same state today. Minnich et al. (1995) state:

> "For logged mixed ponderosa pine forest, old photographs and diaries of lumberman indicate that old-growth stands logged in the western SBM consisted of large individuals (dbh = 2-3 m) of all species. When surveyed by VTM, they were dense stands of regenerating ponderosa pine mainly smaller than 33 cm, mixed with abundant white fir and incense cedar and scattered sugar pine, similar to modern mixed conifer forests… By 1992, density of trees on these logged sites had risen to 378 per ha, still dominated by a cohort smaller than 33 cm dbh."

Thus forests logged at the turn of the century have still not recovered, resulting in loss of habitat that persists today. Detailed records of logging in southern California date back to 1940—a year when four sawmills were active in San Diego and San Bernardino Counties and approximately 18 million board feet was harvested (May 1953). From 1940 till 1977, annual harvests ranged from .5-27 million board feet, mostly from Los Angeles and San Bernardino Counties, but also Riverside and San Diego Counties (May 1953, Waddell and Bassett 1997). In total, 362.3 million board feet have been removed from Los Angeles and San Bernardino Counties since 1947 with harvesting occurring on both public and private lands (McKelvey and Johnston 1992, Waddell and Bassett 1997). Speaking of southern California forests, McKelvey and Johnston (1992) conclude:

> "In the period after World War II, forest structures would have been significantly altered where timber was logged. Because logging would have been concentrated on sites with higher productivity, it undoubtedly impacted spotted owl habitat, though we cannot determine the extent of that impact."

After 1977, harvest has remained below two million board feet and has been zero or less than a million board feet in most years since 1981 (Waddell and Bassett 1997). In sum, logging has contributed to loss of habitat for highly sensitive populations of California spotted owls in southern California and may be part of the cause for sharp declines in the San Bernardino population (LaHaye et al. 1999).

E. Development across the range of the California spotted owl is resulting in substantial loss of habitat

Development on private lands in the Sierra Nevada and southern California presents a significant threat to the California spotted owl, particularly in low elevation riparian hardwood habitats, but elsewhere as well. In the Sierra Nevada, the human population doubled from 1970 to 1990 and is approximately four times peak populations of the gold rush (1849-1852) (Duane 1996a). Further, the population is predicted to triple from 1990 levels by 2040. Duane (1996a) found that though most of the population was concentrated in urban centers, low density, dispersed settlement affected a significant portion of the Sierra Nevada. He states:

> "Most of the new residents have settled near the historic centers of the gold rush, but modern patterns of human settlement have resulted in much more extensive land conversion. Three out of five Sierran residents lived on less than 300 mi^2 (less than 1%) in 1990, but human settlement was spread across nearly 1,741 mi^2 at an average density of at least one housing unit per 32 acres. This constituted 5.44% of the entire Sierra Nevada, or nearly 14% of all private lands (including industrial timberlands)."

Most of this development is occurring in the foothills east of major urban centers, such as Sacramento, and major thoroughfares, such as Highways 49 and 50 and Interstate 80. The highest housing densities, for example, are found in Nevada, Placer, Eldorado and Amador Counties, which are all roughly due east of Sacramento and near all three major highways mentioned above (Duane 1996a). Because of these highways and increasing numbers of long distance commuters, the foothills have experienced the most conversion for human settlement. In terms of the California spotted owl, this is significant both because owls nest in low elevation riparian hardwood forests and because Laymon (1988) found that a proportion of territorial owls migrate down to foothill areas during the winter. Though there is no data on the proportion of such areas that are being developed, clearly development is occurring and in fact Laymon (1988) observed owls roosting near new housing developments in riparian canyons.

The Forest Service and other Federal agencies also conduct projects to maintain infrastructure for a growing population. A number of general projects, such as powerline maintenance and road construction, that resulted in determinations of affect on individual spotted owls, as discussed above, are essentially development projects to support a growing population.

Though foothill woodlands have been the most severely altered, all forest types have been affected. McBride et al. (1996) measured forest conditions in both developed and undeveloped areas in various forest types, including red fir-lodgepole pine, mixed conifer, ponderosa pine and foothill woodland. They found that in all forest types human settlement reduced tree canopy cover and density, stating:

> "Construction of structures, roads, and other infrastructure elements in forests often necessitates the removal of trees and results in reduction of canopy cover and tree density. Trees may also be removed to facilitate access to sunlight, especially in more densely wooded areas. Conversion of tree cover to lawn also contributes to the decrease in tree canopy cover and density."

Canopy cover in mixed conifer was 92% in control areas compared to 64% in developed areas (McBride et al. 1996). Similarly, in ponderosa pine, canopy cover was 90% in control areas compared to 62% in developed areas. The more concentrated the development the greater the proportion of converted land. McBride et. al. (1996) found that in areas where lots were one acre, a greater proportion (41%) of the surface area was covered by impervious materials, such as structures and roads, than in either the three to five acre or 10 to 20 acre lot sizes. These larger lot sizes both had approximately 7.5% of the area covered by impervious material. Thus, as with logging development reduces the density and cover of forests, and when combined with the disturbance from noise, traffic and other human activities (see Wasser et al. 1997), is counter to maintaining owl habitat and territories.

F. Livestock grazing

Though the direct effects of livestock grazing on the California spotted owl have not been studied, grazing is likely to indirectly affect the owl by reducing or eliminating riparian vegetation utilized by the owl in portions of its range; by altering forest structure and fire regimes in both ponderosa pine and mixed conifer forest types; and by reducing the density of potential spotted owl prey items. Both the Sierra and Tahoe National Forests, for example, have determined that issuance of grazing permits "may affect individual California spotted owls, but will not likely lead to a trend towards Federal listing."

Numerous studies from across the west, including California, have shown that livestock grazing results in the complete loss or severe reduction of riparian forest vegetation (see Belsky et al. 1999, Smith 1989) and as a result livestock grazing is considered a prime factor in the approximately 90% reduction in these forests in the western United States (GAO 1988). As of 1992, riparian forests harbored 1.6% of all California spotted owl territories in the Sierra Nevada and 32% of all southern California territories (Verner et al. 1992). Because there are no historical estimates of numbers of territories in riparian forests, it is not possible to determine to what extent these figures represent a decline from past levels. Considering the extent of loss of riparian forests, however, it is quite likely that there has been historical loss of territories in this habitat type. Another likely impact of loss of riparian forests is increased isolation of metapopulations in southern California, as low elevation riparian forests probably once served as dispersal corridors between populations in the various mountain ranges (LaHaye pers. com.).

Livestock grazing has also been implicated in changes in forest structure and fire regime in ponderosa pine forests and mixed conifer forests in many parts of the west, including the Sierra Nevada (e.g. Madany and West 1983, Rummel 1951, Swetnam et al. 2000, Swetnam and Baison 1994, Touchan et al. 1993, Vankat 1977). Historically, the structure of ponderosa pine and mixed conifer forests in the Sierra Nevada and southern California was influenced by frequent, low intensity fires that removed understory vegetation and regeneration and favored fire tolerant species (Minnich et al. 1995, Weatherspoon et al. 1992). Following the introduction of large numbers of sheep in the 1860s and at least 30 years before the advent of fire suppression, frequent fires ceased to burn across most of the landscape (Kilgore and Taylor 1979, Swetnam et al. 2000), probably because of reduction of ground fuels, such as grass, and trailing. Cessation of fire in turn has resulted in copious tree regeneration, increased tree densities, elevated fuel loading and heightened danger of stand replacing fire, particularly in ponderosa pine forests (Weatherspoon et al. 1992). Increased risk of stand replacing fire is considered a threat to existing owl pairs across the range of the California spotted owl. The effects of current livestock grazing on fuel loads in the Sierra Nevada are currently unknown.

Lastly, livestock grazing has been documented to reduce densities of some species of small mammals in a number of different community types (Belsky et al. 1998, Hanley and Page 1982, Johnson 1982, Page et al. 1978, Schulz and Leininger 1991). Because studies have not been conducted on the effects of livestock grazing on prey species of the California spotted owl, the specific effects of livestock on such species within the owl's range are unknown. However, given results of other studies, which showed grazing related declines in some small mammals, it seems likely that livestock grazing may be indirectly effecting the owl by reducing prey abundance.

G. Recreation

Recreation potentially affects California spotted owls in several ways, depending on the type of activity. Light recreation, such as hiking on already established trails or birdwatching, probably has very little impact on the owl. Conversely, more intense forms of recreation, such as off-road vehicle (ORV) or snowmobile use, has the potential to seriously impact the owl through noise. And indeed the Forest Service concluded that an ORV motorcycle race on the Sierra National Forest was "likely to adversely affect the California spotted owl"—the only time such a determination was made. Wasser et al. (1997) documented that male northern spotted owls near logging roads experienced more physiologic stress, which can negatively affect reproduction, survival and resistance to disease, than owls further from roads based on levels of stress hormone in fecal samples. While this study primarily focused on logging roads, the effects from noise from ORVs should be relatively the same, namely reduced fitness of individual owls. This study also indicates that more traffic throughout the Sierra Nevada on the already existing and extensive road system for whatever purpose could potentially harm owls. The infrastructure necessary for recreation is also likely to pose a significant threat to the owl. Construction of roads and trails, resort development, ski resort expansions, and others all have the potential to reduce overall habitat and disturb individual owls.

The Forest Service concluded that a total of 60 recreation projects "may affect the California spotted owl" in the seven National Forests of the Sierra Nevada analyzed above, plus the four southern California National Forests. These projects included ski resort expansions, trail and road construction, ORV races, campground expansion and others.

Duane (1996b) estimated that there are currently 50 to 60 million "recreation visitor days" (RVDs) per year in the Sierra Nevada, of which two thirds occur on National Forest lands. These RVDs were concentrated in the southern and central Sierra, where the most effects on owls were also noted. Duane (1996b) states:

> "The Inyo, Sequoia and Sierra National Forests—each of which is adjacent to at least one of the national parks in the southern and central Sierra Nevada—account for 45% of all RVDs on the USFS lands in the Sierra Nevada. Together with the national parks, this portion of the Sierra Nevada probably represents one of the highest level of recreational activity in the entire world… The Lake Tahoe Basin represents a similar focal point for recreation in the Sierra Nevada, with much of the recreational activity on the Tahoe National Forest, the Eldorado National Forest and the Toiyabe National Forest occurring in association with activities in the Lake Tahoe Basin Management Unit."

Considering that the population of California is expected to double or even triple by 2040 (Duane 1996a), recreational activities are likely to also grow, resulting in further loss of habitat and disturbance to the owl. Duane (1996b) noted that just because population doubles or triples does not necessarily mean there will be twice as many RVDs, but also concluded:

> "Even without a proportionate doubling of demand, however, conflicts are likely to increase between recreational activities and other uses of public lands and resources."

VI. Other natural or manmade factors affecting the continued existence of the California spotted owl

A. Weather

Weather has been identified as one probable cause of declining owl populations by several researchers, who speculated that poor weather can depress fecundity (Steger et al. 1999, Gutiérrez et al. 1999, Verner 1999). And indeed Franklin et al. (In press), in an extensive demographic study of the northern spotted owl in northern California, demonstrated a negative relationship between reproductive output and precipitation during the late nesting period. As stated elsewhere, however, it is unlikely that climate is the sole or primary cause of decline because adult survival, and not fecundity, primarily determines the finite rate of population change (λ). Though adult survival is to a certain extent also affected by weather, Franklin et al. (In press) found that habitat quality was the primary determinant of survival and that high quality habitat buffers the effects of climate on this demographic parameter. They conclude:

> "Habitat quality, as defined by fitness, appeared to buffer variation in annual survival but did not buffer reproductive output. We postulated that the magnitude of λ was determined by habitat quality whereas variation of λ was influenced by recruitment and reproductive output. As habitat quality declines, variation in λ should become more pronounced." (Franklin et al. in press).

This suggests that habitat quality, and not climate, through its effect on annual survival primarily determines whether a population is declining, stable or increasing (see above comparison between Sequoia/Kings Canyon National Parks and Sierra National Forest for additional support for this conclusion).

This is not to say that climate is not important, however. To the contrary, by contributing to variation in λ, weather potentially increases risk of extinction. Franklin et al. (In press) conclude:

> "In other words, as habitat quality decreases, density independent factors become more important in determining variation around λ… Theoretically, an increase in variation around [the mean of] λ, with a greater proportion of this variation caused by climate, will increase the probability of extinction."

In addition, risk of extinction is furthered if variation in demographic parameters and ultimately λ is correlated among different portions of a contiguous population (Schaffer 1987). Preliminary analysis indicates that reproductive success is correlated across the Sierra Nevada with good or bad reproductive years synchronized among populations in the south, central, and possibly northern Sierra (Peery 1999), likely related to fluctuation in regional weather patterns. This suggests that weather further increases risk of extinction for the owl.

Yet another way climate may increase extinction risk is through catastrophic disturbance (Franklin et al. (In press), Shaffer 1987,Goodman 1987). Catastrophic events, such as severe storms, have been found to lower survival and reproductive output (Franklin et al. In press, Steger et al. 1999). For example, Franklin et al. (In press) found that:

> "Both survival and reproductive output appear to have longer periods of relative stability punctuated by shorter periods exhibiting severe declines in both survival and reproduction, which represent catastrophic events for each of these parameters."

Additionally, Steger et al. (1999) observed lower fledgling success on the Sierra National Forest than the Sequoia/Kings Canyon National Park in 1999 and speculated this was caused by a single storm that was measured to be more severe on the former than the latter. If the owl population continues to decline, it will become increasingly likely that such dips in survival and reproduction from catastrophic events will result in extinction (Lande 1993).

Lastly, Franklin et al. (In press) determined that because of the effects of climate on owl demographic parameters, population declines may occur even if habitat loss ceases. They state:

> "If certain long-term climate trends can cause negative rates of population change, as suggested in this study, then climatic variation has the potential to negatively affect northern spotted owl populations, even if no further habitat loss occurs."

Combined with the fact that high quality habitat, including large blocks of core old-growth habitat, were found to buffer the effects of climate on survival (Franklin et al. In press) and that owls are severely declining in the Sierra Nevada, the above conclusion suggests that not only is no further loss of habitat merited, but significant habitat recovery is required. Indeed, Franklin et al. (In press) conclude:

> "This also suggested that habitat maintenance is essential when considered on landscape scales because excessive loss of key landscape habitat components, such as mature and old-growth forest, can exacerbate the effects of unfavorable climatic conditions on survival."

B. Fire

It is widely recognized that historic forest structures in many western forest types were heavily influenced by frequent fires, including ponderosa pine and mixed conifer forests in the Sierra Nevada, and that loss of fire from these systems because of livestock grazing, fire suppression and other factors has resulted in changes in forest structure (Covington and Moore 1994, Kilgore and Taylor 1979, Swetnam and Baison 1994, Touchan et al. 1993, Weatherspoon et al. 1992). It is also well recognized that increased fuel loadings, related to these changes, have increased the likelihood of large crown fires in these forest types (Verner et al. 1992). Such fires pose some risk to existing owl territories.

While it is clear that there is a risk that owl territories will be destroyed by crown fire in the future, it is important to recognize that much of the owl population occurs in portions of the landscape that are not the highest risk and that not all fires destroy owl habitat. Weatherspoon et al. (1992) state:

> "Countryman's (1955) description of fuel conditions within old-growth stands applies in large measure to fuel conditions within many mixed conifer stands used by the California spotted owl. These stands are less flammable under most conditions, because the dense canopies maintain higher relative humidities within the stands and reduce heating and drying of surface fuels by solar radiation and wind."

Fire frequencies in mixed conifer forests of the Sierra Nevada historically ranged from 5-80 years (Swetnam et al. 2000). Many of the existing owl sites and much owl habitat occurs in areas where fire frequencies are at the higher end of this range, including canyon bottoms and north slopes (Gould 1977, Weatherspoon et al. 1992). Further, not all fires in owl habitat will result in territory abandonment even when they are quite large. Stacey and Hodgson (unpub.), for example, found that when a large uncontrollable fire (9700 hectares) swept through their owl study area in the San Mateo Mountains of New Mexico it had little impact on territory occupancy. They conclude:

> "We found that the fire appeared to have little direct impact on the owls. All of the birds that were present before the fire remained within the same territories after the fire.

> Although there were some changes in territorial occupancy the following year, they were no greater than those that occurred in areas not affected by the fire. Burning occurred in a highly patchy manner, and considerable undamaged roosting and foraging habitat remained in all territories. These results indicate that wildfire may be less of a threat to spotted owls in the southwest than is currently supposed."

Similarly, owls were observed to remain in unburned patches of the Cleveland Burn on the Eldorado National Forest (Thomas pers. comm.). Thus, the likely risk to owls from fire is presently undetermined and probably overstated, particularly considering that risk of severe fire may be remaining constant over time. Though recent individual fires in the Sierra Nevada have been hotter, larger and more severe than probably occurred historically, it is important to note that area burned has not increased appreciably over the last 80 years (McKelvey and Busse 1996). This differs from the Southwest where severe fuel accumulations have resulted in less controllable fires and substantial increases in area burned, particularly in the last couple of decades (Swetnam, pers. comm.). This indicates that there is time to take a cautious approach to fuels treatments in the Sierra Nevada.

C. Competition

Within the last 30 years, the barred owl (*Strix varia*) has expanded its range south from Canada, through Oregon and Washington, into California as far south as the Tahoe National Forest (Dark et al. 1998, Gutiérrez et al. 1992, Taylor and Forsman 1976). Barred owls are larger and more aggressive than spotted owls and have been documented to displace them from territories (Dark et al. 1998). Barred owls have also hybridized with spotted owls in a number of cases. Hybridization can lead to loss of fitness due to outbreeding depression and loss of local adaptations (Templeton 1986). Currently, it is unknown to what extent hybridization will occur and what effect it will have on populations of spotted owls. Dark et al. (1998) conclude:

> "Because of the potential for hybridization, competition for food and habitat, and predation, it appears that the barred owl could influence spotted owl populations negatively."

Because barred owls are habitat generalists and do well in logged areas, logging may be part of the cause of their spread (Dark et al. 1998, Dunbar et al. 1991).

VII. Disease and Predation

Known predators of spotted owls include the great horned owl, northern goshawk, red-tailed hawk and barred owl (Forsman et al. 1984, Leskiw and Gutiérrez 1998, and see Gutiérrez et al. 1992). Of these, the great horned owl is likely the most common. Because great horned owls tend to forage in forest openings (Johnson 1992), reducing canopy cover or creating breaks in the forest canopy by logging may expose owls to a heightened risk of predation (Peery 1999). Avian predation resulted in 40% of observed mortalities of northern spotted owls (Bart et al. 1992), indicating predation potentially affects population stability by lowering survival.

Gutiérrez et al. (1992) report that little is known about diseases or parasites in spotted owls or their effects on survival, but also noted that researchers had observed mortality likely caused by disease. Common parasites include round, flat and spiny-headed worms and hippoboscid flies (see Gutiérrez et al. 1995). Gutiérrez (1989) found a 100% infection rate for blood parasites in all three subspecies, but the effect of this high infection rate was unclear. More study is required to determine if diseases and parasites are affecting populations of spotted owls.

VIII. The inadequacy of existing regulatory mechanisms to protect the California spotted owl

Several facets of the California spotted owl's biology are important to consider when determining the adequacy of existing regulations. First, because the owl compensates for low and highly variable fecundity with a long life, survival of adult owls has the greatest impact on population trajectory (Noon and Biles 1990) and effective regulations must ensure adult survival is not compromised. A number of studies indicate that this can be accomplished through maintenance of large blocks of suitable habitat (Franklin et al. In press, Noon and Blakesley 1999). Noon and Blakesley (1999), for example, observed that:

> "In a mathematical context, the finite rate of population change (λ) is most affected by the mean and variance of the survival rate of owls ≥ 1 year old (Noon and Biles 1990)… To the extent that survival rates are affected by habitat loss and fragmentation, changes in management practices may lead to increases in survival" (Noon and Blakesley 1999).

Second, because dispersal by juveniles and adults in search of mates and territories entails a great deal of risk, increasing nearest neighbor distance between owl territories through habitat loss and fragmentation will contribute to increased mortality and population decline. Noon and Blakesley (1999) state:

> "Future management activities, for example, should not increase the mean nearest-neighbor distance among suitable owl pair sites. Management activities which reduce population density by lowering habitat quality or increasing fragmentation will increase the uncertainties associated with successful dispersal and mate finding."

Thus, any management actions targeted towards protecting owl habitat and owl population viability should be considered in the context of their ability to provide both quality habitat within individual home ranges and contiguous habitat across the landscape. As demonstrated below, current regulations on both Forest Service and private lands fail on both counts.

A. The Forest Service's Interim Guidelines

Though the Forest Service is in the process of developing a Draft Environmental Impact Statement revising National Forest Plans in the range of the California spotted owl, existing regulations remain the Interim Guidelines. Thus the following sections analyze the efficacy of these Guidelines towards preserving and increasing owl viability in the Sierra Nevada. If new Guidelines are proposed or adopted while this petition is in deliberation, it is our intention to amend this document with a new analysis of those Guidelines.

The Interim Guidelines provide three elements of protection for the owl: previously established "spotted owl habitat areas" (SOHA), "protected activity centers" (PAC), and matrix lands protection. The SOHAs protect 1,000 acres of habitat within 1.5 miles of the "activity center" of select owl pairs. If only one pair is protected two other SOHAs must be within six miles. If two or three pairs are protected, SOHAs can be up to 12 miles apart. In addition to the SOHAs, the

Interim Guidelines established 300-acre PACs around all known nesting and roosting sites as of 1992, incorporating the best available habitat. Those pairs located since establishment of the Guidelines are not afforded the protection of either reserve. In matrix lands, two tiers of guidelines apply. In "select strata," which are stands preferentially selected by the owl for nesting, roosting or foraging, one entry for timber removal is allowed, but cutting is limited to trees <30" diameter and must retain ≥40% canopy closure, up to eight snags per acre ≥ 30" diameter or a snag basal area of 20 sq. ft./acre, 10-15 tons per acre of the largest downed logs and 40% of the basal area in the largest live and cull trees. In "other strata," which also contains some stands used by the owl for nesting, roosting or foraging, the same guidelines apply, except canopy closure can be reduced below 40% and only 30% of the basal area must be retained in the largest trees. Finally, the Guidelines eliminated requirements that the Forest Service survey for owls after 1993. This system was intended to preserve management options for the owl for an interim period, while still allowing logging of Sierran forests. Verner et al. (1992) state:

> "Management of the forests during this interim period should not foreclose options for whatever long-term management scenario may be adopted for the owl at the end of the interim period. The desired objective, of-course, would be to determine how to maintain spotted owls throughout Sierran conifer forests in a manner compatible with some sustainable level of timber production."

Contrary to their stated purpose, the Guidelines adopt an outmoded system of reserves, fail to protect key habitat values required by the owl, and have allowed substantial effects to California spotted owls and their habitat, potentially contributing to observed population declines.

1. SOHA reserves are widely recognized to be inadequate to preserve the viability of the owl.

SOHA reserves have been soundly rejected by the scientific community because they fail to protect sufficient numbers of pairs in large, contiguous habitat blocks (Anderson and Mahato 1995, Thomas et al. 1990). Because SOHAs only protect one to three pairs in isolated habitat blocks, many will fail to support owls over time because as territories are vacated there is a low probability they will be recolonized. The "Interagency Scientific Committee" that developed a conservation strategy for the northern spotted owl, Thomas et al. (1990), state:

> "Our strategy largely abandons the current and, we believe, flawed system of one to three paired spotted owl habitat areas (SOHAs), in favor of protecting larger blocks of habitat—which we term Habitat Conservation Areas, or HCAs"… "Large blocks of habitat capable of supporting multiple pairs of owls, and spaced closely enough to facilitate dispersal between blocks, are far more likely to ensure a viable population than the current SOHA system."

The Technical Team for the California spotted owl acknowledges the flaws of a SOHA strategy, stating:

> "We agree that a SOHA strategy, culminating in a network of small, relatively isolated 'islands' of older forest suitable for breeding by spotted owls and separated by a "sea" of younger, less suitable or unsuitable habitat, is not a workable strategy to assure long-term maintenance of spotted owls" (Verner et al. 1992).

Yet the Technical Team recommended maintaining the existing system of small SOHAs, arguing that its design is adequate to protect the owl because nesting pairs in the SOHAs will not be isolated by “less suitable or unsuitable habitat” and continued logging will allow fuels treatment that will protect the owl from stand-destroying fire. The Technical Team states:

> “The advantages of such a strategy are many. No decisions must be made about the number of owl pairs needed in blocks of habitat or how far apart to space blocks, because most of the Sierran conifer forests would be suitable for foraging by owls, and nesting and roosting habitat would be widely available… And much of the fuels management problem could be approached physically as part of the strategy to maintain suitable owl habitat by removing the dense surface and ladder fuels that now facilitate stand-destroying fires”

As demonstrated below, however, the Interim Guidelines fail to adequately protect habitat in the matrix between the SOHAs as promised, and logging under the Guidelines has done little to reduce risk of catastrophic fire.

2. PACs provide even less habitat protection than SOHAs.

A major criticism of SOHAs is that they protect too small a proportion of the owl population, too widely dispersed across the landscape. Partially in response to this criticism, the Interim Guidelines established 300 acre PACs around all known nesting and roosting sites. Three hundred acres was chosen because evidence indicated that the mean activity center, defined as an area where owls nest or roost and do a substantial amount of foraging, was found to be 300 acres (Gutiérrez et al. 1992). This area, however, is clearly not sufficient to sustain owl pairs. Home ranges, which encompass the entire area used by an owl for nesting, roosting and foraging, are considerably larger. As noted above, mean combined breeding and non-breeding season home ranges varied from 4,000 to 13,000 acres (Call 1990, Laymon 1988, Zabel et al. 1992). Thus, the actual area used by owls to survive is more than an order of magnitude larger than the PACs. If habitat within home ranges surrounding PACs is insufficient to sustain a pair or it becomes so because of logging then the territory and PAC will probably fail. Failure of PACs to sustain owl pairs results in increased nearest-neighbor distances, ultimately undermining the viability of the owl population. Thus, the crux of the Guidelines’ strategy rests on protection of habitat in matrix lands.

3. The Interim Guidelines allow the continued degradation of key California spotted owl habitat attributes.

The Interim Guidelines fail to protect key attributes of owl habitat identified in numerous studies, including large trees, high canopy closure, traits of advanced stand age, such as snags and broken tops, at least a two layered canopy and potentially large blocks of contiguous habitat (e.g. Bias and Gutiérrez 1992, Franklin et al. In press, Moen and Gutiérrez 1997, LaHaye et al. 1997, Verner et al. 1992). In each case, the Guidelines fall short of providing full protection for the habitat attributes identified in studies as important to the owl. For example, all studies on the owl indicate selection for stands with trees ≥ 20-24” dbh, yet the guidelines only require complete protection of all trees >30” dbh. Similarly, evidence indicates the owl selects stands with ≥70% canopy closure when nesting and roosting and foraging, yet the guidelines allow cutting suitable owl habitat down to ≥ 40% canopy closure. The following sections detail inadequacies in protection for key owl habitat attributes.

Large trees. Despite overwhelming evidence that California spotted owls select stands with trees >20-24" dbh (Bias and Gutiérrez 1992, Call 1990, Laymon 1988, LaHaye et al. 1997, Moen and Gutiérrez 1997), the Interim Guidelines only protect all trees >30" dbh and a portion of trees 20-30" dbh. Allowing cutting of trees 20-30" dbh is damaging to both the owl and Sierran forests. These trees provide critical habitat components required by the owl by contributing to overstory canopy closure and providing a diversity of perching heights for roosting and foraging. Hence, logging trees >20" dbh is counter to maintaining quality owl habitat across the landscape. Noon and Blakesley (1999) state:

> "Given evidence of decline of the owl population in the Lassen National Forest, efforts to accelerate restoration and to increase retention of the large tree components (old trees, snags and downed logs) in harvest units should be made."

Logging trees 20-30" dbh is also counter to one of the primary goals of the Interim Guidelines—reducing stand density and excessive surface and ladder fuels (Verner et al. 1992). This is because such trees are not the cause of increased stand densities in the Sierra Nevada (USDI 1998), contribute little to surface fuels and don't act as fuel ladders (Van Wagdentonk 1996). To the contrary, trees 20-30" dbh in the Sierra Nevada are at comparable levels or lower than they were a century ago. USDI (1998) concluded that between 1952 and 1992 trees >20" dbh decreased 26% by volume in California based on Forest Service data contained in Powell et al. (1993) and other sources (Woodbridge pers. com.). Instead, stand density increases are caused primarily by trees smaller than 12" dbh Powell et al. 1993, Parsons and DeBenedetti 1979).

Further, 20-30" dbh trees do not typically act as fuel ladders under most fire intensities. Bahro (1995) found that 20" dbh Douglas-fir, white fir, and ponderosa pine all exhibit low mortality under low to moderate intensity fire regimes. This is because once these species attain a certain size (generally >15" dbh), they have fire resistant bark and high crowns, characteristics that also make them poor crown fire initiators (Agee 1993, Fischer and Clayton 1983, Flint 1925, Wyant et al. 1986). Agee (1996) defines a "fire safe forest" as one with surface fuels that limit fireline intensity, stands comprised of fire-tolerant trees, and low probability that crown fires will initiate or spread through the forest. Because trees 20-30" dbh of the most common species in the Sierra Nevada are fire resistant, poor initiators of crown fires and not overly dense, they are a key component of a fire safe forest and there is no justification for cutting them based on the need to reduce danger of stand replacing fire.

Lastly, given the dramatic declines of trees >30" dbh used by owls for nesting and roosting and that these trees can take two to several centuries to grow, it is crucial that there is a continual source of replacement for large, old trees. This source is in question because trees 20-30" dbh have greater economic value and are likely to be the primary target of ongoing and future logging. For example, 61.5% of trees marked for cutting in 10 timber sales on the Sierra National Forest were >20" dbh (many of these were >30" and cut under the hazard tree exemption mentioned previously). Thus, the Interim Guidelines by allowing cutting of trees 20-30" dbh allows the further loss and degradation of owl habitat, reducing future options for maintaining owl habitat, while at the same time accomplishing little towards reducing fire danger.

High canopy closure. As documented above, the California spotted owl selects stands for nesting, roosting and potentially foraging with ≥ 70% canopy closure. Yet the Interim Guidelines allow reduction of canopy closure to 40% in select strata. This has allowed the continued loss, degradation and fragmentation of scarce nesting, roosting and foraging habitat. In other strata, the guidelines allow reductions to 30%, precluding development of more owl habitat in the short term and further fragmenting existing habitat. Among other things, this is likely to increase nearest neighbor distances and possibly expose the owl to greater risk of predation from the great horned owl (Johnson 1992).

Dense multi-layered stands. The spotted owl has been shown to select stands with dense, multi-layered canopies, comprised of medium and large trees (11-20" and >20") (Bias and Gutiérrez 1992, Laymon 1988, LaHaye et al. 1997, Moen and Gutiérrez 1997). Because the Interim Guidelines allow cutting of these trees, they will have the effect of simplifying stand structure and further degrading and fragmenting owl habitat. Eliminating multi-layered canopies from stands will afford the owl less perches for foraging and roosting, perhaps reducing prey availability and making it more difficult for owls to select an optimal thermal regime within stand micro-climate by adjusting their height within the canopy (Barrows 1981, Ting 1997).

Large snags and downed wood. The Interim Guidelines only require retention of up to eight snags per acre or 20 sq. ft. basal area of snags/acre (roughly two 42" dbh snags) and 10-15 tons/acre of the largest downed logs. This level of protection is inadequate for several reasons. First, in areas where large or small pockets of trees have been killed, the Forest Service can essentially clearcut all the snags in excess of 20 sq. ft. basal area, including those well above 30" dbh. This is significant because snags and woody debris historically occurred in small to large patches due to common types of natural disturbance. Examples of such disturbances include congregating bark beetles and hot pockets in otherwise low intensity fires. Second, snags and downed wood are used by prey of the spotted owl for feeding and denning and large snags are used for nesting by owls (Gutiérrez et al. 1992). Third, large snags and logs are at much reduced levels because of systematic efforts to eradicate them over the last 60+ years (Franklin and Fites-Kaufman 1996). Lastly, large snags and logs are harder to replace than large trees because a tree first has to grow large and then die and decay. Despite these facts, the Guidelines fall far short of protecting all large snags and the Forest Service has continued to propose and log salvage timber sales and remove hazard trees, further reducing the quantity of large snags and downed wood to the detriment of the owl.

4. Inadequacies in overall protection of California spotted owl habitat.

The Interim Guidelines fail to fully protect four critical aspects of California spotted owl habitat, including large trees (20-30"), snags and large woody debris, high canopy closure and multiple canopy layers, resulting in continued degradation and fragmentation of owl habitat. Lack of stronger protection is based on a premature and potentially flawed assumption that owl habitat and logging can co-occur as long as certain elements of stands are preserved (i.e. trees >30" dbh, >40% canopy closure) (Verner et al. 1992). To date, definitive studies have not been conducted to determine the amount of logging, if any, that can occur in owl habitat without lowering owl survival and thus there is no basis for assuming they can co-occur. Referring to the northern spotted owl, Thomas et al. (1990) conclude:

> "Silvicultural prescriptions might be developed that would yield significant volumes of wood products while maintaining suitable habitat for spotted owls, but we find no clear evidence that such prescriptions currently exist. Until they do, the prudent approach to ensuring the viability of the owl is to protect an adequate distribution and amount of existing habitat."

Based on the fact that the owl is probably declining because of past and present logging and, like the northern spotted owl is dependent on forests with old-growth characteristics, the above conclusion also follows for the California spotted owl. Similarly, the ROD for the Quincy Library Group Forest Recovery Act (QLGFRA) concluded that because owls are declining the prudent course is to maintain suitable habitat, stating:

> "Since the implementation of the interim direction guidelines, several demographic studies have been conducted that show declining California spotted owl populations in the Sierra Nevada, and biologists have concluded that maintaining suitable habitat may be necessary to prevent further population decline."

Beyond even habitat maintenance, the California spotted owl may require significant habitat recovery in contiguous portions of the landscape to attain long-term viability. Instead, the Interim Guidelines have allowed and continue to allow further loss and fragmentation of habitat.

5. The Interim Guidelines fail to prohibit cumulative effects, allowing substantial habitat fragmentation.

The Interim Guidelines allow substantial cumulative effects to individual owls and owl habitat, resulting in further habitat fragmentation. This is in part because there are no regulations governing the proportion of the landscape that can be logged within an owl home range or on the landscape as a whole. This lack of regulation has led to substantial effects to owls on the seven National Forests examined above and has exacerbated existing habitat fragmentation that occurred naturally and from a century of logging. Because habitat fragmentation increases nearest neighbor distances between spotted owls, it increases likelihood of mortality during dispersal, eventually resulting in a lower probability that territories will be recolonized when vacated and greater population instability. Therefore, increasing habitat fragmentation through a lack of regulation on cumulative effects is counter to preserving the population viability of the owl. In a statement that reaffirms all of the above conclusions, Noon and Blakesley (1999) state:

> "Harvest guidelines address factors of owl habitat at the local scale. However, rates of population change are affected by processes operative at both local and landscape scales. Therefore, it is important that harvest activities be evaluated collectively in order to assess their cumulative effects on habitat quality. Future management activities, for example, should not increase the mean nearest-neighbor distance among suitable owl pair sites. Management activities which reduce population density by lowering habitat quality or increasing habitat fragmentation will increase the uncertainties associated with successful dispersal and mate finding."

Because the Interim Guidelines fail to regulate the area of habitat that can be entered for harvest, they are inadequate to protect the owl or its habitat from continued habitat fragmentation, necessitating the owl's listing under the ESA.

6. The Interim Guidelines fail to protect eastside forests utilized by the owl.

The Interim Guidelines and more recently the Herger-Feinstein Quincy Library Group Forest Recovery Act (QLG) both fail to provide significant protection for owl habitat in the eastern Sierra Nevada. Though only small numbers of owls currently occur in eastside forests, it is unknown to what extent they occupied these habitats historically because eastside forests are some of the most heavily logged in the Sierra Nevada (Franklin and Fites-Kaufman 1996). It is quite possible that if these forests were allowed to recover, owl populations may increase in the eastern Sierra Nevada. Instead, the Forest Service decided to allow further degradation of eastside forests by only applying the Guidelines in part. A June 23, 1995 memo from Jim Lawrence at the Pacific Southwest Regional Office directs forests with significant eastside habitats to only follow the Guidelines within 1.5 miles of established PACs. These lax regulations resulted in substantial harvest of eastside forests. For example, since 1993 the Plumas National Forest planned to remove roughly 32 mmbf from 14,430 acres in the eastern Sierra Nevada, compared to 23 mmbf from 19,035 acres in the western Sierra Nevada. Because more volume was planned for removal from a smaller amount of acreage, these figures indicate logging practices are more intensive east of the crest, likely including harvest of large trees. Further, logging is likely to increase in eastside forests because the final decision for the QLG prohibited logging in western Sierra Nevada owl habitat with no concurrent reduction in the amount of acreage scheduled for treatment. Thus, more acres by necessity will be treated east of the crest. This is of concern because the QLG prescribes treatments that are highly destructive to owl habitat, such as group selection and DFPZs. Given the long history of destructive logging practices in eastside forests, the small numbers of owls in these habitats and that other animal species dependent on old-growth eastside pine forests, such as the northern goshawk, are in decline, lack of regulation of logging in eastside habitats is counter to the Forest Service's mandate to maintain species viability within planning areas (the Sierra Nevada) (NFMA at §219.19) and is likely to lead to Federal listing of not just the owl, but likely other species, such as the goshawk.

7. Logging under the Interim Guidelines potentially poses a greater risk to owl viability than crown fire and is an ineffective strategy for reducing risk of crown fire in owl habitat

As noted above, it is unknown what risk crown fire poses to owl population viability. It is, however, known that logging has reduced, and will continue to reduce, owl habitat and territories, and is one of the primary reasons owl viability is in question (Verner et al. 1992). Logging under the Interim Guidelines, for example, has resulted in effects to PACs in 971 instances, SOHAs in 185 instances and owl territories in 183 instances on the seven National Forests in the Sierra Nevada with the majority of the owl population. Thus, we are comparing risk from a known effect (logging) with risk from a possible effect (fire).

Assuming, however, that we knew crown fire would cause the California spotted owl to go extinct within the next 50-100 years, do the Interim Guidelines present a strategy that will substantially reduce the likelihood of this occurring? The Interim Guidelines provide few prescriptions to reduce risk of crown fire on the landscape. Indeed, the Decision Notice enacting the Interim Guidelines states:

> "None of the three alternatives [includes alternative to adopt Interim Guidelines] fully succeeds in reducing the risk of making California spotted owl habitat unsuitable through wildfire. All three alternatives establish minimum levels of dead and down fuel loadings.

> None of the three alternatives establish upper limits to fuel loadings which would reduce surface fire intensity, and hence the risk to California spotted owls… In practice, fuel loadings after harvests can be much higher than the minimums because no standards or Guidelines have been established to keep fuels below some maximum level linked to wildfire risk or fire behavior."

In sum, the Guidelines fail to substantially reduce risk of crown fire to the owl because they do not require treatments that reduce surface fuels. Instead, the Guidelines rely on thinning trees up to 30" dbh to reduce fire danger. Thinning in and of itself, however, is ineffective at reducing fire severity because fire-line intensity is determined by small diameter ground fuels, rather than large diameter trees (Van Wagtendonk 1996). Van Wagtendonk (1996), for example, modeled fire behavior and severity under different management prescriptions and found that thinning either did not reduce or increased fire severity. He concludes:

> "Scenarios that did not treat surface fuels, such as biomassing only the overstory or piling and burning, did not appreciably change fire behavior. Adding the additional fuels resulting from cutting, lopping and scattering understory trees and branches exacerbated fire behavior." (SNEP V II, page 1164)

Because the Interim Guidelines do not specifically require prescribed burning, which is the most effective method of treating surface fuels (Scott 1998), in conjunction with logging or independently, it often does not occur. For example, we randomly chose 19 environmental assessments for timber sales from the seven primary owl Forests in the Sierra Nevada to determine if they conducted prescribed burns within sale units. Of these, 13 units planned to do some burning, but only four burned all acres planned for cutting. In the other sales or units where there was no burning, surface fuels likely remain at or above levels prior to cutting, indicating that cutting did not meet the target of reducing fire danger. Similarly, our review of hundreds of timber sale documents described above indicated that prescribed burning does not as a rule occur in all timber sale units or timber sales. Additionally, many timber sales primarily target larger trees (20-30" dbh or greater), even though smaller trees present the greatest fire danger and are the primary cause of increased stand densities. This is because small trees are often considered not merchantable timber. Thus, thinning as practiced under the Guidelines has accomplished little towards reducing landscape fire danger because it has often focused on larger trees and has not been coupled with a widespread program of prescribed burning.

A strategy relying on prescribed burning is the most likely to reduce crown fire danger to the owl with the least amount of risk (Van Wagtendonk 1996, Weatherspoon et al. 1992). This is because prescribed burning is the most effective way to reduce surface fuel loads (Van Wagtendonk 1996). A strategy of prescribed burning to reduce risk to the owl was described by Weatherspoon et al. (1992) in the Technical Assessment that proposed the Interim Guidelines. The Interim Guidelines, however, failed to include any of the recommendations from this strategy. Significantly, the Guidelines fail to adopt recommendations from Weatherspoon et al. (1992) to perform prescribed burns in and around known nesting and roosting sites to reduce fire danger to the existing population. While they do allow prescribed burning in PACs, the Guidelines don't require or propose any plan for doing so and as a result the Forest Service has completed few burns in or around PACs in the last six years. For example, Biological Evaluations for prescribed burns from the Lassen, Eldorado and Sierra National Forests only identified 43 out of 437 PACs as occurring in or near burns over the last six years, indicating insufficient effort is being made to reduce fire risk at known owl nest and roost sites.

B. Private Lands

1. Regulation of logging on private land is inadequate to protect the owl or its habitat

Because private lands compose a significant portion of the California spotted owl's range, the management of private lands is critical to the availability of habitat for the California spotted owl. Approximately 2.4 million acres, or roughly 40%, of potential spotted owl habitat occurs on land in private ownership in the Sierra Nevada (Verner et al. 1992). Of this amount, 1.45 million acres is owned by industrial private timber companies. Unfortunately, protection of habitat for the California spotted owl on these lands is nearly nonexistent.

In several locations, management of private lands has been found critical to maintaining continuity of the spotted owl population. For example, Beck and Gould (1992) identified four Areas of Concern for the long term viability of the California spotted owl based on significant private land holdings. Thus, though few owls have been found as yet on private lands, private lands have an important role to play in maintaining the long-term viability of the California spotted owl.

In spite of the important role that private lands play in providing habitat for California spotted owl, the primary body of regulation affecting management of this species on private lands, the California Forest Practices Rules, allows significant alteration of spotted owl habitat and does not provide protection to critical features of spotted owl habitat, such as large trees, snags and downed wood, high canopy closure, and multi-layered canopies. This has resulted and continues to result in degradation and destruction of late successional habitat utilized by the California spotted owl. Beardsley et al. (1999), for example, conclude:

> "Any increase in old-growth area in the Sierra Nevada ecosystem, would have to come mostly from the unreserved areas of the national forests, because these forests contain most of the forests having a mean diameter greater than 21 inches (59,000 acres of that was already old growth). Most of the area in private ownership is expected to be managed for non-old-growth values."

Lack of forests with late successional characteristics on private lands is not surprising given that the applicable rules require maximizing timber production utilizing intensive logging methods, and fail to provide any effective protection for spotted owl habitat.

The following section first discusses the lack of protection local regulation provides for habitat of the California spotted owl. Second, the section addresses the intensive logging practices emphasized and encouraged by the California Forest Practice Rules (hereinafter referred to as "the Rules"), and the potential these practices have to degrade and destroy critical attributes of California spotted owl habitat. Finally, we address the failure of the Rules to provide any meaningful protection for spotted owls or their habitat, or any measures that would result in limiting or even mitigating impacts to California spotted owls or their habitat. Throughout this section we use information gathered from our review of planning documents from 416 timber harvests located within 2 miles of selected owl sites as a means to illustrate specific points. A full description of this analysis is presented elsewhere in this document.

In sum, the Rules offer almost no protection to the key characteristics of spotted owl habitat, and encourage logging practices that result in degradation and destruction of spotted owl habitat. As demonstrated by the lack of late successional forest on private lands (Beardsley et al. 1999), these practices are likely to deplete private lands of habitat needed to maintain the viability of the California spotted owl, particularly in the "Areas of Concern" where private lands predominate. Regardless of the regulation governing public lands across the owl's range, the degradation and destruction of private land habitat may result in extirpation of the California spotted owl from large portions of its range.

State Regulation Fails to Provide Adequate Protection of California Spotted Owl Habitat. Regulation governing private timberland encourages the maximization of timber production using intensive logging methods, and lacks any substantial protection for the California spotted owl and its habitat. The Rules (14 CCR Ch. 4 and 4.5) form the primary body of regulation that impact private industrial forest land within the range of the California spotted owl (Menning et al. 1997). The rules are administered by the California Department of Forestry and Fire Protection, and are the regulations implementing the Z'berg Nejedley Forest Practices Act of 1973 (4 Pub. Res. Code Ch. 8).

These rules require timber operators to produce a Timber Harvest Plan (THP) that is intended to serve as a substitute for the planning and environmental protection requirements of the California Environmental Quality Act of 1970 (Pub. Res. Code sections 21000-21177). The Rules provide for timber harvest practices and site preparation practices to be utilized. These regulations are implemented largely by preparation of THPs, which are essentially comprised of a lengthy checklist and supporting documentation, or in the case of the majority of the plans exempted from the THP process, by 1-2 page applications.

Few or none of the logging prescriptions described in the Rules would result in retention of spotted owl habitat features critical to the maintenance of owl populations on private land. As previously discussed, logging practices near owl sites appear to be extensive, sometimes affecting each acre an average of six times over the past eight years. Further, the Rules fail to provide any measures that provide explicit protection for the California spotted owl, and provide no effective measures to protect owl habitat in any meaningful quantity. Finally, the Rules fail to provide a mechanism for identifying individual or cumulative impacts to owls or owl habitat on private lands. The net result is that the Rules do not regulate logging on private lands in a manner that is adequate to maintain owl habitat or populations on private land within the range of the California spotted owl.

2. Logging under the Forest Practices Rules (FPR) results in degradation and destruction of critical features of habitat for the California spotted owl.

Harvest prescriptions allowed when preparing a THP. Because the logging practices named in the Rules are focused on the use of methods to achieve maximum timber production, extensive depletion of owl habitat has occurred and will continue to occur.

For all timber harvest prescriptions under the rules that apply to the normal THP process, silvicultural objectives are defined as follows: "[t]he RPF [registered professional forester] shall select systems and alternatives which achieve *maximum sustained production of high quality timber products*." (Forest Practice Rules, 14 CCR Ch. 4 section 913) (emphasis added). The Rules favor regeneration methods for achieving this objective (FPR, 14 CCR Ch. 4 section 913 (a)). Regeneration methods "are designed to replace a harvestable stand with well spaced growing trees of commercial species. Even age management systems shall be applied…" (FPR, 14 CCR Ch. 4 section 913.1).

This objective of "maximum sustained production" of timber is in direct conflict with the retention of the characteristics that comprise high quality spotted owl habitat. For example, this objective and the regeneration methods described depend on the removal of large trees to provide high quality timber, which in turn leads to the removal of nest, forage and roost sites of the California spotted owl. Regeneration methods have resulted in the removal of key components of spotted owl habitat, such as large, old trees, multilayered canopies, snags, and downed logs (Bias and Gutiérrez 1992, Gutiérrez et al. 1992, LaHaye et al. 1997, Moen and Gutiérrez 1997) over the majority of private lands in the Sierra Nevada. Indeed, this is the clear intent of the Guidelines by stating that harvest should be designed to create "a harvestable stand with well spaced growing trees of commercial species." Specific regeneration methods recommended in the Rules include clearcutting, in which all of the stand is removed at one time (used in 51 of the 416 cases we reviewed); seed tree regeneration, in which most all of the stand is removed, and then the few remaining "seed trees" are removed in a second step (20 cases); shelterwood regeneration, in which a stand is removed in three steps (39 cases); transition (21 cases); and selection and group selection logging (82 cases). Many THPs proposed more than one of these harvest prescriptions. These regeneration methods entail complete removal of forest canopy and large trees, and as is clear by their definitions, would result in elimination of spotted owl habitat. In addition, regeneration methods result in significant reductions in canopy closure. This has the potential to severely degrade and/or destroy California spotted owl habitat by reducing canopy closure to less than that selected by spotted owls, and by eliminating the multi-layered canopies that characterize spotted owl habitat. In addition, the goal of maximum timber production and the various harvest methods are likely to result in removal of merchantable snags and or potential snag recruitment trees.

The Rules also recommend some uneven age regeneration prescriptions, including transition, selection, and group selection logging (FPR, 14 CCR Ch. 4 section 913.1, 913.2). The uneven age methods involve removal of individual or groups of trees. Though occurring over several entries, these methods on private lands are likely to result in removal of habitat characteristics required by the California spotted owl—large, old trees, snags, and dense, multilayered canopies. Verner, et al (1992) found that traditional selection logging has resulted in depletion of the large, old trees utilized by spotted owls, and found that on public lands "[e]ven on lands planned for selection harvest, we have no guarantee that harvest prescriptions will leave any of the large, old trees." (Verner et. al 1992). There is no reason to assume that selection logging would be more likely to result in maintenance of owl habitat than re-generation logging.

Lastly, the Rules define several "intermediate treatments." (FPR, 14 CCR Ch. 4 section 913.3) These treatments include both commercial thinning and sanitation-salvage logging. Under the Rules, commercial thinning is defined as follows:

> "Commercial thinning is the removal of trees in a young-growth stand to maintain or increase average stand diameter of the residual crop trees, promote timber growth, and improve forest health. The residual stand shall consist primarily of healthy and vigorous dominant and codominant trees from the preharvest stand (FPR § 913.3)."

This treatment is designed to maintain young, evenly spaced stands of healthy, straight trees as described above. Generally, such stands, sometimes referred to as plantations, lack most or all of the stand components required by the owl. From the review of owl sites that we conducted, it does not appear that commercial thinning is a dominant logging prescription near owl sites. Of the 416 owl sites, only 28 utilized commercial thinning methods.

The sanitation/salvage method is one of the most commonly utilized prescription under exemptions to the THP process (see below) and is defined in the Rules as removal of trees that are "insect attacked or diseased trees…[or, for sanitation logging] trees…that are dead, dying, or deteriorating" because of damage from a variety of causes (FPR, 14 CCR Ch. 4 section 913.3 (b)). The Rules provide little criteria for defining what constitutes a "dying or diseased" tree. Further, the rules state that "the RPF shall estimate the expected level of stocking to be retained (see Forest Practice Rules, 14 CCR Ch. 4 section 913.3 (b))," rather than prescribing stocking levels specific to the prescription. Thus, it is clear that this prescription could result in removal of numerous large trees, significant reduction in canopy closure, and removal of all merchantable snags or potential snag recruitment trees. This logging method was used in 18 of the 416 cases we reviewed in which a THP was completed.

In addition to intermediate and regeneration methods, there is an additional but ill-defined catch-all prescription used in a number of cases we reviewed— "alternative," used in 32 of the 416 cases. These prescriptions appear to allow the destruction of key habitat components, as do the regeneration prescriptions described above.

In sum, it is apparent that the regeneration methods and intermediate harvest methods utilized are likely to be extremely destructive to critical characteristics of spotted owl habitat, including large trees and multilayered forest canopy. The methods recommended would result in total elimination of the forest characteristics associated with California spotted owl habitat. Without effective restrictions, logging conducted under these rules has destroyed and will continue to destroy and degrade spotted owl habitat over a large portion of its range.

3. Timber harvest operations exempt from THP stocking and analysis requirements are also likely to pose significant threats to habitat for the California spotted owl.

The Rules exempt a number of logging operations from the Timber Harvest Planning process. Approximately 69% of the timber harvest documents we reviewed, or 287 of 416, fell into this category. Specific exemptions from the THP process include "harvesting of dead, dying, or diseased trees of any size" (utilized in approximately 175 cases we reviewed), logging of 3 or less acres (25 cases), "other" (57 cases), and a number of other lesser used exemptions (FPR, 14 CCR Ch. 4 section 1038).

The various exemptions from the THP process and requirements include a number of specific restrictions. The exemption for harvest of "dead, dying, or diseased trees" was utilized most often in the cases we reviewed. This exemption allows logging of no more than 10% of the average volume on each acre. In addition, a number of specific restrictions of potential impacts are built in to the exemption. For example, new road construction is prohibited. However, there are no specific restrictions on impact to spotted owl nest sites or habitat. For example, there are no restrictions on the size of trees removed. In addition, the exemption guidelines fail to limit the frequency in which an exemption can be used for the same area. In numerous cases, our review of timber planning documents indicated that exemptions had been submitted each year for as many as 7 years on the same area. In most cases, the areas with repeated exemptions exceeded 20,000 acres in size. Under this exemption, private landowners can enter stands as often as an exemption is filed (often yearly) and remove up to 10 percent per acre of volume, eventually removing all attributes of suitable owl habitat.

In sum, the dead, dying and diseased exemption results in the degradation of important characteristics of spotted owl habitat. A CDF forester estimated that only about 10% of exempted plans are subject to any review by the CDF, and stated that plans filed under this exemption are considered a "non-discretionary" document, which the CDF is obliged to approve (pers. comm. with Dave Macnamara).

Finally, "emergency management" of timber is also exempted from the requirements of the THP process. This exemption applies to stands that have been substantially damaged by fire or other natural causes. This exemption was used in 33 of the cases we reviewed. Because the Rules fail to define what constitutes a "substantially damaged stand," this exemption could be used in any number of situations that hardly constitute an emergency. For example, it could be used to clearcut a stand where a fire had burned, but left most of the trees alive.

Given the large number of acres and timber harvests occurring under these exemptions, on land that is very near owl sites, this lack of protection raises serious concerns about the effects of timber harvest on owl habitat. Coupled with the degradation and destruction of owl habitat that is occurring under the THP process, current regulation of logging on private lands is clearly not adequate to protect the California spotted owl from becoming endangered with extinction.

4. The Forest Practice Rules lack any substantial protection for the California spotted owl or its habitat.

The California Forest Practices Rules contain no explicit protection for the California spotted owl or substantial protection for its habitat. The Rules fail to require identification of individual or cumulative impacts to the California spotted owl and its habitat and even if they did, lack of protection would result in such identification being meaningless. There are no provisions for protecting owl habitat at any scale. Essentially, under the current Rules timber operators can cut nest stands and every other stand in an owl's home range without restriction. There are no provisions for protection of large trees, high canopy closure or multi-layered stands, and only ineffective provisions to protect other components of owl habitat. Because the rules fail to provide any meaningful protection to owl habitat and yet allow and encourage significant degradation and destruction of owl habitat, they are inadequate to prevent extirpation of the spotted owl from portions of its range.

Explicit protections for the California spotted owl or its habitat are lacking. The Rules contain very little explicit protection for the California spotted owl, in part because it is not a designated sensitive species under the Rules. If this classification were given, the Board of Forestry would be required to "consider, and when possible adopt...feasible mitigation [measures] for protection of the species" that are based on the best available science (FPR, §919.12 (d)). Even if it were designated as a sensitive species, however, this would provide little to no protection because the only real requirement is that the Board "consider" feasible mitigation measures, lacking any requirement that such mitigation is actually carried out. While designation as a sensitive species provides almost no real protection, lack of such designation means the California spotted owl has no explicit protection under state regulation.

The Rules' requirement for mitigation of significant impacts to non-sensitive species fails to provide practical protection to the owl or its habitat. While the Forest Practices Rules provide no explicit protection of the California spotted owl and its habitat, the Rules do require that where significant impacts to non-listed species may result, the forester "shall incorporate feasible practices to reduce impacts" (FPR §919.4, 939.4, 959.4). However, the Rules do not require surveys for spotted owls, do not require identification of owl habitat, and provide no information concerning possible thresholds over which impacts to owl habitat or the species might be "significant." No explicit requirements or technology for assessing cumulative impacts exist. Thus, it is very unlikely that this requirement would result in significant additional protection for owl habitat.

As expected, our review of 416 timber harvest documents that impacted 18 owl sites revealed extensive impacts to land within 2 miles and 0.5 miles of the owl sites we reviewed, and almost no mention, analysis, or mitigation of these impacts in the associated timber harvest documents. Very few of the timber harvest documents mentioned the spotted owl at all, even when impacts were to occur within 0.5 mile of an owl site. Of the 416 timber harvest plans that occurred within a 2 mile radius of the 18 owl sites we examined, only 81 mentioned the California spotted owl and of the 116 timber harvest operations within 0.5 mile of a known owl site, only 21 mentioned the California spotted owl. Of the timber harvest documents that did mention the spotted owl, less than half identified spotted owls within the timber harvest area or made other reference to impacts expected to result from the timber harvest plans; only ten discussed impacts to or characteristics of spotted owl habitat occurring in the project area; and one named mitigation measures designed to avoid impacts to an identified owl. Significantly, 48 of the 81 documents where the owl was mentioned disavowed the presence of spotted owls, either by stating that known spotted owls were located on adjacent Forest Service land, that no spotted owls were found within the THP area, or that the area provided no owl habitat. These oblique references contained mostly generality and no real analysis of possible effects. For example, one such statement erroneously described Forest Service management of owl habitat as follows: "[t]he USFS has designated most of their land as SOHA or PACs."

In sum, the Rules provision to "incorporate feasible practices to reduce impacts" where significant impacts to non-listed species may result provides almost no protection for the California spotted owl because impacts, significant or not, are not identified, the Rules fail to identify what constitutes a significant impact, and reduction of impacts is optional, rather than required.

Requirements for protection of active nest sites provide little short term and no long term protection to California spotted owl nest sites. Under the Migratory Bird Treaty Act (MBTA) (16 U.S.C. section 703 et. seq.), the take of a migratory bird or its nest is prohibited (16 U.S.C. section 703). The spotted owl is listed as a migratory bird (50 CFR 10.13), and thus is entitled to protection under the MBTA. Such protection would include the protection of nest trees from removal during timber harvest. However, the Rules fail to require survey for or identification of nest sites for non-sensitive species, including the spotted owl (FPR § 919.2). Similarly, the Rules fail to provide nest buffers where cutting is prohibited for the spotted owl, as is provided for a number of sensitive species (FPR § 919.3). Thus, even if a nest were by some accident identified, under current regulations only the nest tree and not the surrounding stand would be protected under either the MTBA or the Rules. Such protection would not result in maintenance of nest sites. However, even this minute level of protection is rarely applied. Our review of 416 timber harvest operations within 2 miles of known owl sites, 116 of which were within 0.5 mile of an owl site, found that only 1 timber harvest document provided protection for a nest tree. In addition, neither the Rules or the MBTA require protection of potential nest sites that are not currently active, even if nest sites have recently been active and may be active in the future.

The Rules' requirement for assessment of impacts to late successional forests and for mitigation of impacts do not appear to result in any significant protection of habitat for the California spotted owl. The Rules require very limited assessment of impacts to and almost no protection for late succession forest stands within THP areas (FPR §919.16, 939.16, 959.16). The Rules require that "when late succession stands are proposed for harvesting and such harvest will significantly reduce the amount and distribution of late succession forest stands," then information about these stands must be included within the THP (FPR, §919.16.). In practice, this provision is almost never invoked. Of the 416 timber harvests near owl sites that we reviewed, late successional forests were mentioned in only 7 cases. Out of the 2,366,753 acres of private land impacted by these 416 timber harvests, at least part of which occurred within the 18 owl sites assessed, only 728 acres of late succession forest habitat were identified.

The failure of timber harvest documents to identify impacts to spotted owl habitat with late successional forest characteristics appears to be due to several factors. First, by definition under the FPA, late successional forest stands less than 20 acres in size are not recognized. Conclusions from Beardsley et al. (1999) suggest that large diameter trees that would be needed to satisfy the definition of CWHR classification 5M, 5D, and 6 are in extremely low densities on private
lands. Thus, the few scattered large trees that may exist on private lands are unlikely to be in sufficient densities within stands exceeding 20 acres to merit identification as late-successional forest. It is likely that the last remnants of late-successional forests on private lands lack protection because they cover too small an area. Second, no analysis of late-successional forest. is required unless the timber harvest plan itself would result in a significant reduction of habitat. There is no provision requiring analysis of the cumulative effects of removal of late-seral forest habitat, nor is there discussion of what might constitute a significant reduction in late succession forest habitat. Thus, it is possible for a cumulatively significant reduction of late successional forest to occur because the THP process allows incremental steps in this loss to be ignored. Even if invoked, however, this provision requires analysis and mitigation of impacts only when feasible (FPR §919..16 (a), (b).). No firm protection of old forest characteristics or acres of habitat is required.

In sum, the late succession forest provision provides little protection to older forests even if invoked, and is invoked in practice in so few cases that it appears unlikely that this provision is providing meaningful protection for even a small percentage of California spotted owl habitat.

The Rules requirement for retention of snags provides little or no protection to this feature of owl habitat. Though snags are an important component of spotted owl habitat, the Rules list numerous conditions under which snags may be removed and fail to require that a minimum number of snags be retained. Further, the Rules suggest removal of large (FPR §919.1 (d)) snags near roads and ridgetops (FPR §919.1 (a)(1), (a)(2)). Of the 416 timber harvest documents we reviewed, only five discussed retaining snags. Of these, three documents indicated retaining only snags that were visibly used by wildlife, one indicated that non-merchantable snags would be retained, and one indicated that all merchantable and non-merchantable snags would be retained. Eighty-two of the 416 timber harvest documents stated that snags would be removed near roads, skid trails, and landings, or more broadly. Reasons given for removal of snags included "hazard," fire danger, and a statement that merchantable snags would be removed. It was not clear that snags would be retained in the remaining cases.

In sum, the Rules provide for no minimum number of snags to be retained and encourage removal of snags to such a degree that it is extremely unlikely that snags would be retained at levels needed to maintain suitable habitat for the owl. In practice, few timber harvest documents appear to require retention of snags.

The Forest Practices Rules fail to provide reliable identification and thus avoidance of individual and cumulative impacts to owls and their habitat. As detailed above, the Rules fail to provide any meaningful protection to spotted owls or their habitat. These flaws on their own render the Forest Practices Rules inadequate to maintenance of owl populations and habitat on private lands. Even if the Rules did provide meaningful protection for the owl, however, lack of funding and adequate mechanisms to identify impacts to spotted owls as currently practiced would render such hypothetical regulations ineffective. For example, while the THP process does require a "cumulative effects analysis," lacking identification of individual effects on owls due to funding or absence of analysis guidelines, no cumulative analysis is possible. Further, in the case studies we conducted, no analysis of cumulative effects of multiple timber operations on owl sites was performed, even in the very few cases where owls were identified in the project area.

Numerous independent commissions and academic research groups have reviewed the Forest Practices Rules and found them lacking (Wildlife Habitat/Forest Practice Task Force 1990, Wildlife/Science Committee 1994, Little Hoover Commission 1994, Menning et al. 1997). While critiques have been diverse and lengthy, some common themes include the lack of funding and personnel needed to conduct review of THPs; the lack of a mechanism for conducting analysis of cumulative effects on wildlife and other resources; and the lack of consistency in implementing the provisions of the Forest Practice Rules.

In the cases we reviewed, approximately 69% of the timber harvests were conducted under exemptions to the THP process (287 out of 416). These exemptions addressed timber harvest on 2.3 million acres during a 9 year period. The area covered by THPs was approximately 81,817 acres. Beyond this, a substantial proportion of the acres covered by a THP were also included under an exemption for "harvest of dead, dying, and diseased trees" at some time during the 9 year period. Nonetheless, only 64 THPs reported that prior logging had occurred and none of these mentioned the removal of dead, dying, or diseased trees. Thus, cumulative effects analysis, in the very limited manner that are required under THPs, was completed on less than 4% of the acreage affected by timber harvest during the past 9 years. And in no case were cumulative effects on the owl or its habitat mitigated.

In conclusion, the Rules provide no meaningful protection for spotted owls or their habitat and no provisions for identifying impacts to spotted owls either from individual projects or cumulatively. Thus, even if there were protections, there would be no way of ensuring they were effective or being enforced.

2. Regulations governing development on private lands

County Regulation of Private Lands in the Range of the California Spotted Owl. We reviewed the majority of county plans within the range of the California spotted owl and found that none contained provisions to protect the owl or its habitat from development. Further, because the California spotted owl is not a state listed species, there is no requirement under the California Environmental Quality Act (CEQA) that developers analyze the effects of their actions on the owl. In sum, even though extensive California spotted owl habitat occurs in foothill areas of the Sierra Nevada and southern California and many of these areas are available for development, there is currently no protection for the owl against development.

C. State lands

To date, 17 territories have been found on lands owned or managed by the State of California, 11 of which are considered reliably extant (Gould unpub. data). In the Sierra Nevada, there are 16,580 acres in state parks, 13,840 acres in two state forests and 3,320 acres held by the University of California (Beck and Gould 1992). In southern California, there are 58,482 acres in state parks. Recreation is the main threat to owls occurring in the state parks, but the severity of impacts probably varies between the individual parks based on use and management objectives. Logging occurs in the state forests and has substantially reduced suitable owl habitat. For example, only 960 acres of the 4,807 acre Mountain Home State Forest in Tulare County, remain in an old-growth condition and only 2,000 acres of the 9,033 acre Latour State Forest have a significant large tree component (Beck and Gould 1992). Logging is continuing on both of these state forests. Protection afforded to California spotted owls on state lands by existing regulations is essentially the same as on private lands, meaning there is little to no specific regulations to protect the owl.

D. National Park Service

Four National Parks are located within the range of the California spotted owl, including Lassen Volcanic, Yosemite and Sequoia/Kings Canyon National Parks (NPs). In total, these parks contain 1,719,039 acres, of which approximately 460,687 acres may be suitable for nesting and foraging (Beck and Gould 1992). Surveys have located 130 territories, of which 57 are in Yosemite, 54 are in Sequoia, 12 are in Kings Canyon and 7 are in Lassen Volcanic (Gould unpub. data). Only 64 of the 130 are considered reliably extant, reflecting lack of recent surveys. The mission of the National Parks, which is in part to “maintain all the components and processes of naturally evolving park ecosystems,” is generally in line with maintenance of suitable spotted owl habitat. However, recreation and development of park facilities could pose a threat to individual owls. The Park Service recognizes the spotted owl as a “special status species,” but has not developed specific management guidelines to ensure protection of owls within Park boundaries.

E. Bureau of Land Management

BLM lands are scattered throughout the foothills of the Sierra Nevada and southern California ranges. Many of these lands support forest, woodland and riparian/hardwood stands that are potentially suitable for the California spotted owl. There are approximately 68,500 acres in the Sierra Nevada and 7,560 acres in southern California of potentially suitable habitat on BLM lands (Beck and Gould 1992). Forested BLM lands within the Sierra Nevada are managed partially for timber production, where uneven aged harvest is emphasized. Other BLM lands are managed primarily for livestock grazing. Seventeen owl territories, 14 of which are considered reliable, have been documented on BLM lands (Gould unpub. data). The owl has not been given any special management status on BLM lands, nor does the BLM routinely consider or mitigate the effects of its actions on the owl.

F. Tribal lands

Five owl territories have been located on Native American lands in the Sierra Nevada (1) and southern California (4) (Gould unpub. data). The amount of suitable habitat on these lands is unknown at this time. It is also unknown to what degree management of these lands is compatible with maintenance of suitable habitat.

G. Other regulations protecting California spotted owls on public or private lands.

Migratory Bird Treaty Act (MBTA). The MBTA (16 U.S.C. section 703 et. seq.) prohibits the take of a migratory bird or its nest (16 U.S.C. section 703) and the spotted owl is listed as a migratory bird (50 CFR 10.13). However, this only prohibits killing of the owl or cutting down an active nest tree. It does not provide broad-scale protection of habitat required by the owl.

National Environmental Protection Act (NEPA). NEPA requires Federal agencies, including the Forest Service, to consider the effects of their actions on the environment. It, however, does not prohibit them from choosing alternatives that will negatively effect individuals or populations of California spotted owls.

National Forest Management Act (NFMA). The California spotted owl is listed as a sensitive species by the Forest Service, but this affords it little protection. While the NFMA regulations at 36 C.F.R. §219.19 states that "Fish and Wildlife habitat shall be managed to maintain viable populations of existing native and desired nonnative vertebrate species in the planning area," it does not prohibit the Forest Service from carrying out actions that harm species or their habitat, stating only that "where appropriate, measures to mitigate adverse effects shall be prescribed" (36 C.F.R. §219.19(a)(1)).

IX. Critical Habitat

Petitioners request and strongly recommend the designation of critical habitat for the California spotted owl coincident with its listing. Critical habitat should be designated in all areas where the California spotted owl is currently located and in key unoccupied and unsurveyed areas where restoration is necessary for the conservation of the species.

X. Conclusion

The combination of well documented declines in all demography study areas with compelling evidence these declines are at least partly the result of habitat loss, degradation and fragmentation, hundreds of "may affect" determinations by the Forest Service, and inadequacies in the Interim Guidelines and the State forest practices code all indicate that the California spotted owl incontrovertibly merits listing under the Endangered Species Act.

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Appendix A. Summaries of harvest documents within two miles of 20 owl sites within four 'areas of concern" (Beck and Gould 1992).

Table 1. Summary of harvest documents within 2 miles of 5 selected owl sites in AOC 2. Overlap in harvest areas exists between owl sites, and the sum of the total acres or plans reflects an overestimate of acres represented in the harvest documents.

Owl Site	Type of Plan	Plans filed documenting harvest units w/in 2 miles of owl site	Acreage of plans documenting harvest units w/in 2 miles of owl site	Plans filed documenting harvest units w/in 0.5 miles of owl site	Estimate of harvest acres w/in 2 miles of owl site	Primary Logging Method	Documents referring to owls	Reference to owls	Documents identifying owl location	Documents identifying LSOG forest	Acres of LSOG forest identifie d	Acres of LSOG forest cited as impacted
PL001	THP	1	1,727	1	0	SW, CT	0	none	0	0	0	0
	EX	11	206,901	10	26,740	D/D/D	0	none	0	0	0	0
	EM	5	4,925	3	0	SS	0	none	0	0	0	0
	TOTAL	**17**	**213,553**	**14**	**26,740**							
PL053	THP	0	0	0	0							
	EX	4	154,199	4	20,734	D/D/D	0	none	0	0	0	0
	EM	0	0	0	0		0	none	0	0	0	0
	TOTAL	**4**	**154,199**	**4**	**20,734**							
PL164	THP	4	6,597	0	2,478	S	4		0	1	0	0
	EX	21	331,010	0	16,119	D/D/D	0	none	0	0	0	0
	EM	0	0	0	0							
	TOTAL	**25**	**33,7607**	**0**	**18,597**							
PL306	THP	2	11,280	0	820	S	2		1	0	0	0
	EX	7	334,261	1	20,714	D/D/D	0	none	0	0	0	0
	EM	0	0	0	0							
	TOTAL	**9**	**34,5541**	**1**	**21,534**							
TE096	THP	1	4,540	1	1,237	T	1		1	1	0	0
	EX	13	282,519	6	38,020	D/D/D	0	none	0	0	0	0
	EM	0	0	0	0							
	TOTAL	**14**	**287,059**	**7**	**39,257**							

SW - shelterwood
CT - commercial thin
S - selection
D/D/D - harvest of dead, disease, and dying

Table 2. Summary of harvest documents within 2 miles of 5 selected owl sites in AOC 3. Overlap in harvest areas exists between owl sites, and the sum of the total acres or plans reflects an overestimate of acres represented in the harvest documents.

Owl Site	Type of Plan	Plans filed containing harvest units w/in 2 miles of owl site	Acreage of plans documenting harvest units w/in 2 miles of owl site	Plans filed w/in 0.5 miles of owl site	Estimate of harvest acres w/in 0.5 miles of owl site	Primary Logging Method	Documents referring to owls	Reference to owls	Documents identifying owl location	Documents identifying LSOG forest	Acres of LSOG forest identified	Acres of LSOG forest cited as impacted
PC045	THP	10	2,583	10	1,795	S, CC	6	General, specific	1	2	70	0
	EX	1	3	1	3	C	0	none	0	0	0	0
	EM	1	20	1	20	ST	0	none	0	0	0	0
	TOTAL	**12**	**2,606**	**12**	**1,818**							
SI042	THP	1	560	1	560	CC	1	General	0	0	0	0
	EX	2	15,440	2	8,320	D/D/D	0	none	0	0	0	0
	EM	0										
	TOTAL	**3**	**16,000**	**3**	**8,880**							
SI043	THP	0										
	EX	3	4,623	3	2,712	D/D/D	0	none	0	0	0	0
	EM	0										
	TOTAL	**3**	**4,623**	**3**	**2,712**							

D/D/D - harvest of dead, disease, and dying
S - selection
ST - seed tree removal
CC - clearcut

Table 3. Summary of harvest documents within 2 miles of 5 selected owl sites in AOC 4. Overlap in harvest areas exists between owl sites, and the sum of the total acres or plans reflects an overestimate of acres represented in the harvest documents.

Owl Site	Type of Plan	Plans filed containing harvest units w/in 2 miles of owl site	Acreage of plans documenting harvest units w/in 2 miles of owl site	Plans filed documenting harvest units w/in 0.5 miles of owl site	Estimate of harvest acres w/in 2 miles of owl site	Primary Logging Method	Documents refering to owls	Reference to owls	Documents identifying owl location	Documents identifying LSOG forest	Acres of LSOG forest identified	Acres of LSOG forest cited as impacted
ED014	THP	9	3,760	3	1,326	CC	7	General, specific	2	1	0	0
	EX	54	78,184	7	87	O, D/D/D	0	none	0	0	0	0
	EM	0	0	0	0							
	TOTAL	**63**	**81,944**	**10**	**1,413**							
ED045	THP	9	6,851	1	4,932	CT, SW	5	General, specific	2	1	30	15
	EX	21	210,574	7	7	D/D/D	0	none	0	0	0	0
	EM	0	0	0	0							
	TOTAL	**30**	**217,425**	**8**	**4,939**							
ED198	THP	19	4,589	6	4,147	CC, S	6	General, specific	4	1	0	0
	EX	20	247,089	10	47	D/D/D	0	none	0	0	0	0
	EM	0	0	0	0							
	TOTAL	**39**	**251,678**	**16**	**4,194**							
PC037	THP	9	4,578	5	3,531	CC	9	General, specific	3	1	102	0
	EX	7	272,814	7	70,472	D/D/D	0	none	0	0	0	0
	EM	0	0	0	0							
	TOTAL	**16**	**277,392**	**12**	**74,003**							
PC051	THP	0	0	0	0							
	EX	7	272,841	7	70,472	D/D/D	0	none	0	0	0	0
	EM	0		0	0							
	TOTAL	**7**	**272,841**	**7**	**70,472**							

D/D/D - harvest of dead, disease, and dying O - other S - selection
CT commercial thin SW - shelterwood CC - clearcut

Table 4. Summary of harvest documents within 2 miles of 5 selected owl sites in AOC 5. Overlap in harvest areas exists between owl sites, and the sum of the total acres or plans reflects an overestimate of acres represented in the harvest documents.

Owl Site	Type of Plan	Plans filed containing harvest units w/in 2 miles of owl site	Acreage of plans documenting harvest units w/in 2 miles of owl site	Plans filed documenting harvest units w/in 0.5 miles of owl site	Estimate of harvest acres w/in 2 miles of owl site	Primary Logging Method	Documents refering to owls	Reference to owls	Documents identifying owl location	Documents identifying LSOG forest	Acres of LSOG forest identified	Acres of LSOG forest cited as impacted
CA011	THP	24	12,262	22	5,299	CC	16	General, specific	2	2	0	0
	EX	29	417,187	24	55,584	D/D/D	0	none	0	0	0	0
	EM	5	4,780	0			0	none	0	0	0	0
	TOTAL	**58**	**43,4229**	**46**	**60,883**							
CA032	THP	9	3,501	9	3,107	CC, S	6	General, specific	0	0	0	0
	EX	21	444,701	10	65,419	D/D/D	0	none	0	0	0	0
	EM	2	4,520	0			0	none	0	0	0	0
	TOTAL	**32**	**452,722**	**19**	**68,526**							
TL037	THP	11	7,337	10	3,203	CC	5	Specific	3	1	89	0
	EX	10	152,188	3	25,860	D/D/D	0	none	0	0	0	0
	EM	5		0			0	none	0	0	0	0
	TOTAL	**26**	**159,525**	**13**	**29,063**							
TL152	THP	4	1,411	3	281	CC, ST, CT	1	General	0	1	20	0
	EX	16	112,756	10	18,812	D/D/D	0	none	0	0	0	0
	EM	5	1,102	2			0	none	0	0	0	0
	TOTAL	**25**	**115,269**	**15**	**19,093**							
TL201	THP	21	14,031	18	7,495	CC	14	General, specific	7	2	417	0
	EX	48	422,263	24	47,712	D/D/D	0	none	0	0	0	0
	EM	10	4,475	1	30		0	none	0	0	0	0
	TOTAL	**79**	**440,769**	**43**	**55,237**							

D/D/D - harvest of dead, disease, and dying S - selection
ST - seed tree removal CC – clearcut CT - commercial thin