SCIENTIFIC BASIS FOR ROADLESS AREA CONSERVATION

(June 2002 - Updated October 2003)

Roadless watershed – Siskiyou Wild Rivers Area, southwest Oregon (D. DellaSala)

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EXECUTIVE SUMMARY

National Forest roadless areas contain irreplaceable reserves of wildlife habitat and plant life, and perform many valuable ecosystem services used by all Americans. These wild areas also play an esteemed role in our national identity and history, with interest in their protection dating back to the early 1970s. Despite their importance, National Forest roadless areas have been increasingly threatened by careless road building and inappropriate management for resource extraction purposes. Nation-wide, the USDA Forest Service has over 378,000 miles of roads with a substantial backlog of road maintenance needs. Meanwhile, since the 1970s, about 1 million acres of roadless areas have been logged each year adding to an already over burdened road repair backlog and reducing ecosystem services provided by intact forests.

> **What Is a Roadless Area?**
>
> **Roadless areas are National Forest lands that have remained unroaded for a variety of reasons, including inaccessibility and environmental sensitivity. Roadless areas provide many ecosystem services that are not as readily available in roaded landscapes, such as:**
>
> - Providing refuges for many threatened, endangered, and endemic (rare) fish and wildlife species.
> - Harboring old-growth forests and other rare habitat types that are more resistant to forest fires and effective at controlling climate change.
> - Providing clean drinking water.
> - Serving as unspoiled reference areas for research into issues such as climate change.
> - Acting as buffer zones against invasive, noxious, or exotic species.
> - Protecting important historic and cultural areas.
> - Hosting a wide variety of outdoor recreation enthusiasts

Recognizing these problems, the USDA Forest Service adopted the Roadless Area Conservation Rule on January 12, 2001 to protect inventoried roadless areas totaling 58.5 million acres, an area roughly the size of New York and Pennsylvania. This rule, enacted by executive order of President Clinton, was intended to carefully regulate road construction in roadless areas. On the same day, the USDA Forest Service adopted a Transportation Policy that contained additional protections for roadless areas.

The rule was enacted after a public comment period and 600 open meetings around the nation resulted in an unprecedented 1.6 million comments – overwhelmingly in favor of the rule – from citizens demanding that the degradation of environmentally sensitive roadless areas be halted.

The rule, as originally written, allows for efficient reconstruction and maintenance of USDA Forest Service roads; construction of new roads necessary for National Forest system resource management; and future construction, restoration, and maintenance of roads with minimal long-term adverse environmental impacts. However, the rule is now in jeopardy by recent court decisions and administrative directives aimed at weakening its protections.

Leading up to the enactment of the roadless conservation rule, several scientific studies have demonstrated unequivocal support for the protection of roadless areas. At the same time, scientists were turning their attention to documenting the impacts of roads and associated logging on the extent and rate of forest fragmentation across the nation (see *Conservation Biology* 2000 – Special Edition on roads). The current roads network has produced more than 378,000 miles of roads criss-crossing the National Forests, enough to drive around the globe nearly 16 times. Consequently, roadless areas are what remain of the nation's dwindling intact and functional ecosystems.

There is a long history of conservation and protection in the United States, dating back to the first National Park in 1872 - Yellowstone. Since then, however, the nation has protected just 5% of its land area in National Parks, Wilderness, and National Monuments (DellaSala et al. 1999) – considered far too low to prevent the inevitable march toward extinction of rare, threatened, and endangered fish and wildlife species impacted by the loss of and fragmentation of intact forests. Most (97%) of the nation's protected areas are too small (<25,000 acres) to absorb natural or human-imposed disturbances (DellaSala et al. 1999). This is especially the case in the eastern United States where few inventoried roadless areas (>5,000 acres) remain and restoration of smaller unroaded (1,000-5,000 acres) areas is the best opportunity for intact forests. The Pacific Northwest, Tongass National Forest, and Rocky Mountain region, provide perhaps the nation's last chance at protecting large, functionally intact forests – with the Tongass National Forest containing some of the largest blocks of intact watersheds in the Western hemisphere.

A comprehensive analysis of inventoried roadless areas within six ecoregions of the Pacific Northwest encompassing the range of the northern spotted owl (Strix occidentalis caurina) east and west of the Cascade Mountains in Washington, Oregon, and northern California revealed that roadless areas contributed to:

(1) overall levels of federal lands in protection;
(2) key watersheds essential for salmon survival;
(3) locations of threatened and endangered species;
(4) late-seral (mature/old growth) forests,
(5) elevation representation,
(6) physical habitat representation, and
(7) plant community representation

In addition to their ecological benefits, roadless areas provide many social benefits. Non-motorized recreation is on the rise in the National Forests, which, in many places, cannot keep up with demand for backcountry experiences. Many Western communities are transitioning from extraction-dominated and unsustainable resource economies of the past to more diversified, robust economies of today. Roadless areas, National Parks, and Wilderness areas can contribute to this transition by attracting new businesses associated with accelerated growth in amenities-based and service-related industries and small businesses spreading across the West. Evidence from 410 counties in the West indicates that counties with higher levels of protection tend to have more robust and stronger economies than those having lower levels of protection (Southwick Associates 2001).

Because many (more than 50%) of roadless areas intersect watersheds that provide drinking water to local communities (USDA Forest Service DEIS 2000), these areas are crucial for maintaining a consistent supply of drinking water, particularly in areas subject to droughts. Moreover, roadless areas, because of difficulties in access and lack of fire suppression and logging effects, generally have lower fire risks and fewer insect epidemics than heavily logged and roaded landscapes (DellaSala and Frost 2001). Finally, a commitment to lasting roadless area conservation, while important ecologically and socially, would add just 2% to the nation's protected area network (Strittholt and DellaSala 2001). Furthermore, the ecologically values noted in this report vary considerably among ecoregions. Therefore, roadless areas do not contribute to conservation in a uniform fashion across the nation and further conservation measures will be necessary for a more complete reserve network. While roadless areas are essential in achieving a more representative network of protected areas in many regions, their conservation will need to be supplemented with additional protections and more sustainable resource practices on federal lands as we enter the 21st century – a period of increasing resource demands but shrinking natural capital.

This document is a synthesis of the literature on roadless importance, drawing primarily on the published studies presented in the bibliography and available from the World Wildlife Fund (www.worldwildlife.org/publications) and the Conservation Biology Institute (www.consbio.org). The authors of this document have spent nearly a decade compiling databases and conducting satellite imagery and computer mapping assessments that document the importance of roadless areas and the extent of forest fragmentation across the nation. This document provides a scientific foundation in support of lasting protections for roadless areas.

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SCIENTIFIC OVERVIEW

Many scientists agree that habitat destruction and fragmentation is the leading cause of species loss worldwide (Wilcove et al. 1986, Wilson 1992, Wilcove et al. 2000). According to some scientists (Wilcox 1980), nearly all forest ecosystems are destined to resemble smaller and more isolated habitat "islands" as humans continue to encroach on remaining natural areas. When forests are fragmented into isolated forest islands they no longer retain their functions and begin turning over (i.e., losing) species (Saunders et al. 1991). Forest islands typically lack species found in large, intact areas, especially those that are sensitive to fragmentation (Wilcove et al. 2000). Wide-ranging species like forest carnivores and salmon tend to occur in higher densities in intact watersheds with populations at lower levels or not at all in heavily roaded areas (Noss and Cooperrider 1994, Hitt and Frissell 1999, *Conservation Biology* 2000, Kessler et al. 2001). Small forest islands also are more susceptible to disturbances such as fire and insect outbreaks than large, intact forests that are generally resilient (Perry 1994, DellaSala et al. 1995, DellaSala and Frost 2001).

Nation-wide forests have been extensively fragmented by logging and road building. Over the past several centuries, widespread disturbances in the conterminous United States have dramatically altered the composition, structure, extent, and spatial pattern of forests (Heilman et al. 2002). Previously intact areas have been either permanently replaced by other land uses or degraded to varying degrees by unsustainable forestry practices, landscape fragmentation, exotic species introduction, and alteration of keystone processes and natural disturbance regimes (e.g., fire, hydrological regimes). Using remote sensing imagery and GIS mapping, Heilman et al. (2002) mapped nearly 20,000 land units covering 3.6 million km^2. Few intact forests were found east of the Mississippi and extensive fragmentation from clearcut logging, development, and road building was evident in every forest region of the lower 48 states. Moreover, clearcut logging and road building is increasingly fragmenting the last of the nation's most intact forests - the Tongass National Forest in southeast Alaska (DellaSala et al. 1996, Strittholt, in prep.).

ROADS AND FOREST FRAGMENTATION

The construction of a road is often the first entry into an undisturbed forest, initiating the process of forest fragmentation (Strittholt and DellaSala 2001). Roads inflict numerous impacts on their immediate physical environment (*Conservation Biology* 2000), but more important, roads fragment natural ecosystems and provide access leading to subsequent human disturbances from logging, mining, grazing, introduction of invasive exotics, and urban development resulting in substantial declines in native species and an overall degradation of ecosystem functions (Forman 2000, Strittholt and DellaSala 2001, Heilman et al. 2002). Roads, deforestation, and fragmentation are intimately related.

In forested ecosystems, roads contribute to cumulative impacts, which when combined with other anthropogenic disturbances, reduce habitat for fish and wildlife species (Bennett 1991, Noss and Cooperrider 1994, Spellerberg 1998, Jones et al. 2000, Trombulak and Frissell 2000, *Conservation Biology* 2000). This is well documented across a range of taxa from small mammals and invertebrates (Niemela et al. 1993) to ungulates (moose: Timmermann and Gallath 1982; white-tailed deer: Sage et al. 1983; Rocky Mountain elk: Rost and Bailey 1979, Lyon 1983), large carnivores (Weaver et al. 1986a,b; 1996; Paquet et al. 1996; see *Conservation Biology* 1996, 2000), forest interior species (Reijnen 1996), and reptiles (Rosen and Lowe 1994).

Wilcove et al. (2000) suggested that "roads are the single greatest impact to the movement of sensitive species" and Forman and Hesperger (1996) concluded that "roads cause more effects and have a greater cumulative effect than vehicles." While collectively only two percent of the conterminous United States is covered by roads, the ecological effect is much greater than the area cleared for roads, amounting to approximately one-fourth of the total land area of the United States (Forman and Hesperger 1996, Forman 2000). The bottleneck effect of roads on wildlife has been well documented (see Noss and Cooperrider 1994, and Ercelawn 1999, *Conservation Biology* 2000 for reviews) and includes the following:

- In southeastern Ontario and Quebec, several species of small mammals rarely ventured onto road surfaces when the road clearance exceeded 66 feet (Oxley et al. 1974).

- In Oregon, dusky-footed woodrats and red-backed voles were found at all distances from an interstate highway but never in the highway right-of-way (Adams and Geis 1983).

- In the Mojave Desert, only 1 of 612 white-tailed antelope squirrels was recorded as having crossed an unpaved road (Garland and Bradley 1984).

- In Kansas, very few prairie voles and cotton rats ever crossed a dirt track 10 feet wide (Swihart and Slade 1984).

- Road densities of one mile per square mile has been documented as decreasing habitat effectiveness for elk by 50% compared to roadless watersheds - as road density increased to 6 miles per square mile, elk habitat use fell to zero (Lyon 1983, Wisdom et al. 1986).

- In Arizona and Utah, cougars were concentrated mostly in areas of low road density - road avoidance was documented for paved and improved dirt roads (VanDyke et al. 1986 - also other studies show cougar density is lowest when road densities exceed 0.4 mi/mi^2).

- In the southern Appalachians, black bear cannot maintain viable populations when road density exceeds 0.8 mi/mi^2 due to poaching pressure (Brody 1984 -- also even tiny “first order” roads that permit hunters to easily reach remote areas have demonstrable impacts on black bear harvest).

- In the mainly forested counties of the Adirondacks, there are many times more bears in low than high road-density areas (Brody and Pelton 1989).

- In northwest Montana, grizzly bears avoided habitat within 3,000 feet of open roads (Kasworm and Manley 1987).

- In southeast BC, grizzly bears used the area within 328 feet of roads less than expected and avoidance of roads was independent of traffic volume - suggests that even a few vehicles can displace bears (McLellan and Shackleton 1988).

- In Yellowstone Park, grizzly bears avoided habitat within 1,640 feet of roads during spring and summer and 1.9 mi of roads in fall (Mattson et al. 1987).

- Using radio collared wolves in the Bow Valley, Alberta, Paquet et al. (1996) documented that roads forced wolves into lower quality foraging habitats where snow depths were high and foraging success low and into valley bottomlands that acted as ecological "sinks" where mortality from humans was considerable.

- In Wisconsin, Michigan, Ontario, and Minnesota, studies have shown a strong relationship between road density and presence or absence of wolves. Wolves generally are not present where the density of roads exceeds 0.9 mi/mi^2 (Thiel 1985, Mech et al. 1988). Mech et al. (1988) report wolves using an area with road density above this theoretical threshold but it was adjacent to a large roadless area.

- In the Rocky Mountains of southeastern Wyoming, roads added to forest fragmentation more than clearcuts by dissecting large patches into smaller pieces and by converting forest interior habitat into edge habitat -- edge habitat created by roads was 1.5-2 times more than that created by clearcuts (Reed et al. 1996).

This review of road impacts illustrates the importance of limiting road building on the National Forests by protecting the remaining roadless areas.

IMPORTANCE OF ROADLESS AREAS

Scientific studies make a compelling case for the importance of roadless areas as refugia for biodiversity and as areas of high forest integrity (Noss et al. 1999, DeVelice and Martin 2001, Strittholt and DellaSala 2001). Using Geographic Information Systems mapping, DeVelice and Martin (2001) report that protection of inventoried roadless areas would accomplish the following:

- expand the representativeness of the nation's protected areas so they capture a range of habitat types (not just high elevation – "rock and ice");
- increase the area of protection at lower elevations where fish and wildlife tend to concentrate; and
- increase the number of areas large enough to provide refugia for species needing intact areas relatively undisturbed by people.

While large inventoried roadless areas are mostly associated with forests in the western United States, eastern forests, because of a longer history of road building and logging, have fewer large areas remaining, making a compelling case for protecting smaller (1,000-5,000 acre) unroaded blocks (also see Strittholt and DellaSala 2001). Smaller unroaded areas provide the "building blocks" needed for restoring large intact forests overtime, particularly if they can be combined with strategic road closures and clustered spatially.

The two case study assessments of roadless areas that follow provide extensive documentation of roadless area importance for several ecoregions in the Pacific Northwest and southeast Alaska, including many identified by WWF scientists as among the planet's most biologically diverse (Ricketts et al. 1999, DellaSala et al. 1999).

ROADLESS AREA CONSERVATION ASSESSMENTS – CASE STUDIES

The following case studies reflect a summation of Geographic Information System (GIS) computer mapping and the latest satellite imagery and published databases on Inventoried Roadless Areas to define their importance to conservation. The information presented here is based on published methodologies in the scientific literature on roadless areas (Strittholt and DellaSala 2001, DeVelice and Martin 2001).

PACIFIC NORTHWEST ECOREGIONS

SUMMARY

The objective of this assessment was to evaluate the contribution roadless areas make to complementing the existing reserve network for six ecoregions primarily encompassing the range of the northern spotted owl *(Strix occidentalis caurina*) in the Pacific Northwest, including forests east and west of the Cascades in Oregon, Washington, and northern California. By quantifying the spatial extent of several ecological attributes, we demonstrated that roadless areas contribute significantly to many ecological values worthy of protection, including:

(1) overall levels of federal lands in protection;
(2) key watersheds essential for salmon survival;
(3) locations of threatened and endangered species locations;
(4) late-seral (mature/old growth) forests,
(5) elevation representation,
(6) physical habitat representation, and
(7) plant community representation

The importance of each of the above attributes in roadless areas varied across ecoregions and is summarized as follows.

(1) PROTECTED AREAS - Area and percent of ecoregion totals for existing protected areas, inventoried roadless areas (IRAs), and combined for each of the six ecoregions in the Pacific Northwest shows a wide range of outcomes. Overall, IRAs added 3,703,636 acres (~7%) in enhanced land protection for the Pacific Northwest. Greatest IRA area total was for the Klamath-Siskiyou Forests (KSF) ecoregion, but greater proportions were realized for the two Northern Cascades ecoregions (Cascades Mountain Leeward Forests (CMLF) and Northern Cascades Forest (NCF)). The two ecoregions that gained the least amount of percent area included the Oregon and Washington coastal ecoregion (Central Pacific Coast Forest (CPCF), 1%) and the ecoregion east of the Cascade crest (East Cascades Forest (ECF), 3%)

(2) KEY WATERSHEDS FOR AQUATIC SPECIES - IRAs are very important in providing substantial amounts of key watershed area throughout much of the Pacific Northwest. This was particularly true for the two northern Cascades ecoregions (CMLF and NCF) and the KSF. Further protection of these key watersheds is required especially in the other three ecoregions.

(3) THREATENED AND ENDANGERED SPECIES LOCATIONS - results were highly variable depending on the ecoregion. IRAs were found to contribute to conservation of threatened and endangered species in all cases to some degree. IRAs throughout most of this region contributed little to additional species being represented with the notable exception of CSCF showing a significant increase in additional animal species and CMLF showing a similar result but for plant species. Increases in element occurrences (EOs) were minimal for CPCF and ECF, medium to high for the CSCF and KSF, and very high for plant records only in CMLF and NCF.

(4) LATE SERAL FORESTS - According to 2000 Landsat 7 satellite interpretation, approximately 22.4 million acres of late seral (>80 years old) forest still remain in the Pacific Northwest. Of the 8.2 million acres of existing protected areas (GAP Status 1 and 2), 4 million acres are older forest. Inventoried roadless areas contribute another 3.6 million acres of land (approximately 7% of the Pacific Northwest) and another 1.9 million acres of late-seral forest. Over half of IRAs are currently late-seral forest. Ecoregions that gained substantial areas of late seral forests included CSCF, KSF, and CMLF. NCF gained fewer acres than these ecoregions, but its 296,185 acres amounted to nearly 17 percent of the late seral forest remaining in the ecoregion.

We also examined late-seral forests by productivity category. For this analysis, three elevation bands approximated productivity. Late-seral forests were characterized as having high productivity (0-2,000 feet), medium productivity (2,000-4,000 feet), and low productivity (>4,000 feet). IRAs contributed to all three productivity classes - 48 percent for the low, 43 percent for the medium, and only 9 percent for the high classes. Protected areas and IRAs combined resulted in high representation of low productivity late-seral forests (45%), moderate representation of medium productivity late-seral forests (25%), and low representation of high productivity late-seral forests.

(5) ELEVATION REPRESENTATION - In general, results showed that IRAs occupy more low elevations of the lower elevations than do existing protected areas. For most of the ecoregions examined, IRAs expanded protection down slope from the existing higher elevation protection nodes. Public ownership is concentrated at the higher elevations of every ecoregion; therefore, it is not surprising that the higher and mid-elevations are most represented by existing protected areas and IRAs. In almost every ecoregion, IRAs filled in the remainder of the higher elevations not already part of a protected area with the majority of new area centered at mid-elevations. Peak elevation bands represented by IRAs were highest for CMLF (5,000 - 6,000 ft band) and lowest for CPCF (1,000 - 2,000 ft band). CSCF and ECF concentrated at the 4,000 - 5,000 ft interval, and NCF and KSF concentrated at the 3,000 - 4,000 ft interval. Lowest elevation in all ecoregions examined showed little protection by existing protected areas or IRAs.

(6) PHYSICAL HABITAT REPRESENTATION - Physical habitat types were defined by natural combinations of six parameters - mean annual precipitation, December/July precipitation difference, mean annual temperature, December/July temperature difference, soil depth, and soil water holding capacity (see Vance-Borland 1999 for details). A total of 45 physical habitat classes were defined and mapped for the six ecoregions examined. The Cascade ecoregions (CMLF, NCF, and CSCF) showed the least amount of physical habitat variability (5 classes each) based on the six criteria used. The Klamath-Siskiyou contained the most natural physical variability (12 classes), followed by the CPCF (10 classes), and finally the ECF (8 classes).

Three ecoregions (CPCF, CSCF, and ECF) showed very few gains in physical habitat representation with the inclusion of IRAs. In each of these ecoregions, IRAs contributed little to capture the breadth of natural variability with only one physical habitat type in each ecoregion contributing more than 10 percent to any physical class. IRAs achieved physical habitat representation far better in the northern Cascades ecoregions (CMLF and NCF) and most particularly the Klamath-Siskiyou. Three of five physical habitat types in the NCF ecoregion and 4 of 5 types in the CMLF met the 10 percent threshold. The KSF showed the broadest spectrum of physical habitat types represented in IRAs.

(7) PLANT COMMUNITY REPRESENTATION - Plant community representation was examined by combining existing U.S. Geological Survey Gap Analysis Program (GAP) data for each state, then analyzing the results by ecoregion. Plant community variability ranged from 13 natural classes (CMLF) to 49 (KSF). Plant communities are often more refined and spatially complex than the data reflected, so the findings are based on relatively coarse vegetation data. Further discrimination will be necessary at more detailed scales. In every ecoregion, IRAs contributed acreages over a large number of vegetation classes. In two cases (CPCF and ECF), IRAs did not cover a large enough area to add dramatically to plant community representation, although there were some noteworthy gains in the ECF ecoregion. In the remaining ecoregions (KSF, CSCF, CMLF, and NCF) however, IRAs played a much more important role in advancing representation. Most of the gains in the northern Cascades ecoregions (CMLF and NCF) consisted of adding to representation totals for vegetation types that already met the theoretical representation target of 25 percent. Important gains were made in the CSCF particularly with regards to adding protection to Douglas-fir/Western Hemlock and Mixed Conifer types. The Klamath-Siskiyou showed the greatest gains. IRAs elevated nine vegetation types above the 25 percent threshold and contributed significantly to fifteen more vegetation classes.

In conclusion, when roadless area attributes were combined with the existing federal network of protected areas such as National Parks, National Monuments, and Wilderness, the level of protection for all attributes rose substantially. The combination of roadless areas and existing protected areas, therefore, would achieve many conservation goals related to biodiversity, old-growth forests, key watersheds and salmon strongholds, threatened and endangered species, and many imperiled and rare habitat types on federal lands. However, while our results demonstrate the importance of roadless areas, significant levels of these attributes still remain outside roadless and existing protected areas (e.g., many threatened and endangered species locations occur outside federal lands; significant amounts of mature and old-growth forest occur outside roadless areas) warranting additional protection (also see Strittholt and DellaSala 2001). A more detailed analysis of these findings along with relevant methodologies is as follows.

GENERAL STUDY DESCRIPTION AND ROADLESS AREAS MAPPING

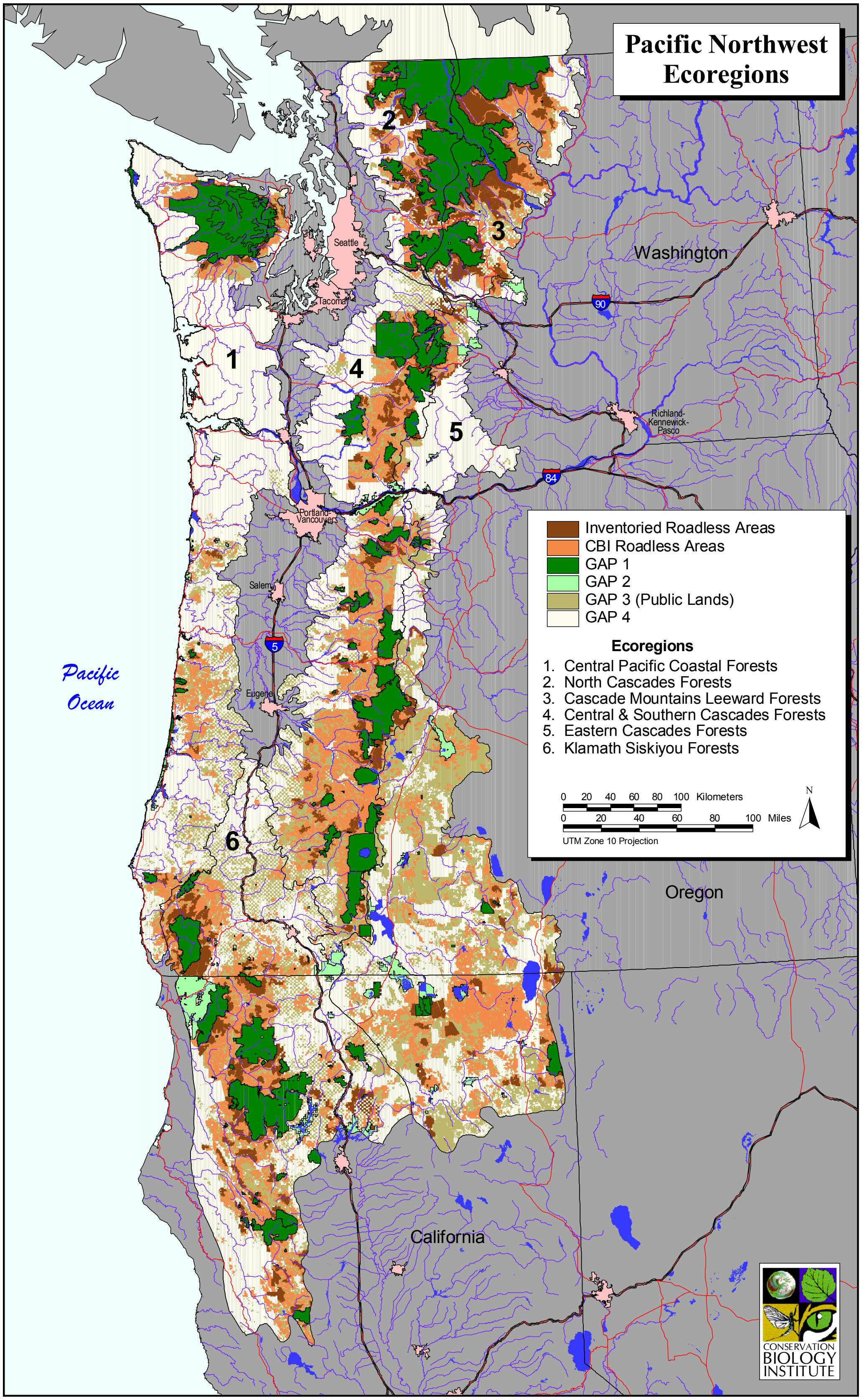
The study area for the Pacific Northwest roadless areas assessment (54,855,896 ac total area) included six different ecoregions as mapped by World Wildlife Fund: (1) Central Pacific Coastal Forests (CPCF), (2) Central & Southern Cascades Forests (CSCF), (3) Klamath-Siskiyou Forests (KSF), (4) Eastern Cascades Forests (ECF), (5) Cascade Mountains Leeward Forests (CMLF), and (6) North Cascades Forests (NCF). A map of the study area showing existing protected areas and inventoried roadless areas (IRAs) is provided in Figure 1. Ecoregion maps are provided in Figures 2 - 6.

The objective of this assessment was to evaluate the contribution roadless areas make to conservation in the Pacific Northwest using previously published methodologies (Strittholt and DellaSala 2001). Ecological attributes evaluated for roadless areas included the following:

(1) key watersheds for aquatic species,
(2) threatened and endangered species locations,
(3) late-seral (mature/old growth) forests,
(4) elevation representation,
(5) physical habitat representation, and
(6) plant community representation.

Although we examined roadless areas 1,000 acres in size or larger in the assessment, this case study focuses only on the inventoried roadless areas (IRAs) component (generally >5,000 acres) as mapped by the USDA Forest Service and included in the Roadless Areas Final Rule issued by the Clinton Administration on January 12, 2001. Area and percent of ecoregion totals for existing protected areas, inventoried roadless areas (IRAs), and combined for each of the six ecoregions in the Pacific

Northwest is provided in Table 1 and shows a wide range of outcomes depending on the ecoregion. Protected areas included all GAP Status 1 (strict protection) and GAP Status 2 (moderate protection) lands categorized by the U.S. Geological Survey Gap Analysis Project. Overall, IRAs added 3,703,636 ac (~7%) in enhanced land protection for the Pacific Northwest. Greatest IRA area total was for the Klamath-Siskiyou Forests ecoregion, but greater proportions were realized for the two Northern Cascades ecoregions (CMLF and NCF). The two ecoregions that gained the least amount of percent area included the Oregon and Washington coastal ecoregion (CPCF, 1%) and the ecoregion east of the Cascade crest (ECF, 3%) because these areas were heavily roaded. In general, IRAs contributed significantly to the reserve network in the Pacific Northwest, but by themselves are inadequate of protecting the full range of conservation values for the region. Our results are consistent with similar studies of roadless contributions (Strittholt and DellaSala 2001, DeVelice and Martin 2001).



Pacific Northwest Ecoregions
Inventoried Roadless Areas
CBI Roadless Areas
GAP 1
GAP 2
GAP 3 (Public Lands)
GAP 4
Ecoregions
1. Central Pacific Coastal Forests
2. North Cascades Forests
3. Cascade Mountains Leeward Forests
4. Central & Southern Cascades Forests
5. Eastern Cascades Forests
6. Klamath Siskiyou Forests
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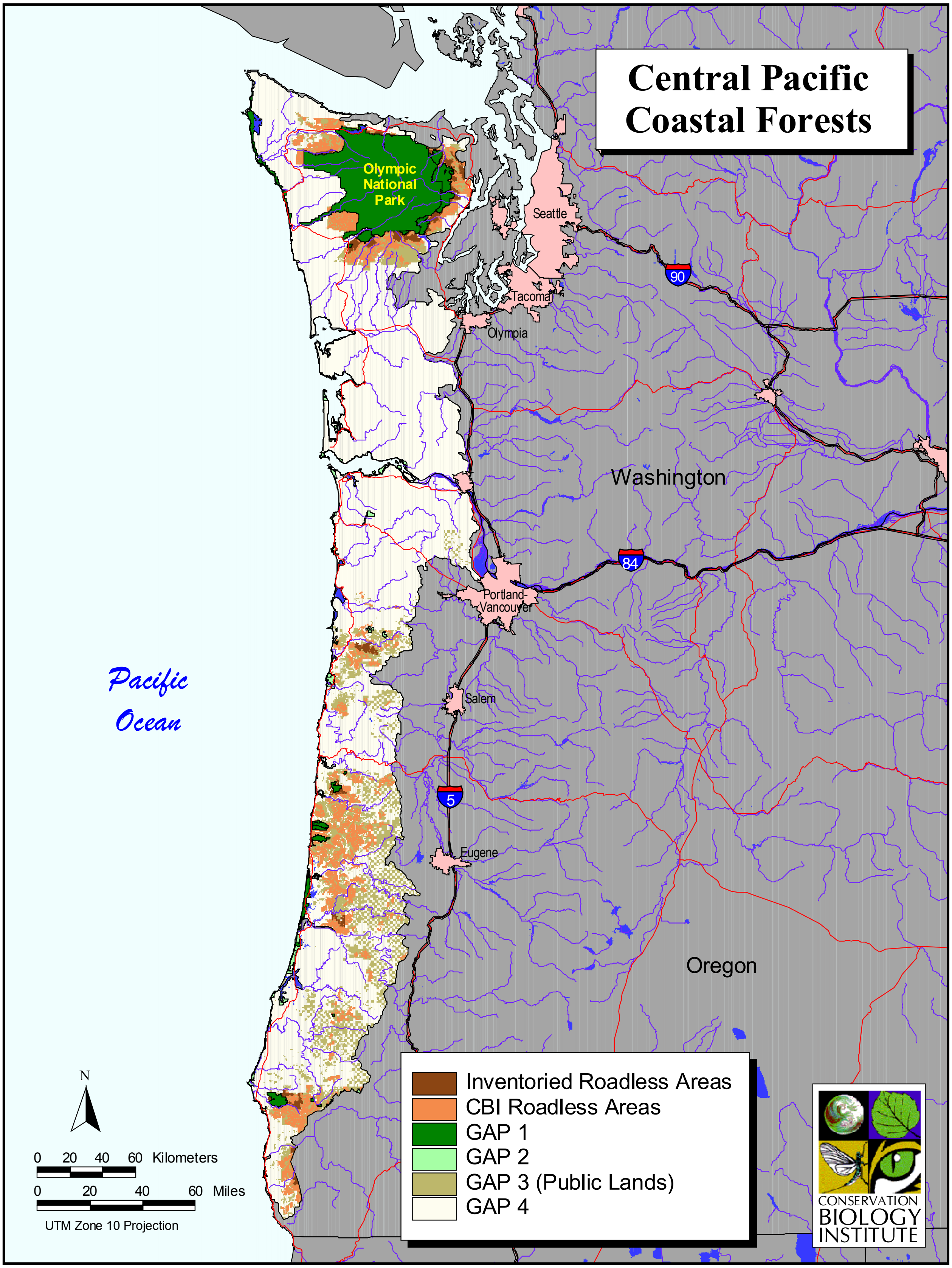
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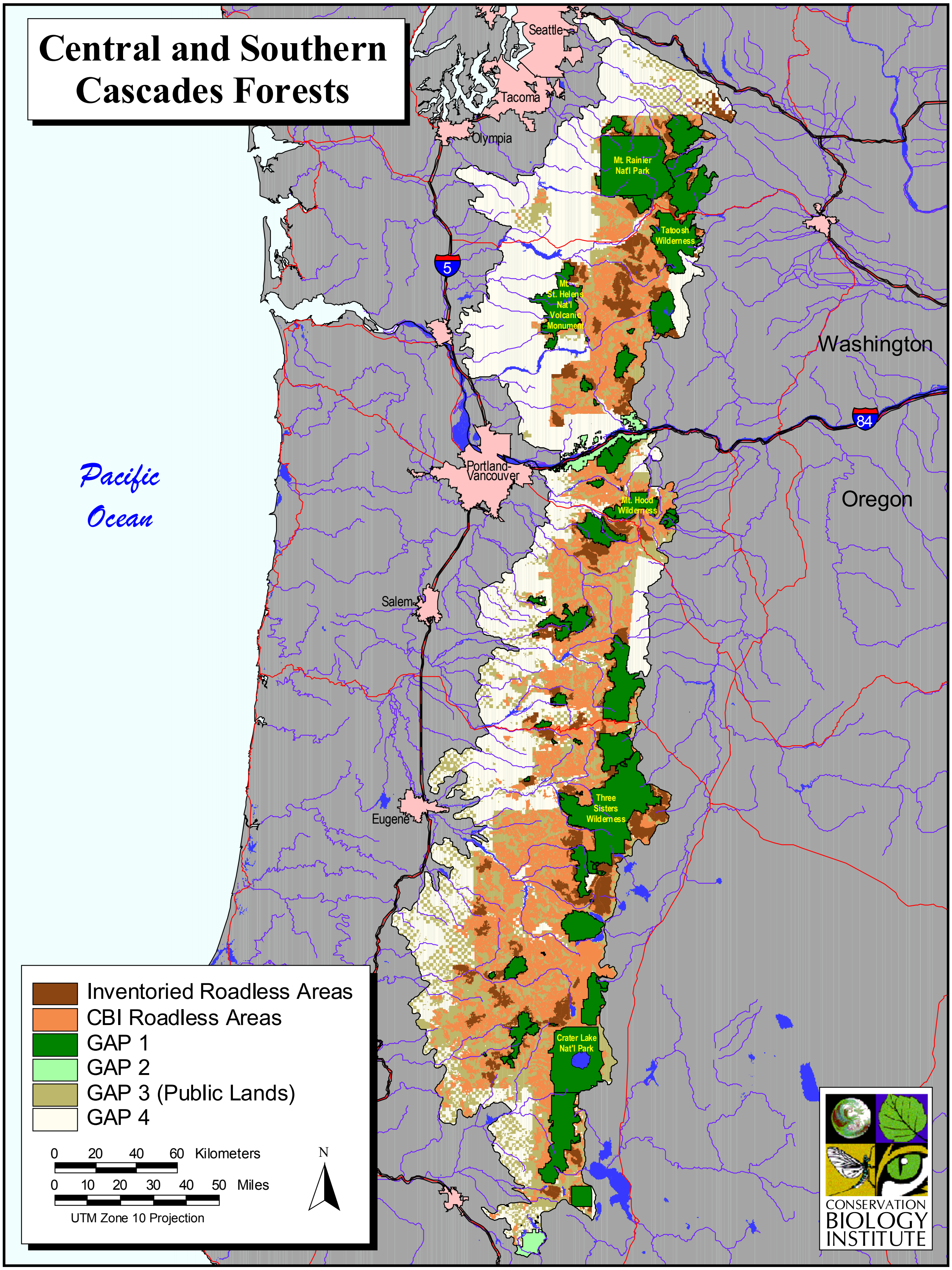
Central and Southern Cascades Forests
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Tacoma
Olympia
Mt. Rainier Nat'l Park
Tatoosh Wilderness
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Mt. St. Helens Nat'l Volcanic Monument
Washington
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Portland-Vancouver
Oregon
Pacific Ocean
Mt. Hood Wilderness
Salem
Three Sisters Wilderness
Eugene
Crater Lake Nat'l Park
Inventoried Roadless Areas
CBI Roadless Areas
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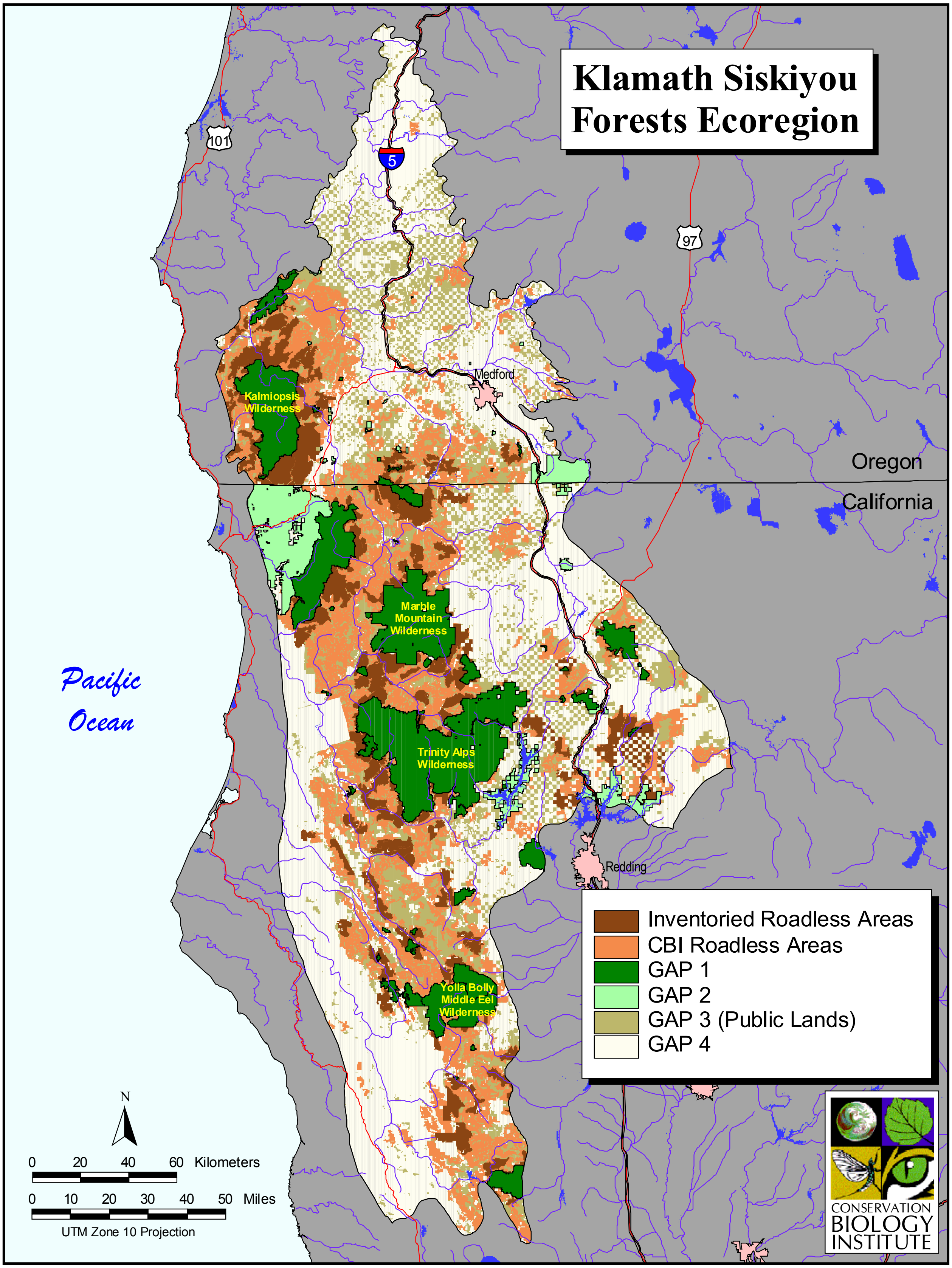

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Marble Mountain Wilderness
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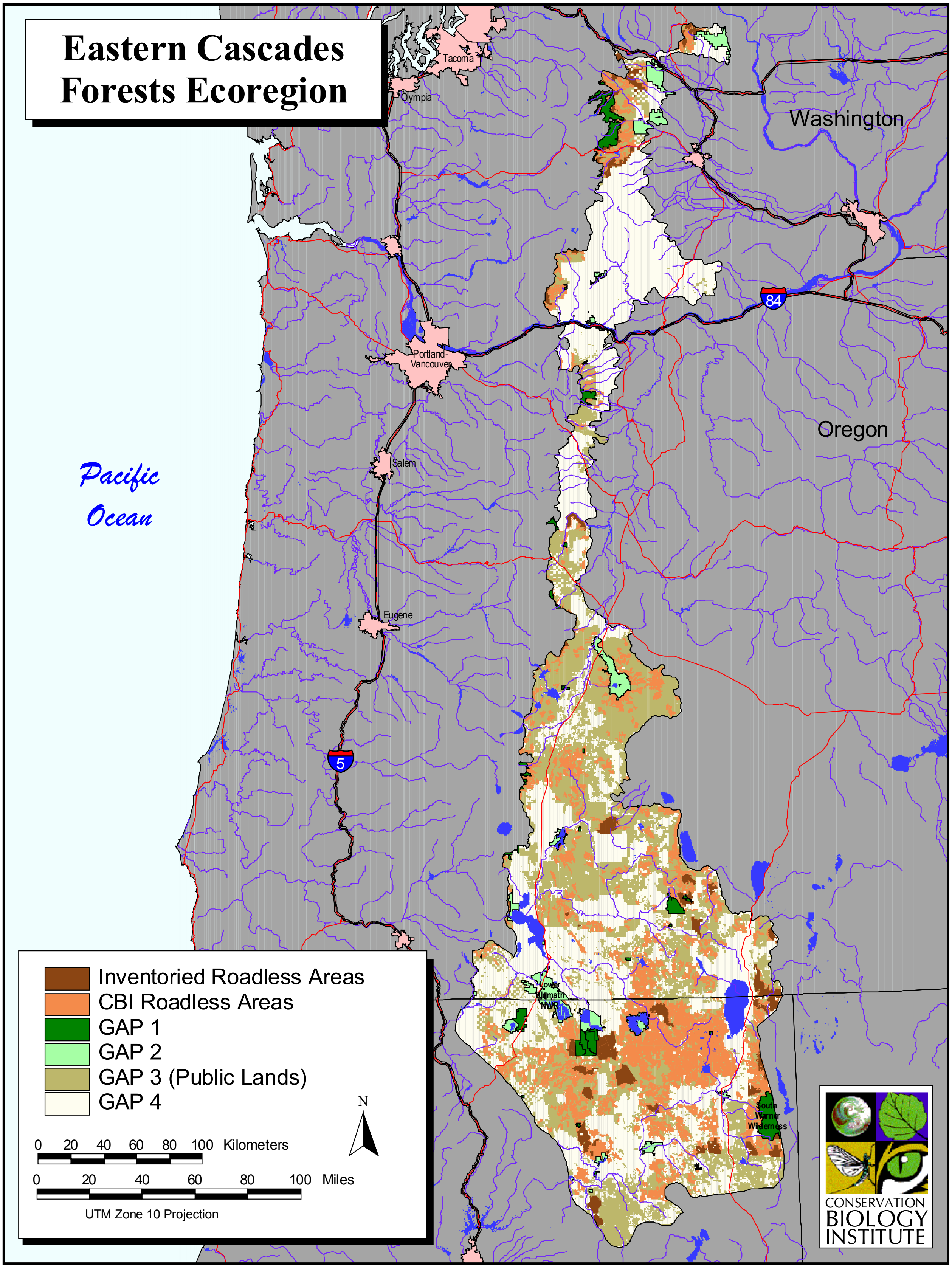
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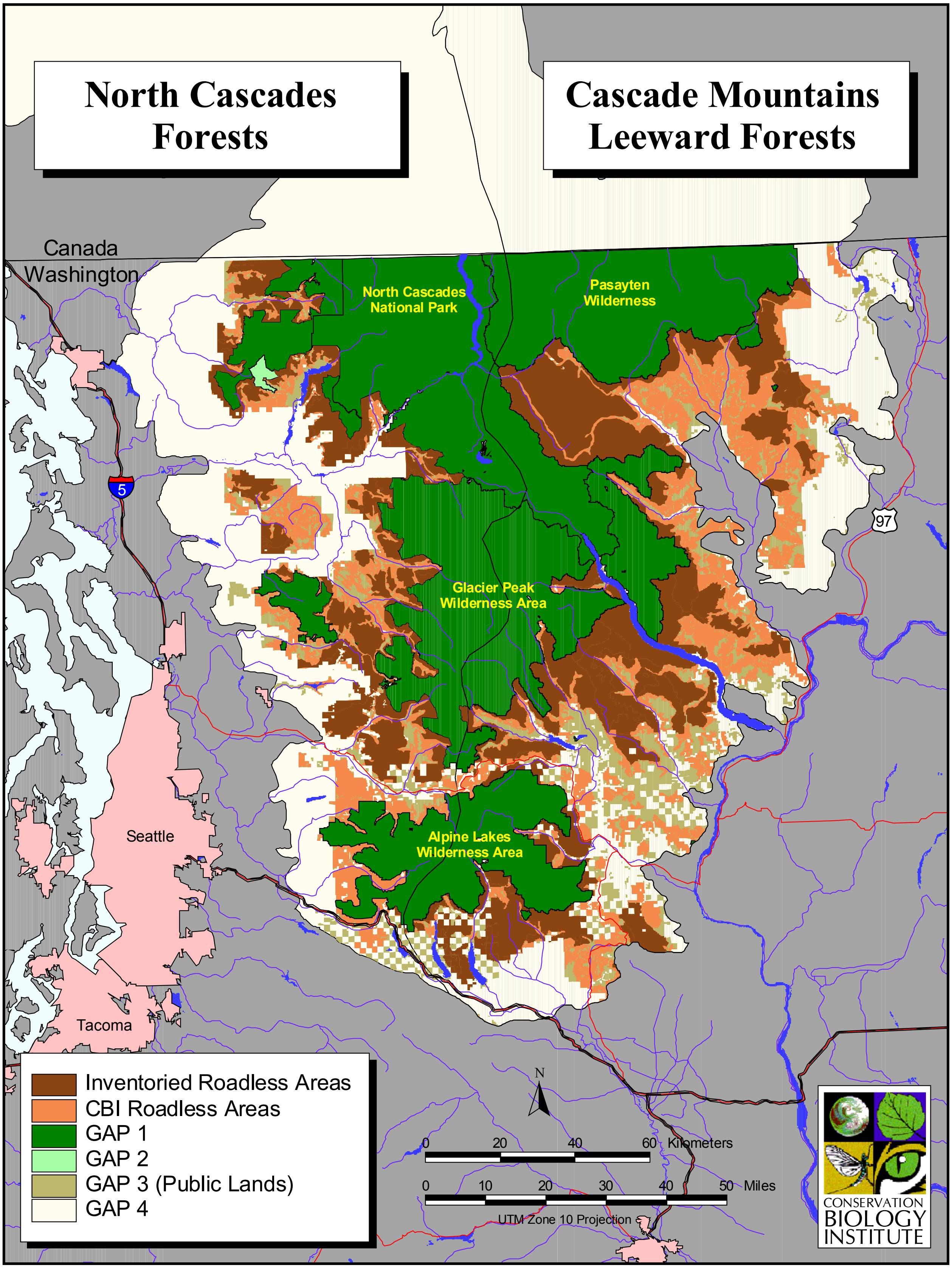
North Cascades Forests
Cascade Mountains Leeward Forests
Canada
Washington
North Cascades National Park
Pasayten Wilderness
5
97
Glacier Peak Wilderness Area
Alpine Lakes Wilderness Area
Seattle
Tacoma
Inventoried Roadless Areas
CBI Roadless Areas
GAP 1
GAP 2
GAP 3 (Public Lands)
GAP 4
N
0 20 40 60 Kilometers
0 10 20 30 40 50 Miles
UTM Zone 10 Projection
CONSERVATION BIOLOGY INSTITUTE

Table 1. Area and percent of ecoregion totals for existing protected areas (GAP Status 1 and 2), inventoried roadless areas (IRAs), and combined for each of the six ecoregions in the Pacific Northwest.

Ecoregion	Ecoregion Area (ac)	Existing Protected Areas (ac)		Inventoried Roadless Areas (IRAs)				Combined Protected Area and IRAs	
		Area (ac)	% of Ecoregion	Area (ac)	Already Protected (ac)	New Area (ac)	% of Ecoregion	Area (ac)	% of Ecoregion
CPCF	10,546,053	1,116,813	11%	156,612	9,439	147,173	1%	1,263,986	12%
CSCF	11,073,090	1,982,725	18%	787,621	27,690	759,931	7%	2,742,657	25%
KSF	12,436,820	1,849,165	15%	1,197,857	93,535	1,104,322	9%	2,953,487	24%
ECF	13,687,259	651,887	5%	468,511	28,735	439,776	3%	1,091,663	8%
CMLF	3,954,643	1,343,816	34%	857,153	0	857,153	22%	2,200,969	56%
NCF	3,158,032	1,274,952	40%	395,281	0	395,281	13%	1,670,233	53%
Totals	54,855,896	8,219,359	15%	3,863,035	159,399	3,703,636	7%	11,922,995	22%

CPCF - Central Pacific Coastal Forests
CSCF - Central-Southern Cascades Forests
KSF - Klamath-Siskiyou Forests
ECF - Eastern Cascades Forests
CMLF - Cascades Mountain Leeward Forests
NCF - Northern Cascades Forests

KEY WATERSHEDS FOR AQUATIC SPECIES

Key watersheds are watersheds identified by fisheries biologists during the development of what became the Northwest Forest Plan that were important areas for persistence and recovery of aquatic species particularly salmon (Table 2).

Table 2. Area (ac) of each ecoregion in the Pacific Northwest study area, key watershed area by ecoregion, and percent of ecoregion identified as key watershed.

Ecoregion Name	Ecoregion Area	Key Watershed Area	Percent Key Watershed
CPCF - Central Pacific Coastal Forests	10,546,053	1,255,394	12
CSCF - Central-Southern Cascades Forests	11,073,090	3,040,986	27
KSF - Klamath-Siskiyou Forests	12,436,820	2,717,865	22
ECF - Eastern Cascades Forests	13,687,259	623,621	5
CMLF - Cascades Mountain Leeward Forests	3,954,643	1,454,206	37
NCF - Northern Cascades Forests	3,158,032	1,085,792	34
Totals	54,855,896	10,177,864	18

Results showed that IRAs are very important in providing substantial amounts of key watershed area throughout much of the Pacific Northwest. This was particularly true for the two northern Cascades ecoregions (CMLF and NCF) and the Klamath-Siskiyou. Further protection of key watersheds is required especially in the other three ecoregions (Table 3).

Table 3. Summary of inclusion of key watersheds within existing protected areas and inventoried roadless areas (IRA) by ecoregion.

	CPCF	CSCF	KSF	ECF	CMLF	NCF	Total PNW
Percent KWS	12	27	21	5	37	34	18
Percent KWS Protected	19	28	37	13	45	48	33
Percent KWS in IRA	7	11	21	5	27	20	16
Area (ac) KWS Protected + IRA	326,402	1,185,984	1,576,362	112,253	1,047,027	738,337	4,986,364
Percent KWS Protected + IRA	**26**	**39**	**58**	**18**	**72**	**68**	**49**

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THREATENED AND ENDANGERED SPECIES

The distribution of threatened and endangered species can be tracked in various ways; however, we chose published databases of state- and federally-listed species available from state heritage programs and summarized the findings according to existing protected areas and IRAs. For general reporting purposes, we separate animal and plant species records (elemental occurrences – EOs), but combine the various status codes (G1/G2, S1/S2, and S3) in the ecoregional summaries presented in Table 4. In Table 5, we report on the three status categories separately. The status categories examined included: globally imperiled species (G1/G2), state imperiled species (S1/S2), and species that demonstrate restricted ranges or are generally rare at the state level (S3). Inventoried roadless areas contain very different levels of EOs by ecoregion, but in every case contribute something to conserving these species. For the two northern Cascades ecoregions (CMLF and NCF) and the Klamath-Siskiyou, IRAs picked up more plant records than animal ones. For the other three ecoregions, percent of EOs in IRAs was generally lower and more balanced between plants and animals.

Table 4. Threatened and endangered animal and plant element occurrence (EO) totals for each ecoregion in the Pacific Northwest (all three status levels combined), including number and percent of EOs inside existing protected areas (GAP Status 1 and 2), inventoried roadless areas (IRAs), and combined.

	Total EOs	Protected EOs	Percent EOs Protected	IRA EOs	**Percent EOs IRA**	Combined EOs	**Percent EOs Combined**
CPCF							
animal species	3,093	640	20%	117	**4%**	757	**24%**
plant species	880	251	28%	27	**3%**	278	**32%**
CSCF							
animal species	3,836	678	18%	659	**17%**	1,337	**35%**
plant species	1,661	398	24%	214	**13%**	612	**37%**
KSF							
animal species	2,744	206	7%	239	**9%**	445	**16%**
plant species	4,871	665	13%	810	**17%**	1,475	**30%**
ECF							
animal species	3,797	312	8%	99	**3%**	411	**11%**
plant species	1,679	116	7%	59	**3%**	175	**10%**
CMLF							
animal species	2,994	368	12%	753	**25%**	1,121	**37%**
plant species	832	230	27%	271	**33%**	501	**60%**
NCF							
animal species	581	129	23%	49	**8%**	178	**31%**
plant species	195	69	35%	50	**26%**	119	**61%**

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Total number of imperiled animal and plant species and actual number of occurrences (EOs) were tracked separately for each status category separately for the entire ecoregion, existing protected areas (GAP Status 1 and 2 lands), inventoried roadless areas (IRAs), and combined existing protected areas and inventoried roadless areas (Table 5). Highlights for each ecoregion include —

CPCF - Number of additional plant and animal species picked up by IRAs was low (3 additional S3 animal species, 6 additional G1/G2 plant species, and 4 additional S1/S2 species). Increases in EOs were minor for all status classes.

CSCF - Number of additional animal species picked up by IRAs was significant (14 additional G1/G2 animal species, 18 additional S1/S2 animal species, and 7 additional S3 animal species) as were increases in EOs overall (9 - 30% depending on the status class). No new plant species were added with IRAs; however, there were modest gains in the representation of EOs found in the existing protected areas (10 - 18% depending on the status class).

KSF - Number of additional animal species picked up by IRAs was minimal (1 additional G1/G2 species and 4 additional S1/S2 species). Number of additional EOs for animal species was also low with the possible exception of S3 species, which showed an increase of 14% within IRAs. Number of additional plant species was a bit higher with 5 new G1/G2 species, 17 new S1/S2 species, and 3 new S3 species. Increases in EOs for plants were more significant (15% increase in G1/G2 species, 15% increase in S1/S2 species, and 26% increase in S3 species).

ECF - Increases in the number of animal species picked up by IRAs was somewhat low (4 additional G1/G2 species, 8 additional S1/S2 species, and 5 additional S3 species). Percent increase in EOs for these species was slight. New plant species included only 1 additional G1/G2 species, 7 additional S1/S2 species, and 1 additional S3 species. Increase in EOs for plants were also quite low (all below 5%).

CMLF - Number of additional animal species was very low except for S3 species (6 additional species added); however, EOs for all of the status classes was quite high (18 - 29% increases). Plants displayed a similar pattern with only 7 additional species encountered in the S1/S2 status class and relatively high EOs (29 - 35% increases).

NCF - Number of additional animal and plant species was minimal (<2) for all status classes except for S3 plants, which showed a very high increase in new species (37). EOs was generally low for animals (6 - 13%) and higher for plants (21% for S1/S2 species and 30% for S3 species).

Table 5. Summaries of threatened and endangered species using element occurrences (EO) contained within existing protected areas (GAP Status 1 and 2), inventoried roadless areas (IRAs), and combined totals by ecoregion.

CPCF - Central Pacific Coastal Forests							
Animal Species	Total	Protected	Protected Percent	IRA	IRA Percent	Combined	Combined Percent
No. of G1/G2 species	7	2	29	1	14	2	29
EO of G1/G2 species	377	117	31	2	**<1**	119	**32**
No. of S1/S2 species	23	9	39	4	17	9	39
EO of S1/S2 species	1001	215	21	54	**5**	369	**27**
No. of S3 species	32	19	59	11	34	20	62
EO of S3 species	1715	208	12	61	**4**	269	**16**
Plant Species	Total	Protected	Protected Percent	IRA	IRA Percent	Combined	Combined Percent
No. of G1/G2 species	17	3	53	1	6	10	59
EO of G1/G2 species	188	31	16	1	**<1**	32	**17**
No. of S1/S2 species	111	57	51	14	13	61	55
EO of S1/S2 species	596	194	33	26	**4**	220	**37**
No. of S3 species	13	8	61	0	0	8	61
EO of S3 species	96	26	27	0	**0**	26	**27**
CSCF - Central-Southern Cascades Forests							
Animal Species	Total	Protected	Protected Percent	IRA	IRA Percent	Combined	Combined Percent
No. of G1/G2 species	14	4	29	5	36	6	43
EO of G1/G2 species	125	27	22	11	**9**	38	**30**
No. of S1/S2 species	28	13	46	16	57	18	64
EO of S1/S2 species	160	77	48	48	**30**	125	**78**
No. of S3 species	41	20	49	17	41	23	56
EO of S3 species	3551	574	16	600	**17**	1174	**33**
Plant Species	Total	Protected	Protected Percent	IRA	IRA Percent	Combined	Combined Percent
No. of G1/G2 species	17	8	47	8	47	8	47
EO of G1/G2 species	264	64	24	27	**10**	91	**34**
No. of S1/S2 species	88	42	48	28	32	42	48
EO of S1/S2 species	888	229	26	97	**11**	326	**37**
No. of S3 species	18	12	67	13	72	12	67
EO of S3 species	509	105	21	90	**18**	195	**38**
KSF - Klamath-Siskiyou Forests							
Animal Species	Total	Protected	Protected Percent	IRA	IRA Percent	Combined	Combined Percent
No. of G1/G2 species	6	2	33	2	33	3	50
EO of G1/G2 species	46	7	15	2	**4**	9	**20**
No. of S1/S2 species	30	10	33	11	37	14	47
EO of S1/S2 species	1362	45	3	55	**4**	100	**7**
No. of S3 species	26	13	50	9	35	13	50
EO of S3 species	1336	154	11	182	**14**	336	**25**
Plant Species	Total	Protected	Protected Percent	IRA	IRA Percent	Combined	Combined Percent
No. of G1/G2 species	65	28	43	21	32	33	51
EO of G1/G2 species	1358	188	14	208	**15**	396	**29**
No. of S1/S2 species	168	65	39	60	36	82	49
EO of S1/S2 species	2934	382	13	454	**15**	836	**28**
No. of S3 species	19	8	42	10	53	11	58

EO of S3 species	579	95	16	148	**26**	243	**42**
ECF - Eastern Cascades Forests							
Animal Species	Total	Protected	Protected Percent	IRA	IRA Percent	Combined	Combined Percent
No. of G1/G2 species	18	6	33	5	28	10	56
EO of G1/G2 species	243	23	9	5	**2**	28	**11**
No. of S1/S2 species	37	20	54	14	38	28	76
EO of S1/S2 species	2418	151	6	18	**1**	169	**7**
No. of S3 species	43	19	44	11	26	24	56
EO of S3 species	1136	138	12	76	**7**	214	**19**
Plant Species	Total	Protected	Protected Percent	IRA	IRA Percent	Combined	Combined Percent
No. of G1/G2 species	16	8	50	3	19	9	56
EO of G1/G2 species	112	13	12	4	**4**	17	**15**
No. of S1/S2 species	87	32	37	12	14	39	45
EO of S1/S2 species	479	57	12	26	**5**	83	**17**
No. of S3 species	22	11	50	8	36	12	54
EO of S3 species	1088	46	4	29	**3**	75	**7**
CMLF - Cascades Mountain Leeward Forests							
Animal Species	Total	Protected[1]	Protected Percent	IRA[2]	IRA Percent	Combined	Combined Percent
No. of G1/G2 species[3]	4	3	75	3	75	3	75
EO[4] of G1/G2 species	1025	141	14	301	**29**	442	**43**
No. of S1/S2 species[5]	8	5	62	6	75	6	75
EO of S1/S2 species	1208	156	13	312	**26**	468	**39**
No. of S3 species[6]	36	13	36	13	36	19	53
EO of S3 species	761	71	9	140	**18**	211	**28**
Plant Species	Total	Protected	Protected Percent	IRA	IRA Percent	Combined	Combined Percent
No. of G1/G2 species	7	5	71	3	43	5	71
EO of G1/G2 species	55	12	22	16	**29**	28	**51**
No. of S1/S2 species	57	36	63	29	51	43	75
EO of S1/S2 species	369	127	34	114	**31**	241	**65**
No. of S3 species	15	13	87	12	80	14	93
EO of S3 species	408	91	22	141	**35**	232	**57**
NCF - Northern Cascades Forests							
Animal Species	Total	Protected	Protected Percent	IRA	IRA Percent	Combined	Combined Percent
No. of G1/G2 species	5	3	60	4	80	4	80
EO of G1/G2 species	182	39	21	11	**6**	50	**28**
No. of S1/S2 species	8	5	62	4	50	6	75
EO of S1/S2 species	197	43	22	11	**6**	54	**27**
No. of S3 species	14	8	57	5	36	9	64
EO of S3 species	202	47	23	27	**13**	74	**37**
Plant Species	Total	Protected	Protected Percent	IRA	IRA Percent	Combined	Combined Percent
No. of G1/G2 species	1	0	0	0	0	0	0
EO of G1/G2 species	2	0	0	0	**0**	0	**0**
No. of S1/S2 species	26	14	54	11	42	16	61
EO of S1/S2 species	89	23	26	19	**21**	42	**47**
No. of S3 species	10	9	90	8	80	10	100
EO of S3 species	104	40	38	31	**30**	77	**68**

LATE-SERAL FORESTS

Based on Landsat 7 satellite imagery obtained in 2000, approximately 22 million acres (36%) of the Pacific Northwest (East Cascades to the Pacific and U.S.-Canada border to northern California) has been classified as late-seral forest (>80 years old). These forests are not distributed uniformly across the landscape with over half located in two ecoregions - Central and Southern Cascades Forests and Klamath-Siskiyou Forests (Table 6).

Table 6. Distribution of late-seral forest (>80 years old) throughout the Pacific Northwest, U.S.

Ecoregion	Ecoregion Area (ac)	Late-Seral Forest Area (ac)	Percent Late-Seral Forest
CPCF	10,546,053	3,470,080	32.90%
CSCF	11,073,090	5,507,419	49.73%
KSF	12,436,820	5,402,886	43.44%
ECF	13,687,259	2,905,196	21.22%
CMLF	3,954,643	1,744,094	44.10%
NCF	3,158,032	1,767,706	55.97%
WVF	3,676,227	754,522	20.52%
PLF	4,249,384	868,684	20.44%
Totals	62,432,866	22,420,587	35.91%

CPCF - Central Pacific Coastal Forests
CSCF - Central-Southern Cascades Forests
KSF - Klamath-Siskiyou Forests
WVF - Willamette Valley Forests
ECF - Eastern Cascades Forests
CMLF - Cascades Mountain Leeward Forests
NCF - Northern Cascades Forests
PLF - Puget Lowland Forests

Likewise, distribution of late-seral forests also differs according to ownership. Approximately 24 million acres (38%) of this region of the Pacific Northwest is under public ownership, which contains 14.6 million acres (approximately 2/3) of all late-seral forests. Total area of existing protected areas (GAP Status 1 and 2) is 8.2 million acres with nearly half of this land area (4 million acres) in late-seral forest. Inventoried roadless areas (IRAs) would contribute another 3.6 million acres of land (approximately 7% of the Pacific Northwest) and another 1.9 million acres of late-seral forest. Over half of IRAs are currently late-seral forest. Ecoregions that gained substantial areas of late-seral forests included CSCF, KSF, and CMLF. NCF gained fewer acres than these ecoregions, but its 296,185 acres amounted to nearly 17 percent of the late-seral forest remaining in the ecoregion (Table 7).

We also examined late-seral forests by productivity category. For this analysis, three elevation bands approximated productivity. Late-seral forests were characterized as having high productivity (0-2,000 feet), medium productivity (2,000-4,000 feet), and low productivity (>4,000 feet). IRAs contributed to all three productivity classes - 48 percent for the low, 43 percent for the medium, and only 9 percent for the high classes (Table 8). Protected areas and IRAs combined resulted in high representation of low productivity late-seral forests (45%), moderate representation of medium productivity late seral forests (25%), and low representation of high productivity late-seral forests.

Table 7. Summary statistics by ecoregion for all late-seral forest (>80 years old) including total area, protected acres, IRA acres, and combined totals.

Ecoregion	Late-Seral Forest Area (ac)	Late-Seral Forest in Protected Areas (ac)	Percent of Late-Seral Forest in Protected Areas	Late-Seral Forest in IRAs (ac)	Percent of Late-Seral Forest in Protected Areas	Combined Late-Seral Forest Area (ac)	Percent of Combined Late-Seral Forest Area
CPCF	3,470,080	701,552	20.22%	91,918	2.65%	793,470	22.87%
CSCF	5,507,419	1,028,859	18.68%	496,010	9.01%	1,524,869	27.69%
KSF	5,402,886	789,292	14.61%	473,678	8.77%	1,262,970	23.37%
ECF	2,905,196	144,647	4.98%	132,935	4.57%	277,582	9.55%
CMLF	1,744,094	649,087	37.22%	449,666	25.78%	1,098,753	63.00%
NCF	1,767,706	679,553	38.44%	296,185	16.75%	975,738	55.20%
WVF	754,522	2,236	0.30%	0	0.00%	2,236	0.30%
PLF	868,684	4,188	0.48%	0	0.00%	4,188	0.48%
Totals	22,420,587	3,999,414	17.84%	1,940,392	8.65%	5,939,806	26.49%

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ECF - Eastern Cascades Forests
CMLF - Cascades Mountain Leeward Forests
NCF - Northern Cascades Forests
PLF - Puget Lowland Forests

Table 8. Summary statistics on late-seral forest according to forest productivity classes including total area, protected area, IRAs, and combined totals.

Productivity Status	Total Area (ac)	Public Area (ac)	Percent of Status Class	Protected Area (ac)	Percent of Status Class	IRA Area (ac)	Percent of Status Class	Combined Area (ac)	Percent of Status Class
High	6,675,005	2,194,464	32.88%	403,274	6.04%	162,831	2.44%	566,106	8.48%
Medium	8,603,035	5,383,546	62.58%	1,347,736	15.67%	842,863	9.80%	2,190,599	25.46%
Low	7,142,548	6,996,295	97.95%	2,248,403	31.48%	934,698	13.09%	3,183,098	44.57%
Totals	22,420,588	14,574,304	65.00%	3,999,414	17.84%	1,940,392	8.65%	5,939,803	26.49%

ELEVATION REPRESENTATION

Ecosystem representation can be evaluated in various ways. For this assessment, we examined this important conservation consideration in three different ways - elevation, physical habitats, and dominant plant communities. This analysis reviews the results for the first approach - elevation. Elevation is one of several important drivers of regional biodiversity. Distinct natural communities are often distributed along elevation gradients and are therefore important to evaluate.

In general, results showed that IRAs occupy more of the lower elevations than existing protected areas. Part of this is because most, if not all, of the higher elevations are already under protected status. For most ecoregions, IRAs just expanded protection down slope from the existing higher elevation protection nodes (Table 9). In addition, it is important to point out that the opportunity for protecting each elevation band depends to a large extent on the amount of public ownership. For this study area, like in most mountainous regions, public ownership is skewed toward higher, less productive lands. Public ownership is 74 percent for areas >4,000 feet, 60 percent for mid-elevations (2,000 - 4,000), and 27% for lower elevations (0 - 2,000 feet). Summary tables and histograms for each ecoregion are provided in Plates 1-6. In almost every case, the histograms and accompanying tables show IRAs filling in the remainder of the higher elevations, but with the majority of new area centered at mid-elevations. Peak elevation bands represented by IRAs were highest for CMLF (5,000 - 6,000 ft band) and lowest for CPCF (1,000 - 2,000 ft band). CSCF and ECF concentrated at the 4,000 - 5,000 ft interval, and NCF and KSF concentrated at the 3,000 - 4,000 ft interval. Lowest elevation in all ecoregions examined shows little protection by existing protected areas or IRAs.

Table 9. Summary totals for 10 elevation bands for all ecoregions including total area, protected areas, IRAs, and combined area. Shaded area highlights peak elevation bands represented in total area.

Elevation Band (ft)	Total Area (ac)	Percent	Existing Protected Area (ac)	Percent of Band Protected	IRA Area (ac)	Percent of Band in IRA	Combined Area (ac)	Percent of Band Combined
0-1,000	7,879,153	14.36%	270,751	3.44%	64,203	0.81%	334,954	4.25%
1,000-2,000	8,273,418	15.08%	497,074	6.01%	237,345	2.87%	734,418	8.88%
2,000-3,000	8,911,174	16.24%	885,498	9.94%	613,226	6.88%	1,498,724	16.82%
3,000-4,000	8,649,404	15.77%	1,319,432	15.25%	877,111	10.14%	2,196,544	25.40%
4,000-5,000	11,251,192	20.51%	1,977,906	17.58%	854,951	7.60%	2,832,857	25.18%
5,000-6,000	6,737,730	12.28%	1,790,760	26.58%	600,502	8.91%	2,391,263	35.49%
6,000-7,000	2,523,204	4.60%	1,081,630	42.87%	342,751	13.58%	1,424,381	56.45%
7,000-8,000	537,898	0.98%	318,779	59.26%	105,185	19.55%	423,964	78.82%
8,000-9,000	63,178	0.12%	50,023	79.18%	7,802	12.35%	57,825	91.53%
>9,000	29,545	0.05%	27,506	93.10%	559	1.89%	28,065	94.99%
Totals	54,855,896	100.00%	8,219,359	14.98%	3,703,636	6.75%	11,922,995	21.74%

Plate 1. ELEVATION REPRESENTATION - CPCF

	Elevation (ft)	Total Area (ac)	Percent	Existing Protected Area (ac)	Percent of Band Protected	IRA Area (ac)	Percent of Band in IRA	Combined Area (ac)	Percent of Band Combined
1	0-1,000	6,264,996	59.41%	207,675	3.31%	34,895	0.56%	242,512	3.87%
2	1,000-2,000	2,694,173	25.55%	161,174	5.98%	44,135	1.64%	205,308	7.62%
3	2,000-3,000	932,093	8.84%	204,320	21.92%	34,629	3.72%	238,948	25.64%
4	3,000-4,000	326,366	3.09%	224,520	68.79%	24,559	7.53%	249,079	76.32%
5	4,000-5,000	198,744	1.88%	189,977	95.59%	7,924	3.99%	197,901	99.58%
6	5,000-6,000	103,963	0.99%	103,466	99.52%	996	0.96%	104,461	100.48%
7	6,000-7,000	24,460	0.23%	24,425	99.86%	35	0.14%	24,460	100.00%
8	7,000-8,000	1,257	0.01%	1,257	100.00%	0	0.00%	1,257	100.00%
9	8,000-9,000								
10	>9,000								
	Totals	10,546,052	100.00%	1,116,813		147,173		1,263,986	

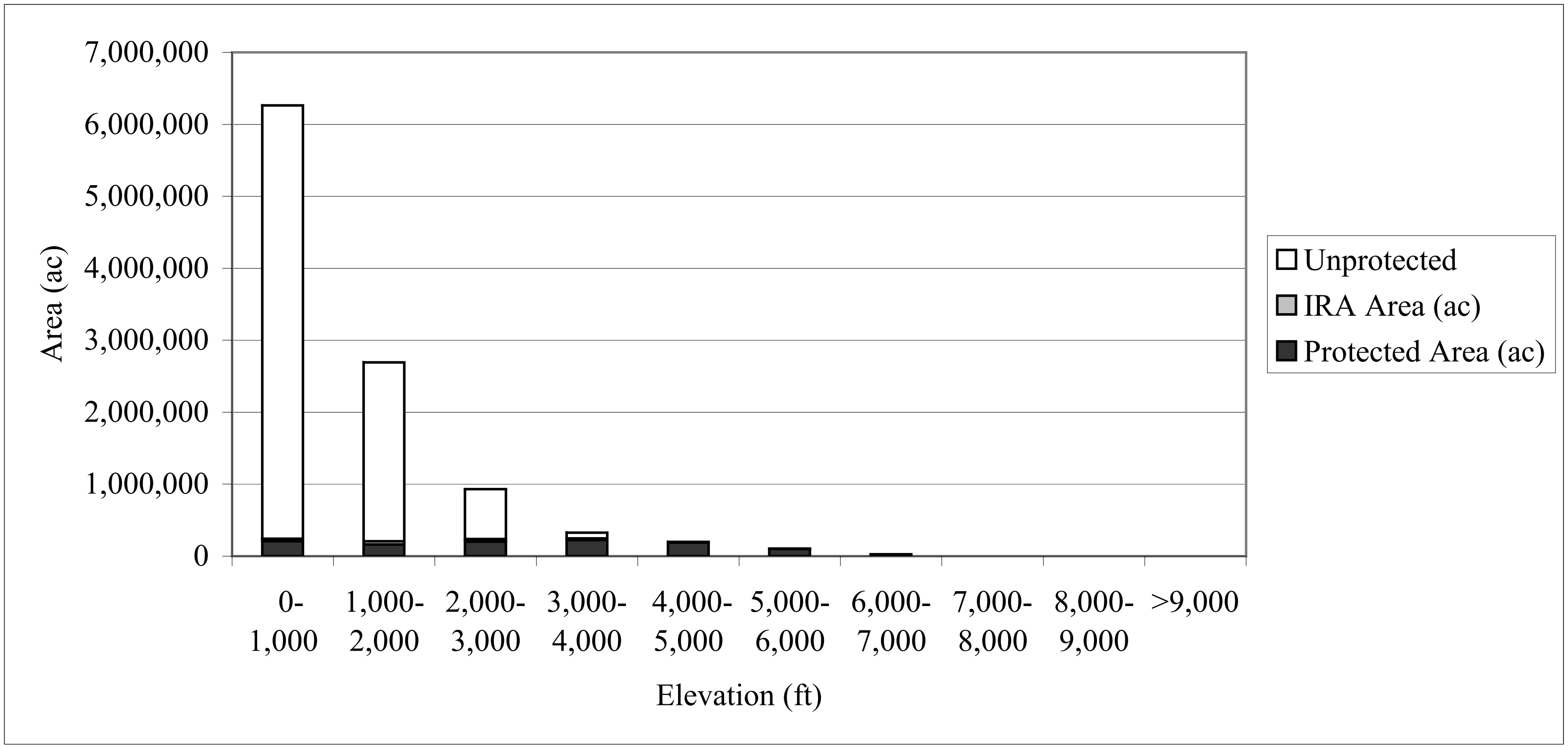


Plate 2. ELEVATION REPRESENTATION - CSCF

	Elevation (ft)	Total Area (ac)	Percent	Existing Protected Area (ac)	Percent of Band Protected	IRA Area (ac)	Percent of Band in IRA	Combined Area (ac)	Percent of Band Combined
1	0-1,000	519,772	4.69%	22,251	4.28%	1,671	0.32%	23,922	4.60%
2	1,000-2,000	2,047,364	18.49%	48,593	2.37%	15,730	0.77%	64,323	3.14%
3	2,000-3,000	2,440,710	22.04%	135,385	5.55%	114,863	4.71%	250,248	10.25%
4	3,000-4,000	2,494,123	22.52%	288,469	11.57%	189,342	7.59%	477,810	19.16%
5	4,000-5,000	1,823,978	16.47%	477,367	26.17%	214,755	11.77%	692,122	37.95%
6	5,000-6,000	1,198,112	10.82%	611,807	51.06%	160,462	13.39%	772,270	64.46%
7	6,000-7,000	435,637	3.93%	301,700	69.25%	58,807	13.50%	360,507	82.75%
8	7,000-8,000	79,280	0.72%	67,170	84.72%	3,851	4.86%	71,021	89.58%
9	8,000-9,000	18,601	0.17%	15,848	85.20%	406	2.18%	16,254	87.38%
10	>9,000	15,513	0.14%	14,134	91.11%	44	0.29%	14,179	91.40%
	Totals	11,073,090	100.00%	1,982,725	17.91%	759,931	6.86%	2,742,657	24.77%

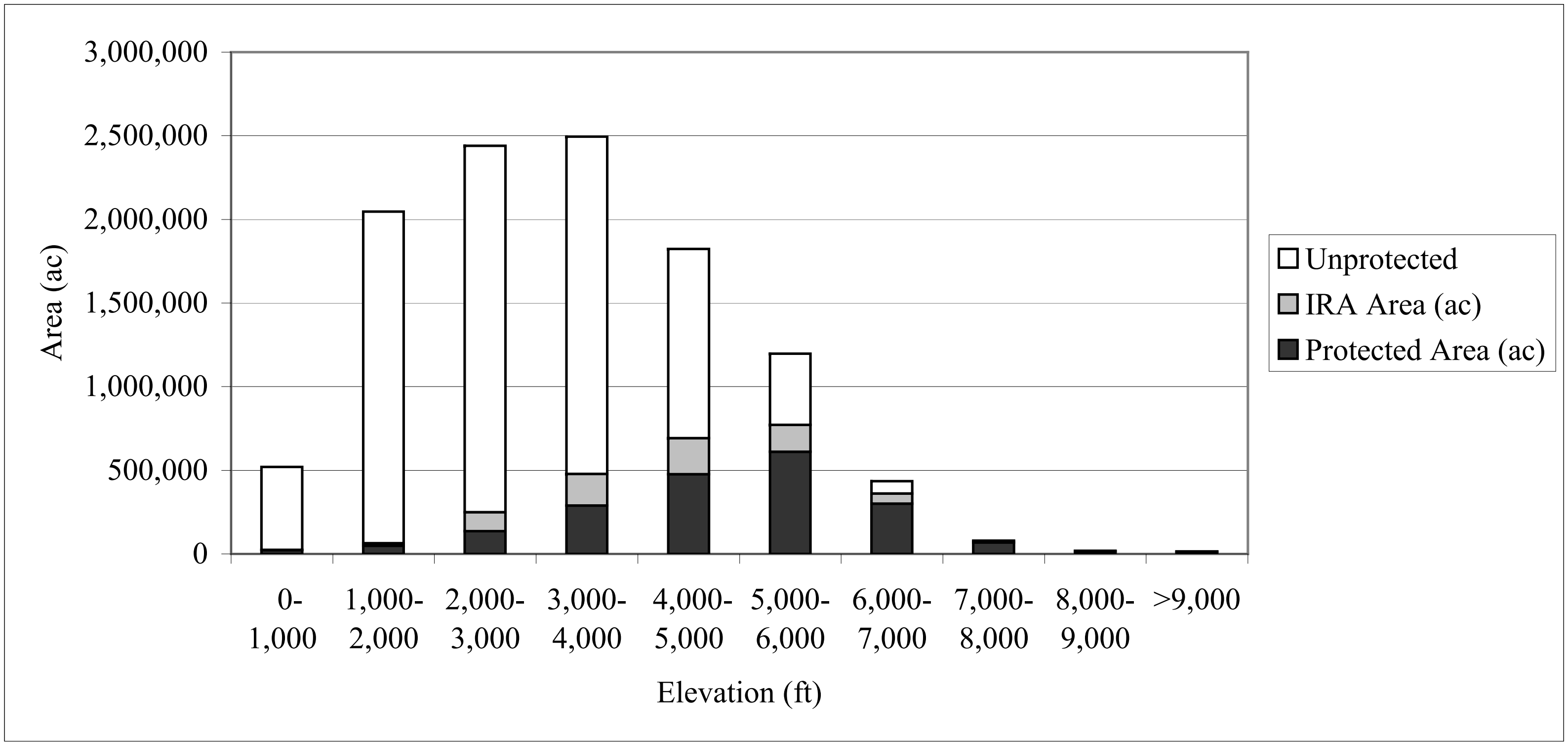


Plate 3. ELEVATION REPRESENTATION - KSF

	Elevation (ft)	Total Area (ac)	Percent	Existing Protected Area (ac)	Percent of Band Protected	IRA Area (ac)	Percent of Band in IRA	Combined Area (ac)	Percent of Band Combined
1	0-1,000	664,183	5.34%	31,407	4.73%	23,688	3.57%	55,095	8.30%
2	1,000-2,000	2,439,668	19.62%	209,428	8.58%	140,216	5.75%	349,643	14.33%
3	2,000-3,000	3,367,914	27.08%	332,893	9.88%	320,281	9.51%	653,174	19.39%
4	3,000-4,000	2,891,658	23.25%	342,588	11.85%	321,912	11.13%	664,500	22.98%
5	4,000-5,000	1,699,882	13.67%	347,224	20.43%	174,643	10.27%	521,867	30.70%
6	5,000-6,000	902,469	7.26%	326,840	36.22%	85,964	9.53%	412,804	45.74%
7	6,000-7,000	370,447	2.98%	187,579	50.64%	30,612	8.26%	218,191	58.90%
8	7,000-8,000	77,859	0.63%	51,685	66.38%	5,966	7.66%	57,651	74.05%
9	8,000-9,000	11,631	0.09%	9,162	78.77%	526	4.52%	9,688	83.30%
10	>9,000	11,006	0.09%	10,359	94.12%	515	4.68%	10,874	98.80%
	Totals	12,436,716	100.00%	1,849,165	14.87%	1,104,322	8.88%	2,953,487	23.75%

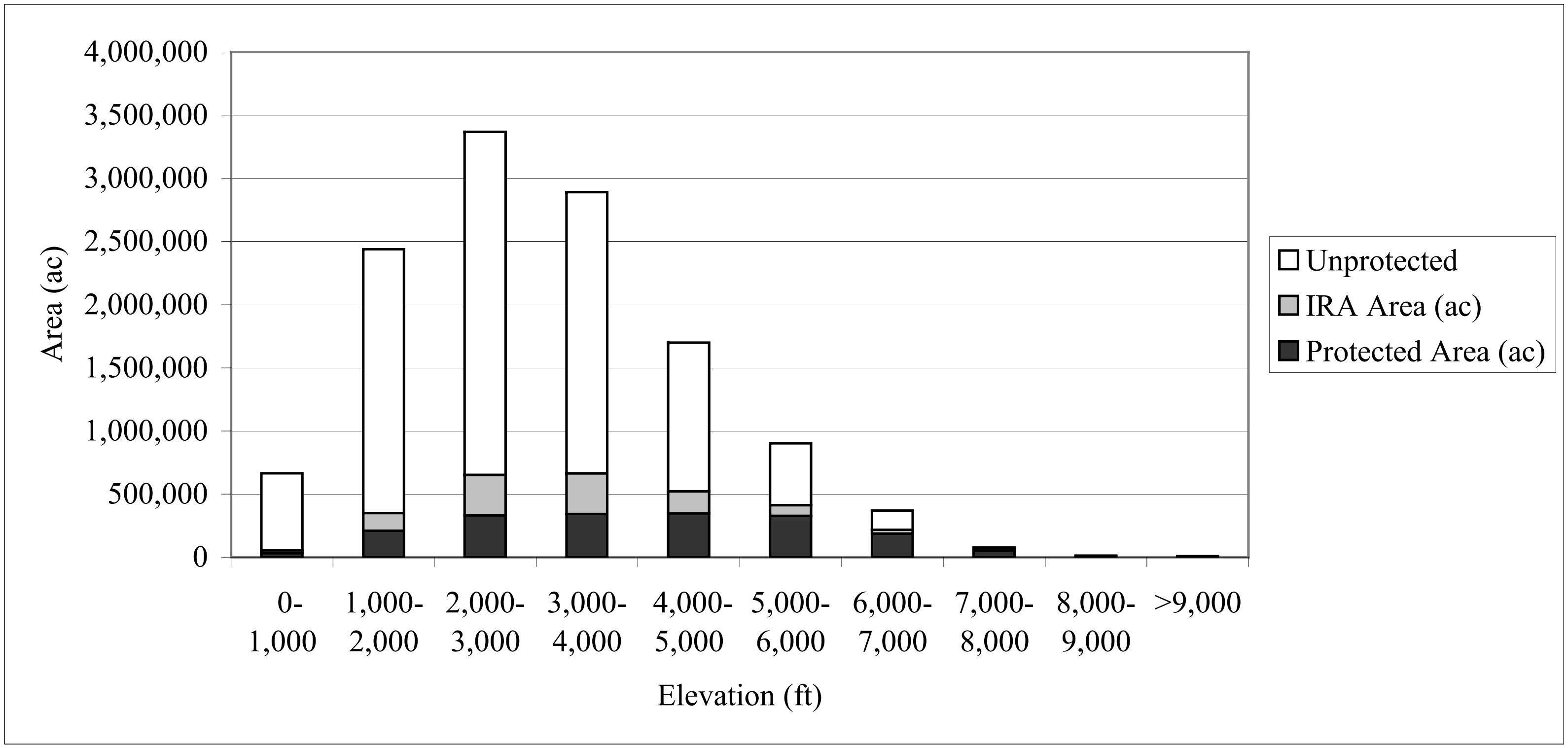


Plate 4. ELEVATION REPRESENTATION - ECF

	Elevation (ft)	Total Area (ac)	Percent	Existing Protected Area (ac)	Percent of Band Protected	IRA Area (ac)	Percent of Band in IRA	Combined Area (ac)	Percent of Band Combined
1	0-1,000	94,205	0.69%	4,562	4.84%	0	0.00%	4,561	4.84%
2	1,000-2,000	350,583	2.56%	9,051	2.58%	171	0.05%	9,222	2.63%
3	2,000-3,000	900,314	6.58%	20,276	2.25%	12,317	1.37%	32,592	3.62%
4	3,000-4,000	1,489,181	10.88%	72,756	4.89%	63,145	4.24%	135,902	9.13%
5	4,000-5,000	6,205,928	45.34%	346,390	5.58%	120,283	1.94%	466,673	7.52%
6	5,000-6,000	3,438,875	25.12%	73,340	2.13%	80,769	2.35%	154,109	4.48%
7	6,000-7,000	996,093	7.28%	68,137	6.84%	92,885	9.32%	161,022	16.17%
8	7,000-8,000	190,652	1.39%	42,821	22.46%	64,409	33.78%	107,230	56.24%
9	8,000-9,000	20,189	0.15%	13,329	66.02%	5,796	28.71%	19,125	94.73%
10	>9,000	1,239	0.01%	1,226	98.97%	0	0.00%	1,226	98.97%
	Totals	13,687,259	100.00%	651,887	4.76%	439,776	3.21%	1,091,663	7.98%

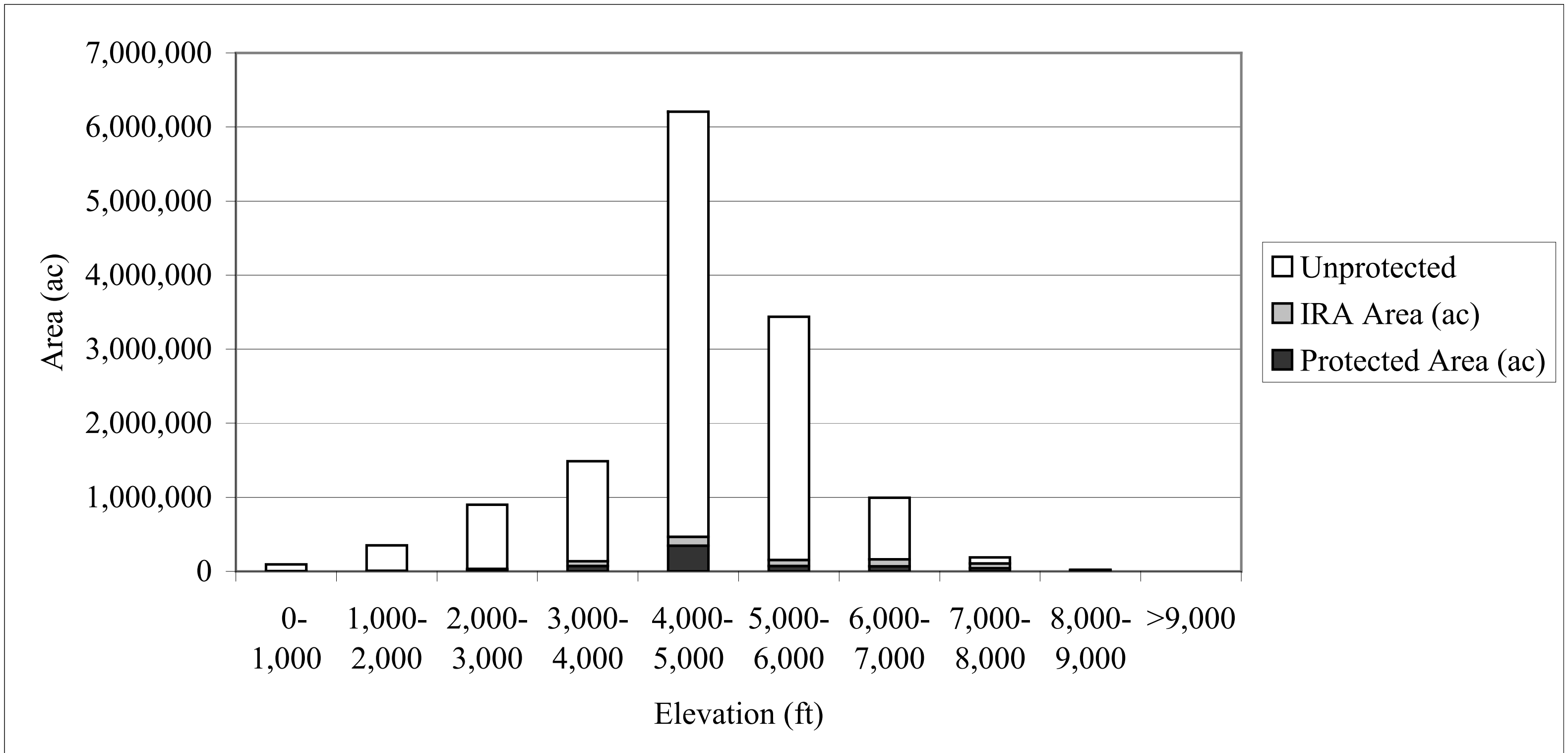


Plate 5. ELEVATION REPRESENTATION - CMLF

	Elevation (ft)	Total Area (ac)	Percent	Existing Protected Area (ac)	Percent of Band Protected	IRA Area (ac)	Percent of Band in IRA	Combined Area (ac)	Percent of Band Combined
1	0-1,000	2,697	0.07%	0	0.00%	0	0.00%	0	0.00%
2	1,000-2,000	220,984	5.59%	12,601	5.70%	9,797	4.43%	22,398	10.14%
3	2,000-3,000	660,298	16.70%	39,794	6.03%	50,738	7.68%	90,532	13.71%
4	3,000-4,000	771,711	19.51%	122,117	15.82%	135,869	17.61%	257,987	33.43%
5	4,000-5,000	771,993	19.52%	261,955	33.93%	219,646	28.45%	481,600	62.38%
6	5,000-6,000	789,063	19.95%	398,822	50.54%	249,901	31.67%	648,723	82.21%
7	6,000-7,000	576,278	14.57%	380,958	66.11%	159,197	27.62%	540,155	93.73%
8	7,000-8,000	154,458	3.91%	121,482	78.65%	30,931	20.03%	152,413	98.68%
9	8,000-9,000	7,104	0.18%	6,030	84.88%	1,074	15.12%	7,104	100.00%
10	>9,000	57	0.00%	57	100.00%	0	0.00%	57	100.00%
	Totals	3,954,643	100.00%	1,343,816	33.98%	857,153	21.67%	2,200,969	55.66%

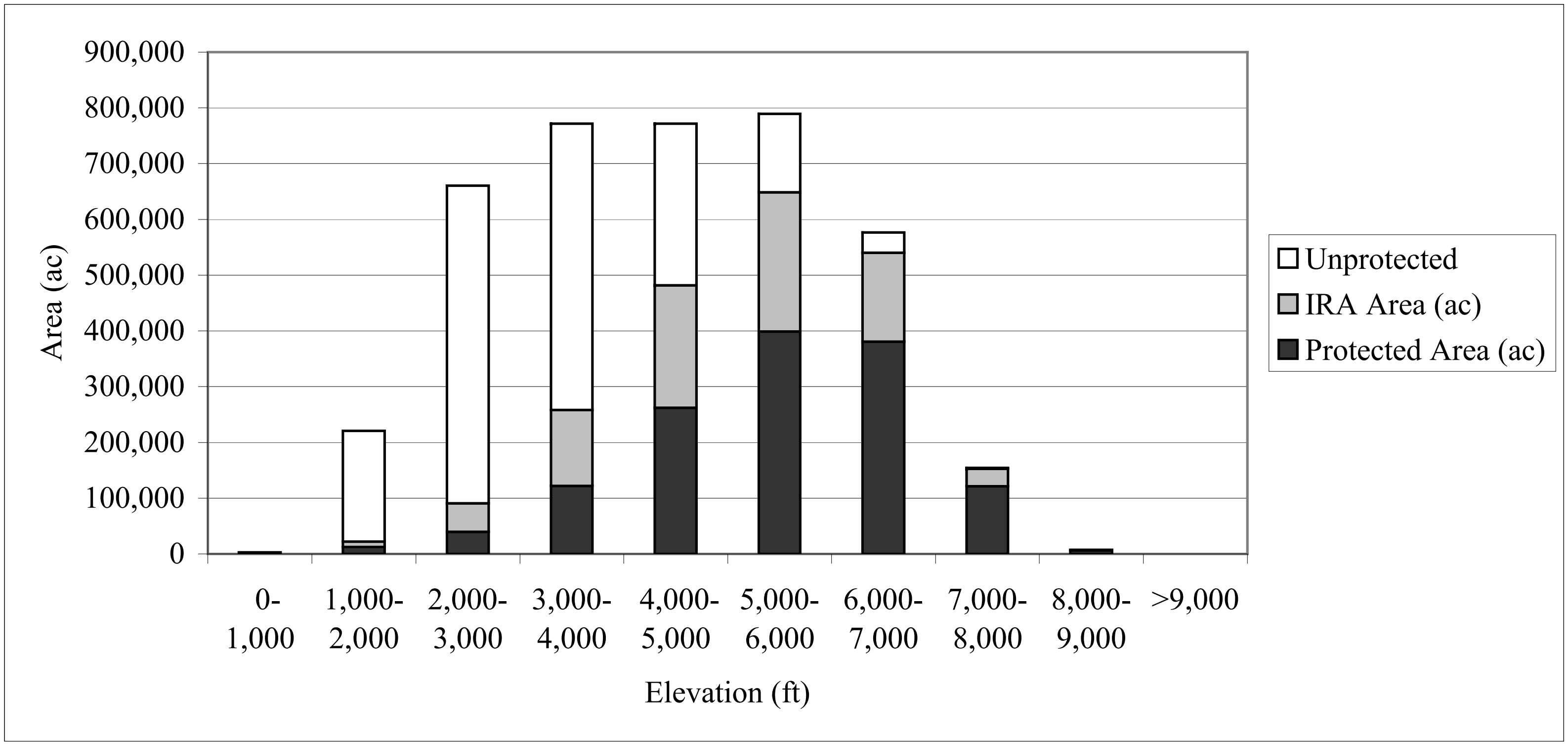
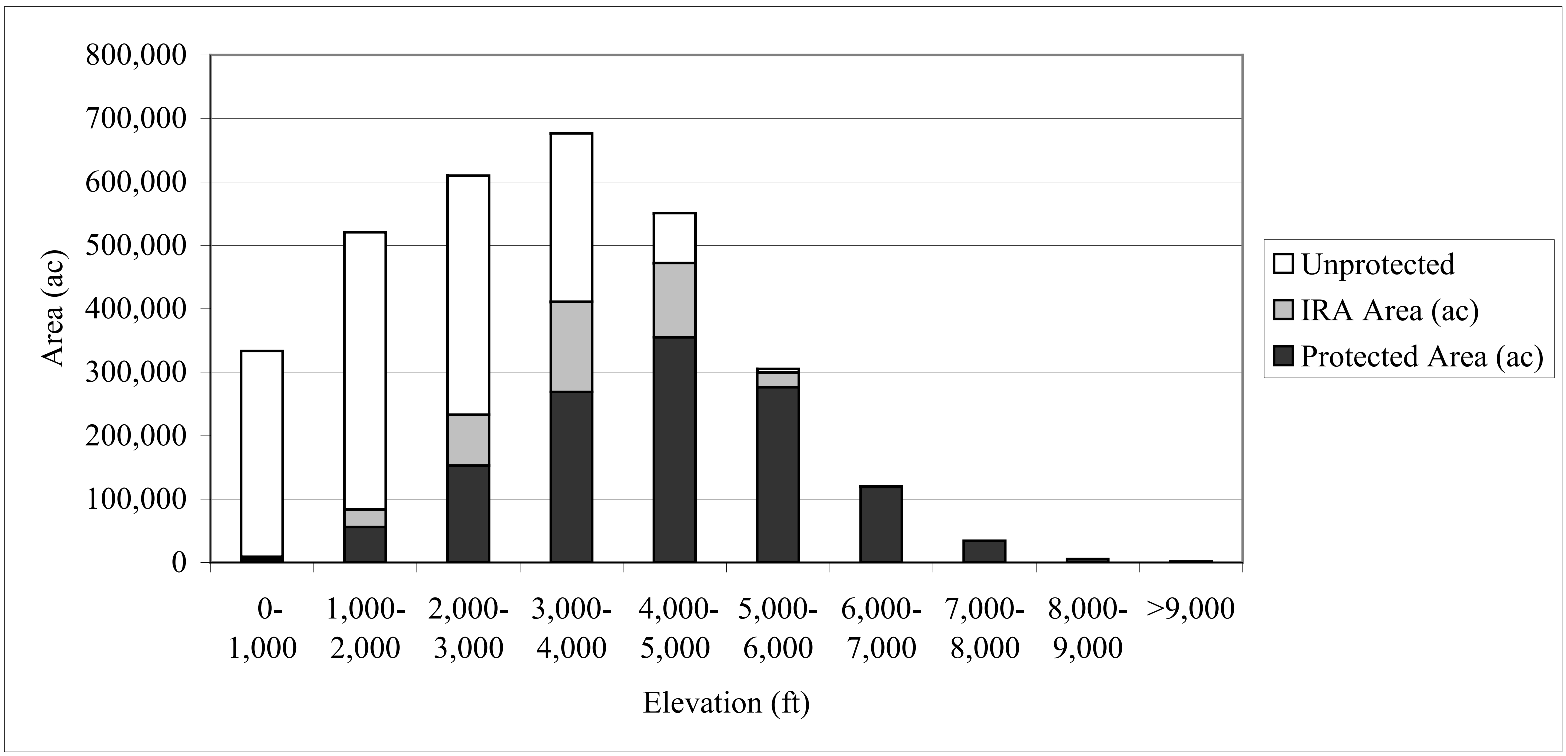


Plate 6. ELEVATION REPRESENTATION - NCF

	Elevation (ft)	Total Area (ac)	Percent	Existing Protected Area (ac)	Percent of Band Protected	IRA Area (ac)	Percent of Band in IRA	Combined Area (ac)	Percent of Band Combined
1	0-1,000	333,300	10.55%	4,914	1.47%	3,948	1.18%	8,862	2.66%
2	1,000-2,000	520,647	16.49%	56,227	10.80%	27,296	5.24%	83,523	16.04%
3	2,000-3,000	609,741	19.31%	152,830	25.06%	80,399	13.19%	233,229	38.25%
4	3,000-4,000	676,365	21.42%	268,982	39.77%	142,284	21.04%	411,266	60.81%
5	4,000-5,000	550,666	17.44%	354,994	64.47%	117,144	21.27%	472,137	85.74%
6	5,000-6,000	305,249	9.67%	276,462	90.57%	22,932	7.51%	299,394	98.08%
7	6,000-7,000	120,288	3.81%	118,795	98.76%	1,251	1.04%	120,046	99.80%
8	7,000-8,000	34,392	1.09%	34,365	99.92%	27	0.08%	34,392	100.00%
9	8,000-9,000	5,654	0.18%	5,654	100.00%	0	0.00%	5,654	100.00%
10	>9,000	1,730	0.05%	1,730	100.00%	0	0.00%	1,730	100.00%
	Totals	3,158,032	100.00%	1,274,952	40.37%	395,281	12.52%	1,670,233	52.89%



PHYSICAL HABITAT REPRESENTATION

The second way we examined representation was by physical habitat types as defined by natural combinations of mean annual precipitation, December/July precipitation difference, mean annual temperature, December/July temperature difference, soil depth, and soil water holding capacity (see Noss et al. 1999 for similar analysis). A total of 45 physical habitat classes were defined and mapped for the six ecoregions examined. The Cascade ecoregions (CMLF, NCF, and CSCF) showed the least amount of physical habitat variability (5 classes each) based on the six criteria used. The Klamath-Siskiyou contained the most natural physical variability (12 classes), followed by the CPCF (10 classes), and finally the ECF (8 classes). In the ecoregion summaries that follow in Plates 7-12, tables provide information for each physical habitat type (represented simply as a number) in terms of total area, area contained in existing protected areas, area contained in IRAs, and area combined. Acreages highlighted in yellow represent the top three physical habitat types contained within IRAs. Physical habitat types highlighted in green are those where there was an increase in percent of class by more than 10 percent due to IRA protection.

Three ecoregions (CPCF, CSCF, and ECF) showed very few gains in physical habitat representation. In each of these ecoregions, IRAs contributed little to capture the breadth of natural variability with only one physical habitat type in each ecoregion contributing more than 10 percent to any physical class. IRAs achieved physical habitat representation far better in the northern Cascades ecoregions (CMLF and NCF) and the Klamath-Siskiyou. Three of five physical habitat types in the NCF ecoregion and 4 of 5 types in the CMLF met the 10 percent threshold. The KSF also showed a broad enhancement of physical habitat types with 5 of 12 physical habitat types meeting the 10 percent mark.

If a theoretical representation target were set at 25% for all physical habitat types, the following observations can be made.

CPCF - Four physical habitat types, which make up 80 percent of the CPCF ecoregion requires far more protection. The remaining six types, most of which concentrated in the Olympic National Park, surpass the 25% target. IRAs contributed very little to meet the 25% target for any of the 10 physical habitat types.

CSCF - Three of the five physical habitat types already attained the 25% representation threshold without IRAs. IRAs did not contribute enough to any one physical habitat types to move its status from under the 25% target to surpassing it. However, IRAs did add considerable acreage to the two physical habitat types (#2 and #4 - both more productive types) that were the least represented by existing protected areas.

KSF - The contribution by IRAs to the physical habitat types in the KSF ecoregion were quite significant. Of the 12 physical habitat types mapped, six meet the 25% representation target. IRAs acreage moved three of them from under the 25% threshold to over it. IRAs also contributed significant amounts of area to three other physical habitat types bringing them close to meeting the 25% target as well. Contribution to physical habitat representation by IRA in the KSF is very high.

ECF - IRAs contributed area to every physical habitat types class, especially #3, #5, and #6, but not enough to bring any of the eight physical habitat types to meet the 25% threshold. The one type that achieved this target did so without the added area of IRA.

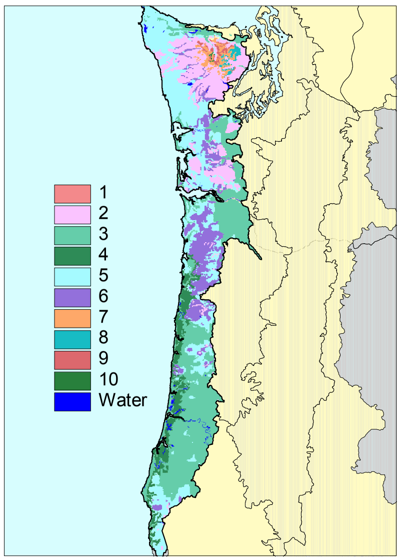
CMLF - Three of the five physical habitat types in this ecoregion were adequately represented (based on the 25% target) without the help of IRAs. IRAs contributed further to all of these but more importantly pushed one physical habitat type from 13% to 33% representation (#5) and added 4% of one type not represented at all by existing protected areas.

NCF - Two of the five physical habitat types described for the NCF ecoregion were represented with the combined acres from existing protected areas and IRAs. IRAs added significantly to two physical habitat types (#4 and #5), bringing each significantly closer to the 25% threshold.

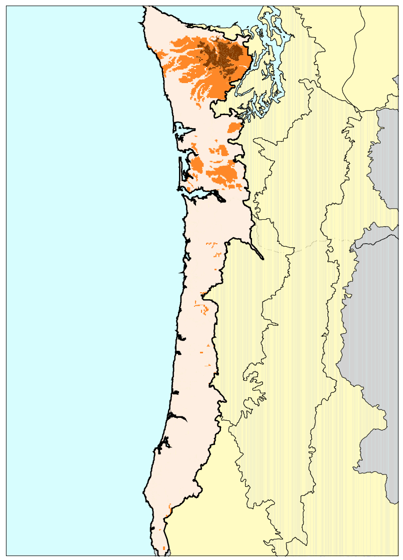
Plate 7. PHYSICAL HABITAT REPRESENTATION - CPCF

Physical Habitat	Area (ac)	Percent of Ecoregion	Protected Area (ac)	Percent Protected	Percent of Class	IRA Area (ac)	Percent IRA	Percent of Class	Combined Area (ac)

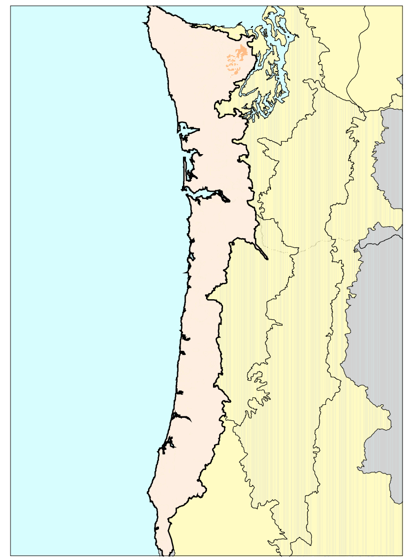
Type											
1	33,111	0.31%	9,143	0.82%	27.61%	0	0.00%	0.00%	9,143	0.72%	27.61%
2	1,491,496	14.14%	489,011	43.79%	32.79%	62,269	42.31%	4.17%	551,280	43.61%	36.96%
3	3,757,156	35.63%	97,073	8.69%	2.58%	31,333	21.29%	0.83%	128,406	10.16%	3.42%
4	745,007	7.06%	22,980	2.06%	3.08%	2,224	1.51%	0.30%	25,204	1.99%	3.38%
5	2,896,259	27.46%	120,091	10.75%	4.15%	23,969	16.29%	0.83%	144,059	11.40%	4.97%
6	1,209,060	11.46%	61,528	5.51%	5.09%	14,826	10.07%	1.23%	76,354	6.04%	6.32%
7	166,545	1.58%	165,310	14.80%	99.26%	494	0.34%	0.30%	165,804	13.12%	99.55%
8	67,953	0.64%	55,103	4.93%	81.09%	8,401	5.71%	12.36%	63,505	5.02%	93.45%
9	77,837	0.74%	74,624	6.68%	95.87%	2,718	1.85%	3.49%	77,342	6.12%	99.37%
10	4,942	0.05%	4,942	0.44%	100.00%	0	0.00%	0.00%	4,942	0.39%	100.00%
water	96,689	0.92%	17,008	1.52%	17.59%	939	0.64%	0.97%	17,947	1.42%	18.56%
Totals	10,546,054	100.00%	1,116,813	100.00%	10.59%	147,173	100.00%	1.40%	1,263,986	100.00%	11.99%



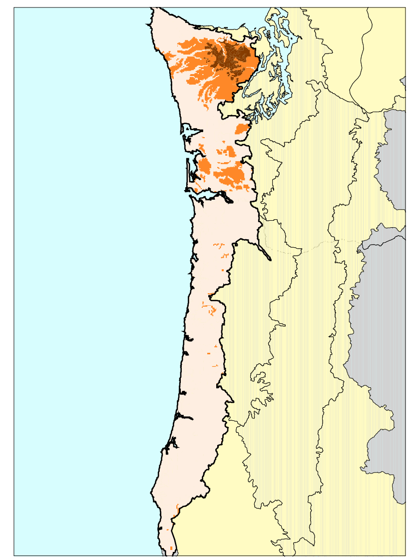
Physical Habitat Types



Physical Habitats Protected



Physical Habitats IRA

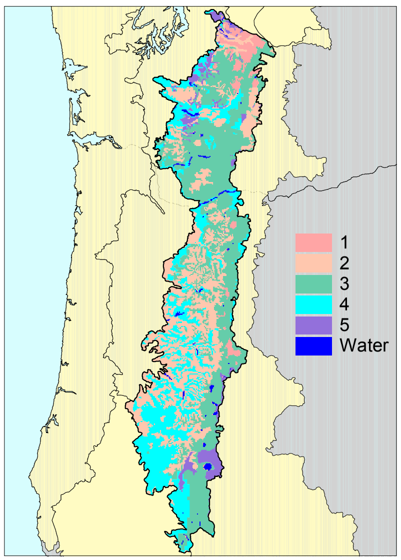


Physical Habitats Combined

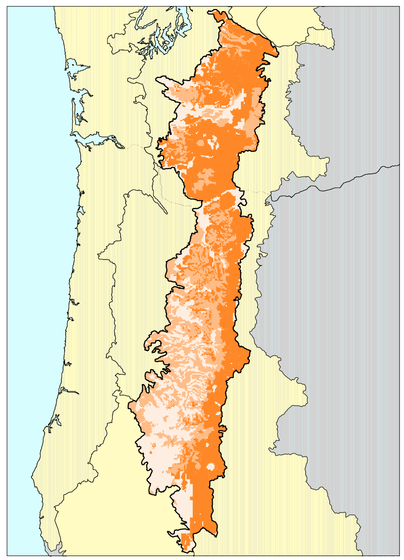
0 - 10 %
11 - 25 %
26 - 50%
51 - 75%
76 - 100%

Plate 8. PHYSICAL HABITAT REPRESENTATION - CSCF

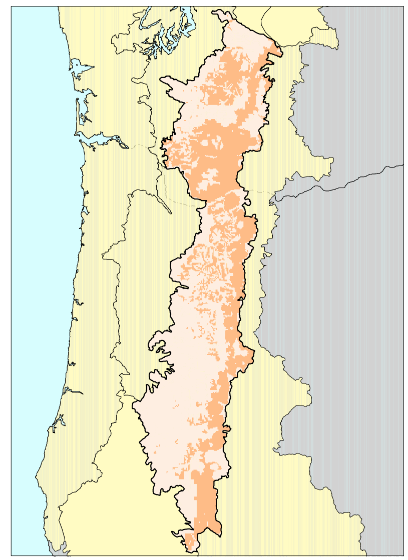
Physical Habitat Type	Area (ac)	Percent of Ecoregion	Protected Area (ac)	Percent Protected	Percent of Class	IRA Area (ac)	Percent IRA	Percent of Class	Combined Area (ac)	Percent Combined	Percent of Class
1	411,916	3.72%	156,111	7.87%	37.90%	17,486	2.30%	4.25%	173,597	6.33%	42.14%
2	3,170,540	28.63%	322,316	16.26%	10.17%	168,007	22.11%	5.30%	490,323	17.88%	15.46%
3	4,236,530	38.26%	1,204,049	60.73%	28.42%	438,804	57.74%	10.36%	1,642,852	59.90%	38.78%
4	2,587,878	23.37%	75,356	3.80%	2.91%	107,279	14.12%	4.15%	182,635	6.66%	7.06%
5	539,666	4.87%	218,790	11.03%	40.54%	27,410	3.61%	5.08%	246,200	8.98%	45.62%
water	126,560	1.14%	6,104	0.31%	4.82%	945	0.12%	0.75%	7,049	0.26%	5.57%
Totals	11,073,090	100.00%	1,982,725	100.00%	17.91%	759,931	100.00%	6.86%	2,742,656	100.00%	24.77%



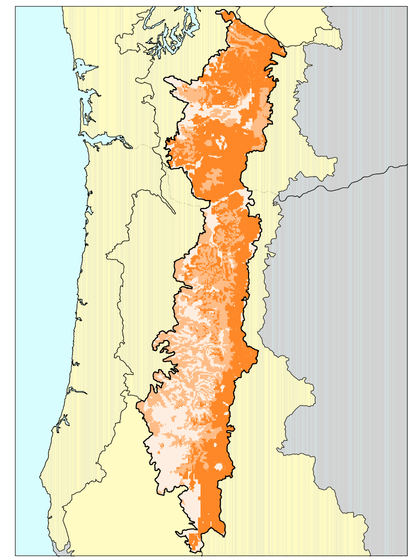
Physical Habitat Types



Physical Habitats Protected



Physical Habitats IRA

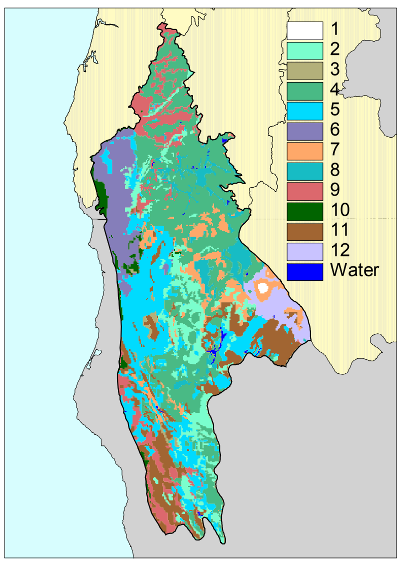


Physical Habitats Combined

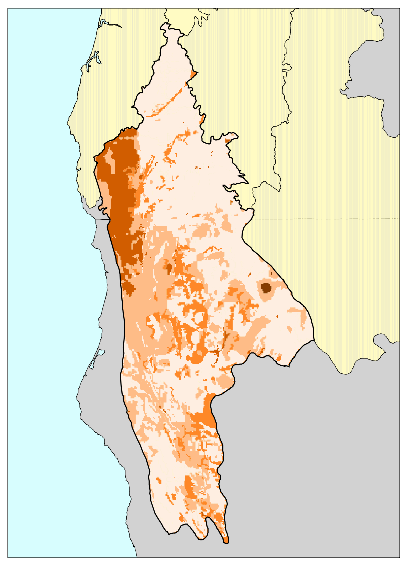
0 - 10 % | 11 - 25 % | 26 - 50% | 51 - 75% | 76 - 100%

Plate 9. PHYSICAL HABITAT REPRESENTATION - KSF

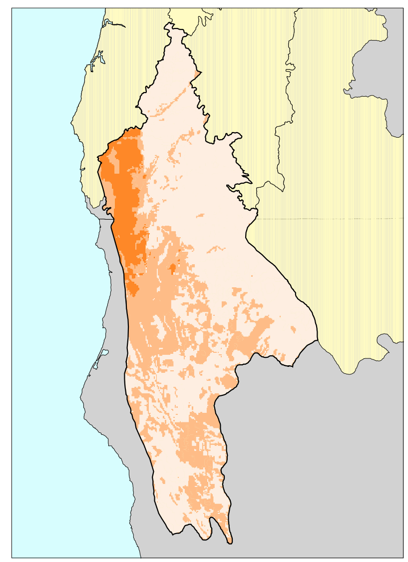
Physical Habitat Type	Area (ac)	Percent of Ecoregion	Protected Area (ac)	Percent Protected	Percent of Class	IRA Area (ac)	Percent IRA	Percent of Class	Combined Area (ac)	Percent Combined	Percent of Class
1	19,574	0.16%	15,879	0.86%	81.12%	1,740	0.16%	8.89%	17,619	0.60%	90.02%
2	1,159,068	9.32%	369,436	19.98%	31.87%	156,880	14.21%	13.54%	526,316	17.82%	45.41%
3	104,063	0.84%	28,533	1.54%	27.42%	18,647	1.69%	17.92%	47,179	1.60%	45.34%
4	3,865,461	31.08%	327,754	17.72%	8.48%	276,218	25.01%	7.15%	603,972	20.45%	15.62%
5	2,250,991	18.10%	324,032	17.52%	14.40%	262,047	23.73%	11.64%	586,079	19.84%	26.04%
6	890,238	7.16%	477,364	25.82%	53.62%	164,074	14.86%	18.43%	641,438	21.72%	72.05%
7	710,357	5.71%	98,996	5.35%	13.94%	45,746	4.14%	6.44%	144,742	4.90%	20.38%
8	526,264	4.23%	22,578	1.22%	4.29%	1,243	0.11%	0.24%	23,821	0.81%	4.53%
9	934,837	7.52%	1,737	0.09%	0.19%	10,442	0.95%	1.12%	12,179	0.41%	1.30%
10	205,154	1.65%	50,366	2.72%	24.55%	37,256	3.37%	18.16%	87,622	2.97%	42.71%
11	1,341,427	10.79%	104,951	5.68%	7.82%	126,051	11.41%	9.40%	231,002	7.82%	17.22%
12	390,486	3.14%	5,210	0.28%	1.33%	3,978	0.36%	1.02%	9,188	0.31%	2.35%
water	38,900	0.31%	22,330	1.21%	57.40%	0	0.00%	0.00%	22,330	0.76%	57.40%
Totals	12,436,820	100.00%	1,849,165	100.00%	14.87%	1,104,322	100.00%	8.88%	2,953,488	100.00%	23.75%



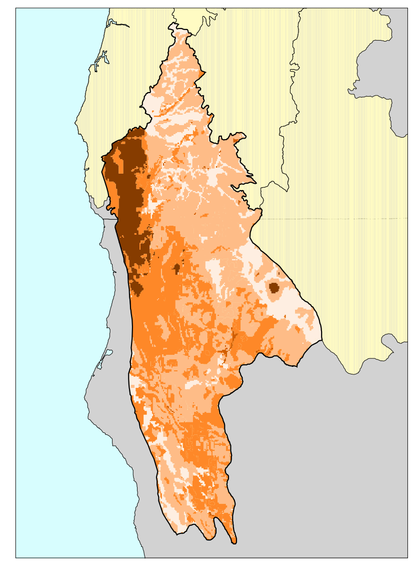
Physical Habitat Types



Physical Habitats Protected



Physical Habitats IRA

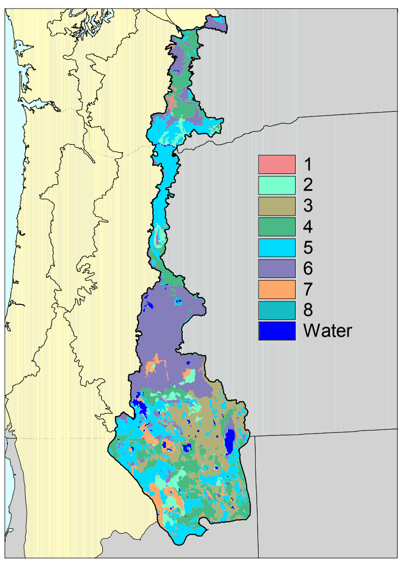


Physical Habitats Combined

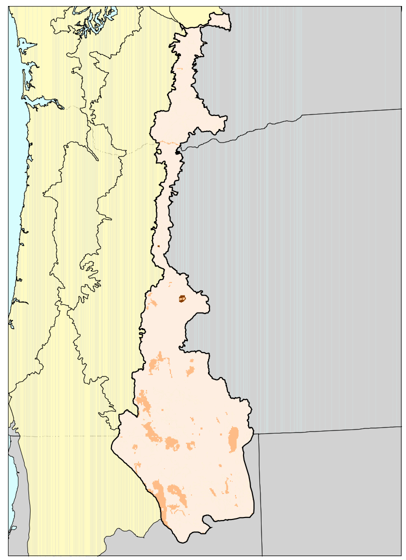
0 - 10 % | 11 - 25 % | 26 - 50% | 51 - 75% | 76 - 100%

Plate 10. PHYSICAL HABITAT REPRESENTATION - ECF

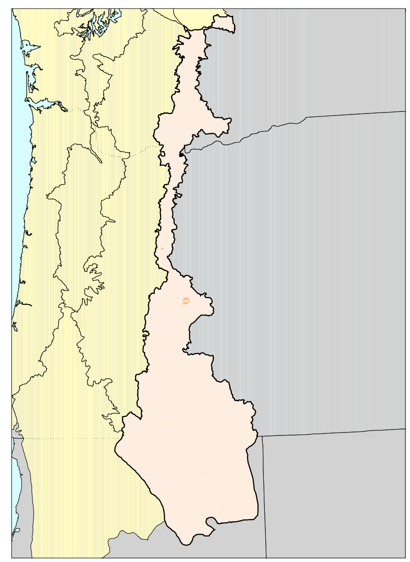
Physical Habitat Type	Area (ac)	Percent of Ecoregion	Protected Area (ac)	Percent Protected	Percent of Class	IRA Area (ac)	Percent IRA	Percent of Class	Combined Area (ac)	Percent Combined	Percent of Class
1	75,168	0.55%	7,758	1.19%	10.32%	1,919	0.44%	2.55%	9,677	0.89%	12.87%
2	776,817	5.68%	31,781	4.88%	4.09%	32,628	7.42%	4.20%	64,409	5.90%	8.29%
3	2,219,192	16.21%	67,816	10.40%	3.06%	96,685	21.99%	4.36%	164,502	15.07%	7.41%
4	2,560,932	18.71%	116,864	17.93%	4.56%	73,414	16.69%	2.87%	190,278	17.43%	7.43%
5	3,483,106	25.45%	120,368	18.46%	3.46%	129,349	29.41%	3.71%	249,717	22.87%	7.17%
6	3,700,894	27.04%	157,654	24.18%	4.26%	102,203	23.24%	2.76%	259,857	23.80%	7.02%
7	558,283	4.08%	90,338	13.86%	16.18%	480	0.11%	0.09%	90,818	8.32%	16.27%
8	17,423	0.13%	15,265	2.34%	87.61%	2,158	0.49%	12.39%	17,423	1.60%	100.00%
water	295,444	2.16%	44,043	6.76%	14.91%	939	0.21%	0.32%	44,982	4.12%	15.23%
Totals	13,687,259	100.00%	651,888	100.00%	4.76%	439,776	100.00%	3.21%	1,091,663	100.00%	7.98%



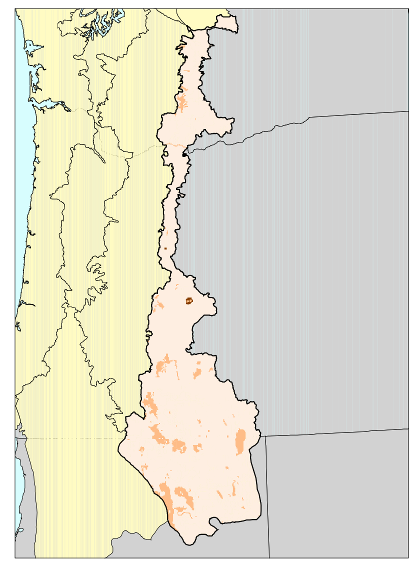
Physical Habitat Types



Physical Habitats Protected



Physical Habitats IRA



Physical Habitats Combined

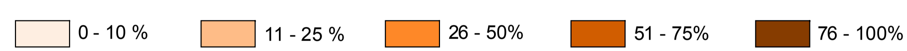
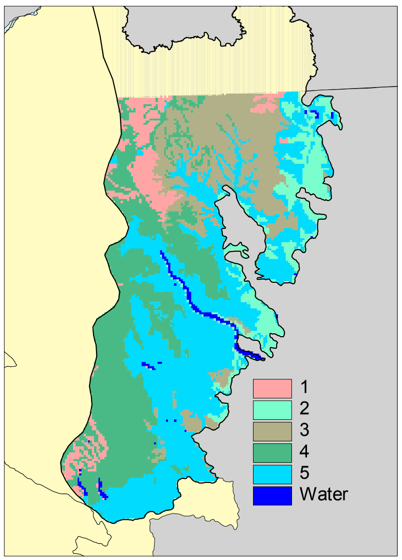
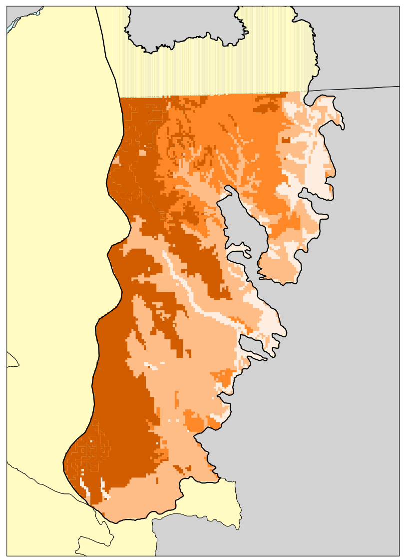


Plate 11. PHYSICAL HABITAT REPRESENTATION - CMLF

Physical Habitat Type	Area (ac)	Percent of Ecoregion	Protected Area (ac)	Percent Protected	Percent of Class	IRA Area (ac)	Percent IRA	Percent of Class	Combined Area (ac)	Percent Combined	Percent of Class
1	269,843	6.82%	142,764	10.62%	52.91%	93,908	10.96%	34.80%	236,672	10.75%	87.71%
2	329,120	8.32%	0	0.00%	0.00%	13,450	1.57%	4.09%	13,450	0.61%	4.09%
3	707,843	17.90%	297,847	22.16%	42.08%	180,724	21.08%	25.53%	478,571	21.74%	67.61%
4	1,122,032	28.37%	703,674	52.36%	62.71%	281,479	32.84%	25.09%	985,152	44.76%	87.80%
5	1,473,969	37.27%	198,132	14.74%	13.44%	286,893	33.47%	19.46%	485,025	22.04%	32.91%
water	51,836	1.31%	1,399	0.10%	2.70%	699	0.08%	1.35%	2,098	0.10%	4.05%
Totals	3,954,643	100.00%	1,343,816	100.00%	33.98%	857,153	100.00%	21.67%	2,200,969	100.00%	55.66%



Physical Habitat Types



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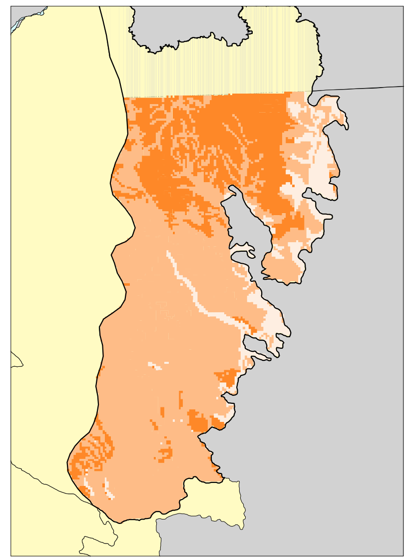
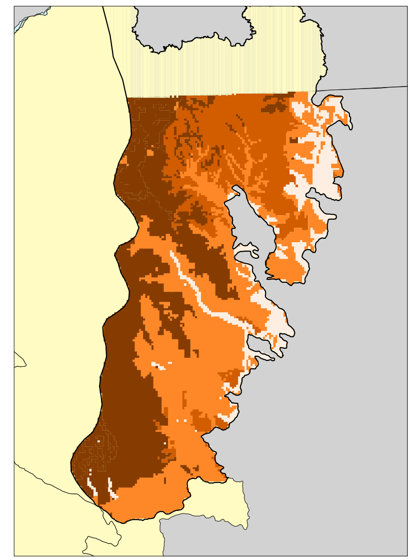


Physical Habitats IRA

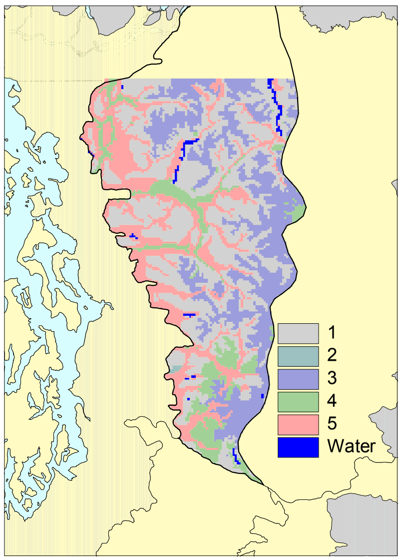


Physical Habitats Combined

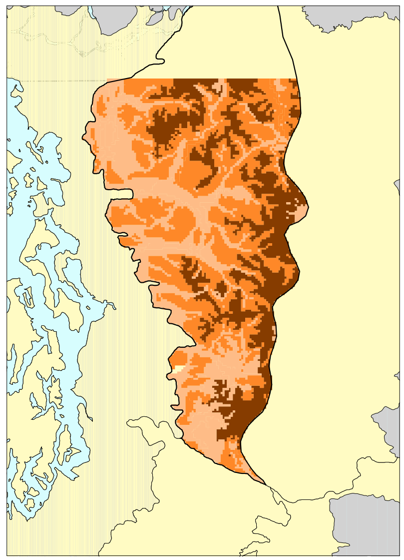
0 - 10 % | 11 - 25 % | 26 - 50% | 51 - 75% | 76 - 100%

Plate 12. PHYSICAL HABITAT REPRESENTATION - NCF

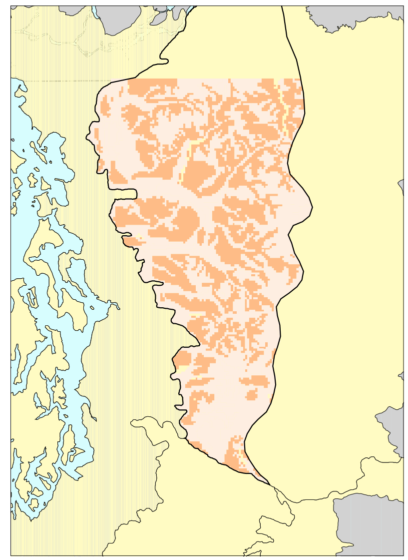
Physical Habitat Type	Area (ac)	Percent of Ecoregion	Protected Area (ac)	Percent Protected	Percent of Class	IRA Area (ac)	Percent IRA	Percent of Class	Combined Area (ac)	Percent Combined	Percent of Class
1	1,312,738	41.57%	476,065	37.34%	36.27%	244,524	61.86%	18.63%	720,588	43.14%	54.89%
2	4,172	0.13%	0	0.00%	0.00%	0	0.00%	0.00%	0	0.00%	0.00%
3	795,398	25.19%	667,679	52.37%	83.94%	83,294	21.07%	10.47%	750,973	44.96%	94.41%
4	304,072	9.63%	40,848	3.20%	13.43%	30,200	7.64%	9.93%	71,048	4.25%	23.37%
5	713,674	22.60%	78,973	6.19%	11.07%	37,263	9.43%	5.22%	116,236	6.96%	16.29%
water	27,978	0.89%	11,388	0.89%	40.70%	0	0.00%	0.00%	11,388	0.68%	40.70%
Totals	3,158,032	100.00%	1,274,952	100.00%	40.37%	395,281	100.00%	12.52%	1,670,233	100.00%	52.89%



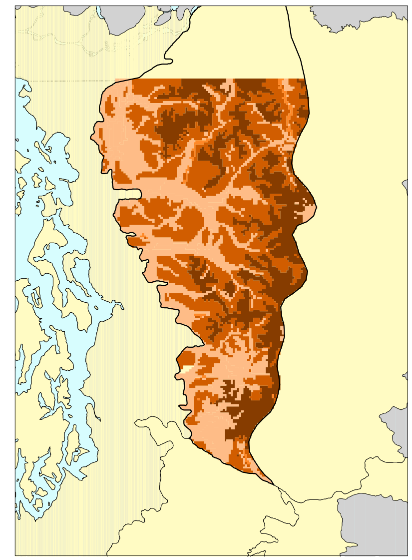
Physical Habitat Types



Physical Habitats Protected



Physical Habitats IRA



Physical Habitats Combined

0 - 10 % | 11 - 25 % | 26 - 50% | 51 - 75% | 76 - 100%

PLANT COMMUNITY REPRESENTATION

Plant community representation was examined by combining existing U.S. Geological Survey Gap Analysis Program (GAP) data for each state, then analyzing the results by ecoregion. Plant community variability ranged from 13 natural classes (CMLF) to 49 (KSF). As can be reviewed in the ecoregion summary pages that follow, IRAs contributed in various ways across the Pacific Northwest study region. In every ecoregion, IRAs contributed acreages over a large number of vegetation classes. Whether the amount of acreage added was enough to meet plant community representation targets is the more important question. The theoretical representation goal used throughout this analysis was 25 percent. In two cases (CPCF and ECF), IRAs did not cover a large enough area to add dramatically to this conservation criterion, although there were some noteworthy gains in the ECF ecoregion. In the remaining ecoregions (KSF, CSCF, CMLF, and NCF) however, IRAs played a much more important role in advancing representation in important ways.

Below are brief summaries of the results for each of the six ecoregions examined (Plates 13-18). More detailed tables, lists, and maps for each ecoregion follow. These plant community representation reviews contain: (1) a complete list of vegetation types including total areas (in acres), acres in existing protected areas, acres in IRAs, and acres existing protected areas and IRAs combined along with percentages of each; (2) a table summarizing the number of vegetation classes that meet different representation ranges; (3) a list of vegetation classes that do not meet the 25 percent representation threshold; and (4) maps showing the information from the second item in this list spatially. Colors in the first table represent the following - (orange = unnatural vegetation classes; gray = water and not included in the representation tabulations; yellow = top three acreage gains by IRAs; and green = vegetation classes that gained >10% of percent class type from IRAs.

CPCF - Twenty-one vegetation types were found in the CPCF ecoregion. Nine classes (primarily high elevation types associated with Olympic National Park and neighboring wilderness areas) are already well protected (>25% representation) by existing protected areas. The combined area covered by these vegetation types is approximately 20 percent. IRAs further added to acreage to these classes bringing several of them close to 100 percent representation level. IRAs contained small portions of many of the other classes, but contributed little to meeting any additional representation target. The only exception was for Douglas-fir/Port Orford Cedar. IRAs added nearly 14 percent of its total area bringing its representation level over the 25 percent threshold. Eleven of the 21 vegetation types covering over 80 percent of the ecoregion do not meet the established representation target.

CSCF - The CSCF ecoregion is composed of 22 different vegetation types. The ecoregion is dominated by Douglas-fir/Western Hemlock (~39% of the ecoregion) followed by True Fir/Hemlock (13% of the ecoregion). Fifteen of the vegetation classes, including True Fir/Hemlock, met the 25 percent representation target with the existing protected areas. IRAs added acreage to most of the classes and enough to bring three additional classes past the 25 percent level. IRAs also added considerable acreage of Douglas-fir/Western Hemlock (+5% of total class area) and Mixed Conifer (+7%). IRAs were found to be very important in meeting plant community representation goals for this ecoregion.

KSF - Forty-nine vegetation types were defined in the KSF ecoregion. Thirty-six percent of the ecoregion is comprised of approximately equal amounts of Mixed Conifer and Montane Hardwood/Conifer. Ponderosa Pine makes up an additional 12 percent. So nearly half of the KSF is made up of three general vegetation classes. The remaining 46 classes make up anywhere from 0.02 percent to eight percent of the ecoregion. With existing protected areas, 14 classes meet the 25 percent representation threshold. After IRAs are added, the number of vegetation classes that reach this level climbs to 23. Representation levels above 50 percent climbed by four with IRAs added. Although the 25 percent representation target was not reached, significant acreage was added to ten more vegetation classes. IRAs were found to be very important in the KSF ecoregion in terms of plant community representation. In spite of the gains, over half (26) of the plant community types mapped at this course level still do not meet the 25 percent threshold, particularly in the eastern third of the ecoregion.

ECF - The ECF ecoregion contains 48 plant community types. Nearly one-third is dominated by Ponderosa Pine. Eighteen percent is converted to human use, and the remaining area covered by 47 classes ranging in coverage from 0.01 - 8.4 percent. Because so many vegetation types cover such relatively small areas, the limited number of IRAs in the ecoregion were able to elevate five of them above the 25 percent threshold when combined with existing protected areas. Important gains were made in a handful of other types, but overall the level of plant community representation by existing protected areas and IRAs combined in this ecoregion is low. Nearly 75 percent of the mapped vegetation types do not meet the 25 percent representation threshold.

CMLF - Thirteen vegetation types make up the CMLF ecoregion. With existing protected areas, nine classes meet the 25 percent representation target. IRAs added more acreage to these totals bringing six more classes above 75 percent representation. IRAs added enough acreage to allow Douglas-fir and Grand Fir to meet the 25% representation target. Additional noteworthy gains were for the Ponderosa Pine vegetation class. Only two classes (Douglas-fir and Riparian) remained below the 25 percent representation target after combining existing protected areas and roadless areas.

NCF - Similar to its neighbor, the NCF ecoregion contains 14 plant community types. Ten of them were adequately represented (>25%) with protected areas alone. IRAs added significantly to many of these classes bringing their representation even higher pushing three types past the 75 percent mark. Although not enough to meet the 25 percent goal, important gains were also made in Douglas-fir/Western Hemlock (+10%) and Hardwoods (+6%). After combining existing protected areas and roadless areas, four plant community types remained below the representation threshold.

Plate 13. PLANT COMMUNITY REPRESENTATION - CPCF

VEGTYPE	Area (ac)	Percent of ecoregion	Protected Area (ac)	Percent	Percent of class	IRA Area (ac)	Percent	Percent of class	Combined Area (ac)	Percent	Percent of class
AGRICULTURE	317,959	7.45%	1,942	0.17%	0.61%	0	0.00%	0.00%	1,942	0.15%	0.61%
DEVELOPED	108,698	2.55%	3,101	0.28%	2.85%	98	0.16%	0.09%	3,199	0.25%	2.94%
DISTURBED	1,137,232	26.65%	2,280	0.21%	0.20%	2,302	3.63%	0.20%	4,582	0.36%	0.40%
MODIFIED GRASSLAND	14,237	0.33%	0	0.00%	0.00%	0	0.00%	0.00%	0	0.00%	0.00%
NEW DOUGLAS-FIR	1,663,437	38.98%	3,560	0.32%	0.21%	10,361	16.35%	0.62%	13,921	1.10%	0.84%
ALPINE TUNDRA	32,826	0.77%	32,826	2.95%	100.00%	0	0.00%	0.00%	32,826	2.59%	100.00%
ALPINE PARKLANDS	80,328	1.88%	79,392	7.15%	98.83%	608	0.96%	0.76%	79,999	6.31%	99.59%
BARREN	14,996	0.35%	14,233	1.28%	94.91%	667	1.05%	4.45%	14,899	1.18%	99.35%
SUBALPINE FIR	39,284	0.92%	36,789	3.31%	93.65%	2,167	3.42%	5.52%	38,956	3.07%	99.16%
MOUNTAIN HEMLOCK	199,293	4.67%	186,422	16.78%	93.54%	4,997	7.88%	2.51%	191,419	15.10%	96.05%
ALPINE SHRUBLAND	64,766	1.52%	60,270	5.43%	93.06%	0	0.00%	0.00%	60,270	4.75%	93.06%
BEACH/OCEAN SHORELINE	49,040	1.15%	23,985	2.16%	48.91%	7,330	11.57%	14.95%	31,315	2.47%	63.86%
SILVER FIR	359,322	8.42%	260,738	23.47%	72.56%	26,058	41.11%	7.25%	286,797	22.63%	79.82%
RIPARIAN WETLAND	60,289	1.41%	24,159	2.17%	40.07%	5	0.01%	0.01%	24,164	1.91%	40.08%
DOUGLAS FIR-PORT ORFORD CEDAR	95,792	2.24%	14,157	1.27%	14.78%	13,172	20.78%	13.75%	27,329	2.16%	28.53%
SITKA SPRUCE-WESTERN HEMLOCK	456,432	10.69%	64,326	5.79%	14.09%	3,376	5.33%	0.74%	67,702	5.34%	14.83%
FRESHWATER WETLAND	55,967	1.31%	4,331	0.39%	7.74%	2,100	3.31%	3.75%	6,431	0.51%	11.49%
DOUGLAS FIR-WESTERN HEMLOCK	3,269,892	76.62%	261,073	23.50%	7.98%	62,794	99.08%	1.92%	323,867	25.55%	9.90%
ESTUARINE WETLAND	8,834	0.21%	777	0.07%	8.80%	0	0.00%	0.00%	777	0.06%	8.80%
SISKIYOU HARDWOODS	65,625	1.54%	3,801	0.34%	5.79%	1,071	1.69%	1.63%	4,872	0.38%	7.42%
WATER	152,871	3.58%	9,853	0.89%	6.45%	2,639	4.16%	1.73%	12,492	0.99%	8.17%
MIXED CONIFER	111,114	2.60%	2,081	0.19%	1.87%	1,919	3.03%	1.73%	3,999	0.32%	3.60%
HARDWOODS	356,297	8.35%	7,320	0.66%	2.05%	100	0.16%	0.03%	7,420	0.59%	2.08%
DOUGLAS FIR-WHITE FIR-TANOAK	51,961	1.22%	748	0.07%	1.44%	253	0.40%	0.49%	1,001	0.08%	1.93%
MIXED FOREST	1,776,028	41.61%	18,648	1.68%	1.05%	5,155	8.13%	0.29%	23,803	1.88%	1.34%
JEFFERY PINE	2,969	0.07%	0	0.00%	0.00%	0	0.00%	0.00%	0	0.00%	0.00%
COASTAL LODGEPOLE PINE	561	0.01%	0	0.00%	0.00%	0	0.00%	0.00%	0	0.00%	0.00%
Totals	10,546,053	247.10%	1,116,813	100.53%	10.59%	147,173	232.21%	1.40%	1,263,986	99.72%	11.99%

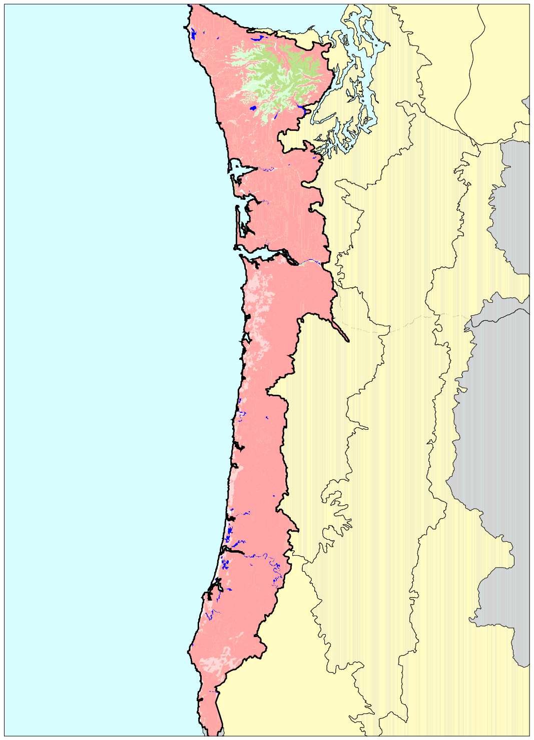
Number of CPCF vegetation types represented at different protection levels.

CPCF	Existing Protected Areas	IRAs	Combined
Number 0 - 10%	10	19	9
Number 11- 25%	2	2	2
Number 26-50%	2	0	2
Number 51-75%	1	0	1
Number >75%	6	0	7
Total	21	21	21

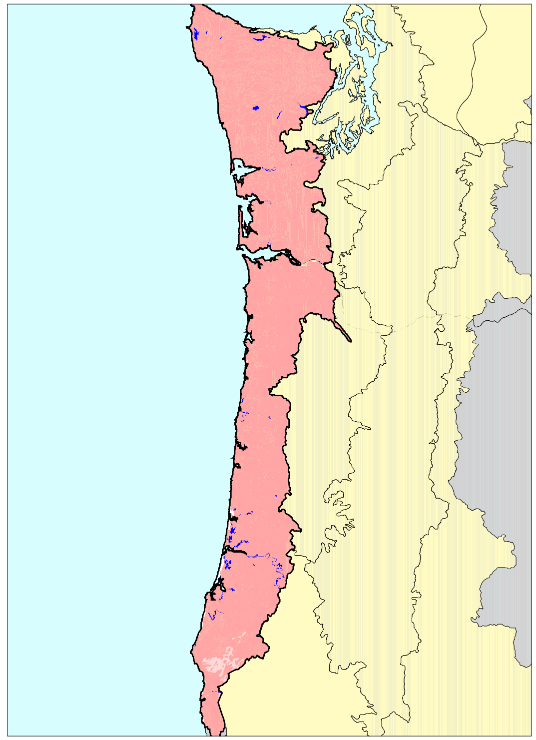
LIST OF VEGETATION TYPES THAT DO NOT MEET 25% REPRESENTATION TARGET - CPCF

DOUGLAS FIR-WESTERN HEMLOCK
ESTUARINE WETLAND
SISKIYOU HARDWOODS
MIXED CONIFER
HARDWOODS
DOUGLAS FIR-WHITE FIR-TANOAK
MIXED FOREST
JEFFERY PINE
COASTAL LODGEPOLE PINE
SITKA SPRUCE-WESTERN HEMLOCK
FRESHWATER WETLAND

Plate 13 (continued) PLANT COMMUNITY REPRESENTATION - CPCF



Plant Communities Protected



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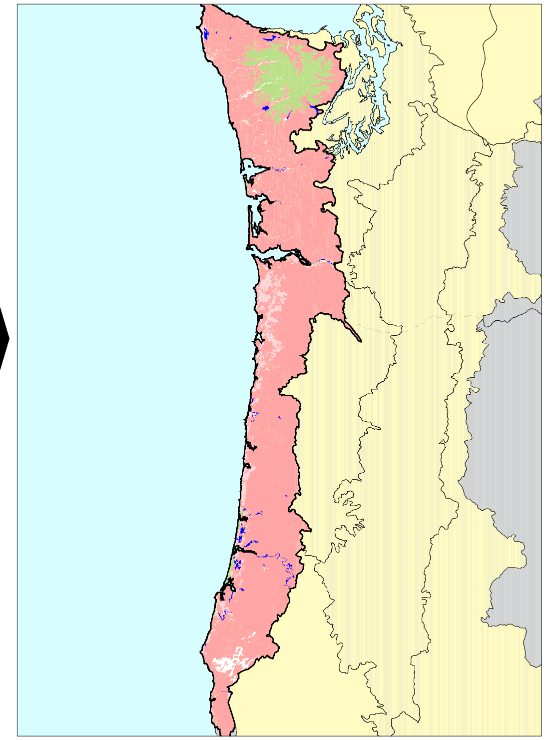


Plant Communities Combined

0 - 10 %
11 - 25 %
26 - 50%
51 - 75%
76 - 100%

Plate 14. PLANT COMMUNITY REPRESENTATION - CSCF

VEGTYPE	Area (ac)	Percent	Protected Area (ac)	Percent	Percent of class	IRA Area (ac)	Percent	Percent of class	Combined Area (ac)	Percent	Percent of class
AGRICULTURE	96,392	0.87%	59	0.00%	0.06%	0	0.00%	0.00%	59	0.00%	0.06%
DEVELOPED	10,520	0.10%	253	0.01%	2.40%	12	0.00%	0.11%	265	0.01%	2.52%
DISTURBED	1,320,754	11.93%	61,340	3.09%	4.64%	33,387	4.24%	2.53%	94,727	3.42%	7.17%
ALPINE PARKLANDS	60,088	0.54%	45,685	2.30%	76.03%	890	0.11%	1.48%	46,576	1.68%	77.51%
ALPINE TUNDRA	27,424	0.25%	22,486	1.13%	81.99%	2,029	0.26%	7.40%	24,515	0.89%	89.39%
BARREN	167,831	1.52%	141,130	7.12%	84.09%	13,147	1.67%	7.83%	154,277	5.57%	91.92%
DOUGLAS FIR-WESTERN HEMLOCK	4,287,536	38.72%	262,953	13.26%	6.13%	199,871	28.89%	5.31%	490,514	17.71%	11.44%
DOUGLAS FIR-WHITE FIR-TANOAK	28,238	0.26%	6,401	0.32%	22.67%	0	0.00%	0.00%	6,401	0.23%	22.67%
FRESHWATER WETLAND	14,427	0.13%	543	0.03%	3.76%	6,137	0.78%	42.54%	6,680	0.24%	46.30%
GRAND FIR	69,841	0.63%	22,165	1.12%	31.74%	17,869	2.27%	25.59%	40,034	1.45%	57.32%
GRASSLANDS	87,446	0.79%	82,114	4.14%	93.90%	1,241	0.16%	1.42%	83,355	3.01%	95.32%
HARDWOODS	181,828	1.64%	8,108	0.41%	4.46%	191	0.02%	0.11%	8,300	0.30%	4.56%
INT. W REDCEDAR-WESTERN HEMLOCK	84,447	0.76%	50,550	2.55%	59.86%	6,376	0.81%	7.55%	56,925	2.06%	67.41%
LODGEPOLE PINE	14,210	0.13%	3,173	0.16%	22.33%	7,237	0.92%	50.93%	10,410	0.38%	73.26%
MIXED CONIFER	991,106	8.95%	47,224	2.38%	4.76%	70,149	8.91%	7.08%	117,373	4.24%	11.84%
MIXED FOREST	369,174	3.33%	8,752	0.44%	2.37%	2,037	0.26%	0.55%	10,790	0.39%	2.92%
MOUNTAIN HEMLOCK	538,331	4.86%	357,444	18.03%	66.40%	63,042	8.00%	11.71%	420,485	15.18%	78.11%
PONDEROSA PINE	43,691	0.39%	13,383	0.68%	30.63%	1,803	0.23%	4.13%	15,186	0.55%	34.76%
RIPARIAN	24,253	0.22%	2,496	0.13%	10.29%	8	0.00%	0.03%	2,504	0.09%	10.32%
SHASTA RED FIR-MOUNTAIN HEMLOCK	48,158	0.43%	35,949	1.81%	74.65%	8,747	1.11%	18.16%	44,696	1.61%	92.81%
SHRUBLANDS	156,719	1.42%	95,114	4.80%	60.69%	24,802	3.15%	15.83%	119,916	4.33%	76.52%
SILVER FIR	588,543	5.32%	112,415	5.67%	19.10%	79,930	10.15%	13.58%	192,345	6.94%	32.68%
SISKIYOU HARDWOODS	1,022	0.01%	0	0.00%	0.00%	0	0.00%	0.00%	0	0.00%	0.00%
SUBALPINE FIR	274,562	2.48%	111,005	5.60%	40.43%	36,612	4.65%	13.33%	147,618	5.33%	53.76%
TRUE FIR-HEMLOCK	1,463,206	13.21%	485,159	24.47%	33.16%	182,918	23.22%	12.50%	668,077	24.12%	45.66%
WATER	123,344	1.11%	6,824	0.33%	5.30%	1,496	0.19%	1.21%	8,033	0.29%	6.51%
Totals	11,073,090	100.00%	1,982,725	100.00%	17.91%	759,931	100.00%	6.86%	2,770,060	100.00%	25.02%

Number of CSCF vegetation types represented at different protection levels.

CSCF	Existing Protected Areas	IRAs	Combined
Number 0 - 10%	5	13	4
Number 11- 25%	4	6	3
Number 26-50%	5	2	4
Number 51-75%	4	1	4
Number >75%	4	0	7
Total	22	22	22

LIST OF VEGETATION TYPES THAT DO NOT MEET 25% REPRESENTATION TARGET-CSCF

HARDWOODS
MIXED FOREST
DOUGLAS FIR-WESTERN HEMLOCK
DOUGLAS FIR-WHITE FIR-TANOAK
MIXED CONIFER
MIXED FOREST
RIPARIAN

Plate 14 (continued) PLANT COMMUNITY REPRESENTATION - CSCF

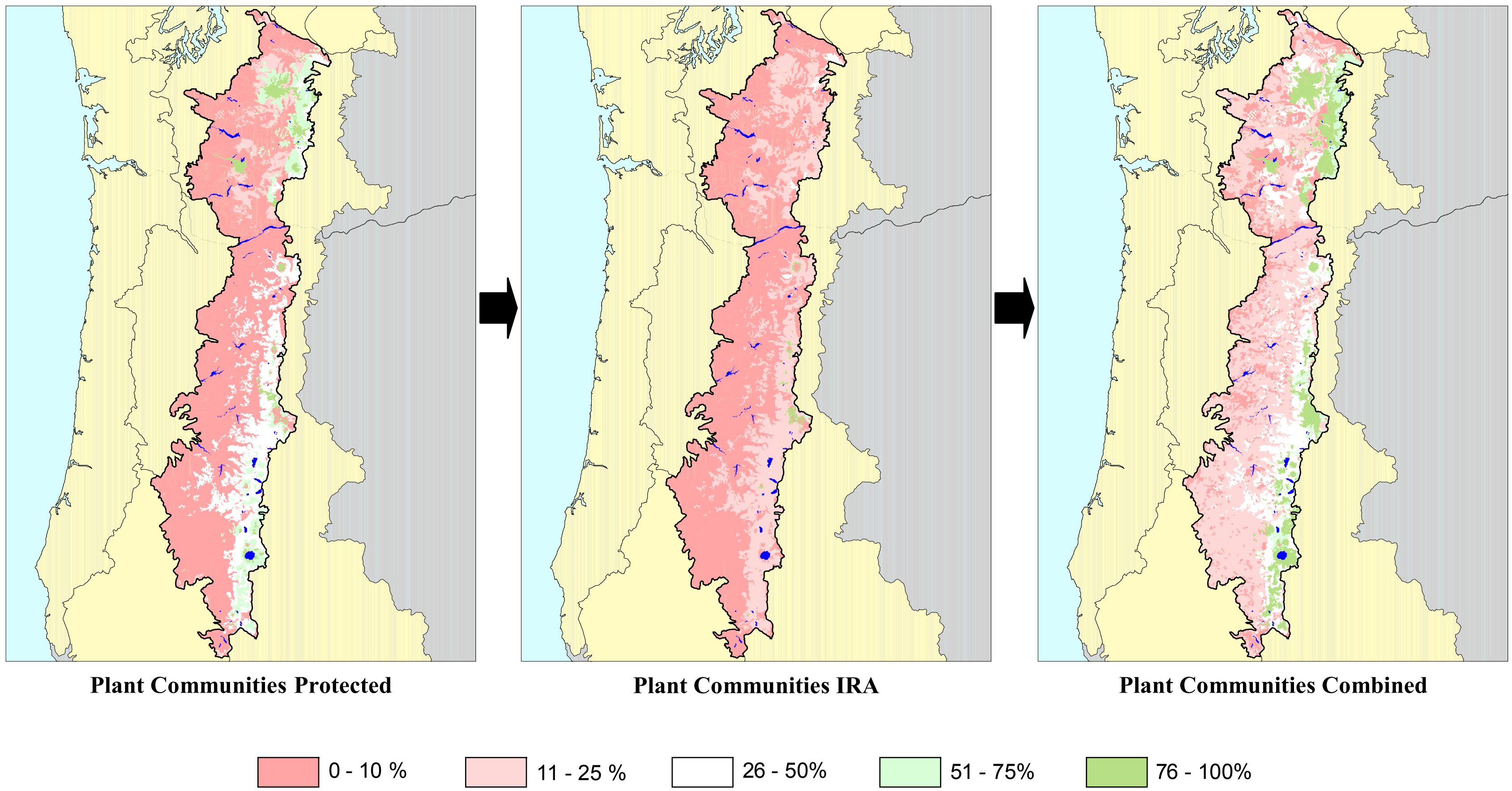


Plate 15. PLANT COMMUNITY REPRESENTATION - KSF

VEGTYPE	Area (ac)	Percent	Protected Area (ac)	Percent	Percent of class	IRA Area (ac)	Percent	Percent of class	Combined Area (ac)	Percent	Percent of class
AGRICULTURE	741,794	5.96%	5,240	0.28%	0.71%	132	0.01%	0.02%	5,371	0.18%	0.72%
DEVELOPED	98,354	0.79%	0	0.00%	0.00%	250	0.02%	0.25%	250	0.01%	0.25%
DISTURBED	252,990	2.03%	4,239	0.23%	1.68%	140	0.01%	0.06%	4,379	0.15%	1.73%
ALPINE DWARF SHRUB/MIXED CONIFER	1,914	0.02%	0	0.00%	0.00%	1,914	0.17%	100.00%	1,914	0.06%	100.00%
ALPINE PARKLANDS	8,199	0.07%	239	0.01%	2.92%	152	0.01%	1.86%	392	0.01%	4.78%
BARREN	123,558	0.99%	80,179	4.34%	64.89%	11,578	1.05%	9.37%	91,757	3.11%	74.26%
BITTERBRUSH	10,681	0.09%	0	0.00%	0.00%	0	0.00%	0.00%	0	0.00%	0.00%
BLUE OAK WOODLAND	89,309	0.72%	3,114	0.17%	3.49%	13,481	1.22%	15.09%	16,595	0.56%	18.58%
BLUE OAK-FOOTHILL PINE	277,092	2.23%	3,319	0.18%	1.20%	13,988	1.27%	5.05%	17,307	0.59%	6.25%
CHAMISE-REDSHANK CHAPARRAL	53,370	0.43%	264	0.01%	0.49%	2,521	0.23%	4.72%	2,785	0.09%	5.22%
CLOSED-CONE PINE-CYPRESS	44,586	0.36%	24,323	1.32%	54.55%	8,241	0.75%	18.48%	32,564	1.10%	73.04%
COASTAL OAK WOODLAND	16,580	0.13%	0	0.00%	0.00%	0	0.00%	0.00%	0	0.00%	0.00%
DOUGLAS-FIR/PORT ORFORD CEDAR	70,509	0.57%	19,840	1.07%	28.14%	10,635	0.96%	15.08%	30,475	1.03%	43.22%
DOUGLAS-FIR/WESTERN HEMLOCK	176,560	1.42%	16,047	0.87%	9.09%	34,852	3.16%	19.74%	50,899	1.72%	28.83%
DOUGLAS-FIR/WHITE FIR/TANOAK	1,043,213	8.39%	119,466	6.46%	11.45%	111,379	10.09%	10.68%	230,845	7.82%	22.13%
DOUGLAS-FIR	161,866	1.30%	45,057	2.44%	27.84%	24,668	2.23%	15.24%	69,724	2.36%	43.08%
DOUGLAS-FIR/HARDWOODS	227,263	1.83%	34,487	1.86%	15.17%	10,894	0.99%	4.79%	45,380	1.54%	19.97%
DOUGLAS-FIR/MIXED CONIFER	248,688	2.00%	53,590	2.90%	21.55%	22,969	2.08%	9.24%	76,560	2.59%	30.79%
EASTSIDE PINE	5,586	0.04%	0	0.00%	0.00%	0	0.00%	0.00%	0	0.00%	0.00%
FRESHWATER WETLAND	6,576	0.05%	218	0.01%	3.31%	0	0.00%	0.00%	218	0.01%	3.31%
GRASSLANDS	58,344	0.47%	0	0.00%	0.00%	0	0.00%	0.00%	0	0.00%	0.00%
GRASSLANDS/EASTSIDE CONIFER	119,941	0.96%	2,248	0.12%	1.87%	448	0.04%	0.37%	2,696	0.09%	2.25%
GRASSLANDS/MONTANE HARDWOOD	82,199	0.66%	264	0.01%	0.32%	4,451	0.40%	5.41%	4,715	0.16%	5.74%
HARDWOODS	64,173	0.52%	717	0.04%	1.12%	0	0.00%	0.00%	717	0.02%	1.12%
JEFFREY PINE	265,058	2.13%	43,459	2.35%	16.40%	63,163	5.72%	23.83%	106,622	3.61%	40.23%
JUNIPER WOODLANDS	176,544	1.42%	3,038	0.16%	1.72%	0	0.00%	0.00%	3,038	0.10%	1.72%
LODGEPOLE PINE	5,739	0.05%	5,738	0.31%	99.98%	1	0.00%	0.01%	5,739	0.19%	99.99%
MANZANITA SHRUBLAND	12,190	0.10%	11,843	0.64%	97.15%	0	0.00%	0.00%	11,843	0.40%	97.15%
MIXED CHAPARRAL	48,426	0.39%	5,680	0.31%	11.73%	6,929	0.63%	14.31%	12,608	0.43%	26.04%
MIXED CONIFER	2,240,957	18.02%	364,661	19.72%	16.27%	215,443	19.51%	9.61%	580,104	19.64%	25.89%
MIXED FOREST	16,018	0.13%	258	0.01%	1.61%	731	0.07%	4.56%	989	0.03%	6.18%
MONTANE CHAPARRAL	70,425	0.57%	35,119	1.90%	49.87%	4,007	0.36%	5.69%	39,125	1.32%	55.56%
MONTANE HARDWOOD	149,671	1.20%	2,841	0.15%	1.90%	5,276	0.48%	3.53%	8,117	0.27%	5.42%
MONTANE HARDWOOD/CONIFER	2,218,574	17.84%	298,454	16.14%	13.45%	216,596	19.61%	9.76%	515,050	17.44%	23.22%
OAK CHAPARRAL	2,132	0.02%	1,124	0.06%	52.74%	0	0.00%	0.01%	1,124	0.04%	52.75%
PONDEROSA PINE	1,482,995	11.92%	238,885	12.92%	16.11%	163,754	14.83%	11.04%	402,639	13.63%	27.15%

PONDEROSA PINE/OAK WOODLAND	190,829	1.53%	2,352	0.13%	1.23%	11,094	1.00%	5.81%	13,446	0.46%	7.05%
PONDEROSA PINE/CHAPARRAL	139,099	1.12%	58,351	3.16%	41.95%	7,672	0.69%	5.52%	66,023	2.24%	47.46%
PONDEROSA PINE/MONTANE HARDWOOD	168,232	1.35%	9,276	0.50%	5.51%	31,018	2.81%	18.44%	40,294	1.36%	23.95%
RED FIR	121,932	0.98%	58,575	3.17%	48.04%	14,560	1.32%	11.94%	73,135	2.48%	59.98%
RED FIR/CHAPARRAL	45,169	0.36%	22,977	1.24%	50.87%	9,970	0.90%	22.07%	32,947	1.12%	72.94%
REDWOOD FOREST	16,891	0.14%	236	0.01%	1.40%	0	0.00%	0.00%	236	0.01%	1.40%
RIPARIAN	2,105	0.02%	2,104	0.11%	99.98%	0	0.00%	0.00%	2,104	0.07%	99.97%
SAGEBRUSH SCRUB	22,937	0.18%	0	0.00%	0.00%	0	0.00%	0.00%	0	0.00%	0.00%
SERPENTINE SHRUBLANDS	32,361	0.26%	18,658	1.01%	57.65%	4,283	0.39%	13.24%	22,941	0.78%	70.89%
SHASTA RED FIR-MOUNTAIN HEMLOCK	5,860	0.05%	562	0.03%	9.59%	0	0.00%	0.00%	562	0.02%	9.59%
SIERRAN MIXED CONIFER	383,940	3.09%	6,598	0.36%	1.72%	27,755	2.51%	7.23%	34,354	1.16%	8.95%
SISKIYOU MIXED HARDWOODS	133,524	1.07%	7,290	0.39%	5.46%	2,681	0.24%	2.01%	9,971	0.34%	7.47%
SUBALPINE CONIFER	190,022	1.53%	160,148	8.66%	84.28%	7,882	0.71%	4.15%	168,030	5.69%	88.43%
TRUE FIR-HEMLOCK	29,943	0.24%	2,916	0.16%	9.74%	12,324	1.12%	41.16%	15,240	0.52%	50.89%
VALLEY OAK WOODLAND	29,408	0.24%	0	0.00%	0.00%	124	0.01%	0.42%	124	0.00%	0.42%
WATER	50,573	0.41%	25,874	1.40%	51.16%	39	0.00%	0.08%	25,913	0.88%	51.24%
WHITE FIR	201,921	1.62%	49,297	2.67%	24.41%	26,327	2.38%	13.04%	75,624	2.56%	37.45%
Totals	12,436,820	100.00%	1,849,165	100.00%	14.87%	1,104,322	100.00%	8.88%	2,953,487	100.00%	23.75%

Number of KSF vegetation types represented at different protection levels.

KSF	Existing Protected Areas	IRAs	Combined
Number 0 - 10%	26	35	21
Number 11- 25%	9	12	5
Number 26-50%	5	1	10
Number 51-75%	5	0	8
Number >75%	4	1	5
Total	49	49	49

LIST OF VEGETATION TYPES THAT DO NOT MEET 25% REPRESENTATION TARGET - KSF

ALPINE PARKLANDS
BITTERBRUSH
BLUE OAK WOODLAND
BLUE OAK-FOOTHILL PINE
CHAMISE-REDSHANK CHAPARRAL
COASTAL OAK WOODLAND
DOUGLAS-FIR/WHITE FIR/TANOAK
DOUGLAS-FIR/HARDWOODS
EASTSIDE PINE
FRESHWATER WETLAND
GRASSLANDS
GRASSLANDS/EASTSIDE CONIFER
GRASSLANDS/MONTANE HARDWOOD
HARDWOODS
JUNIPER WOODLANDS
MIXED FOREST
MONTANE HARDWOOD
MONTANE HARDWOOD/CONIFER
PONDEROSA PINE/OAK WOODLAND
PONDEROSA PINE/MONTANE HARDWOOD
REDWOOD FOREST
SAGEBRUSH SCRUB
SHASTA RED FIR-MOUNTAIN HEMLOCK
SIERRAN MIXED CONIFER
SISKIYOU MIXED HARDWOODS
VALLEY OAK WOODLAND

Plate 15 (continued) PLANT COMMUNITY REPRESENTATION - KSF

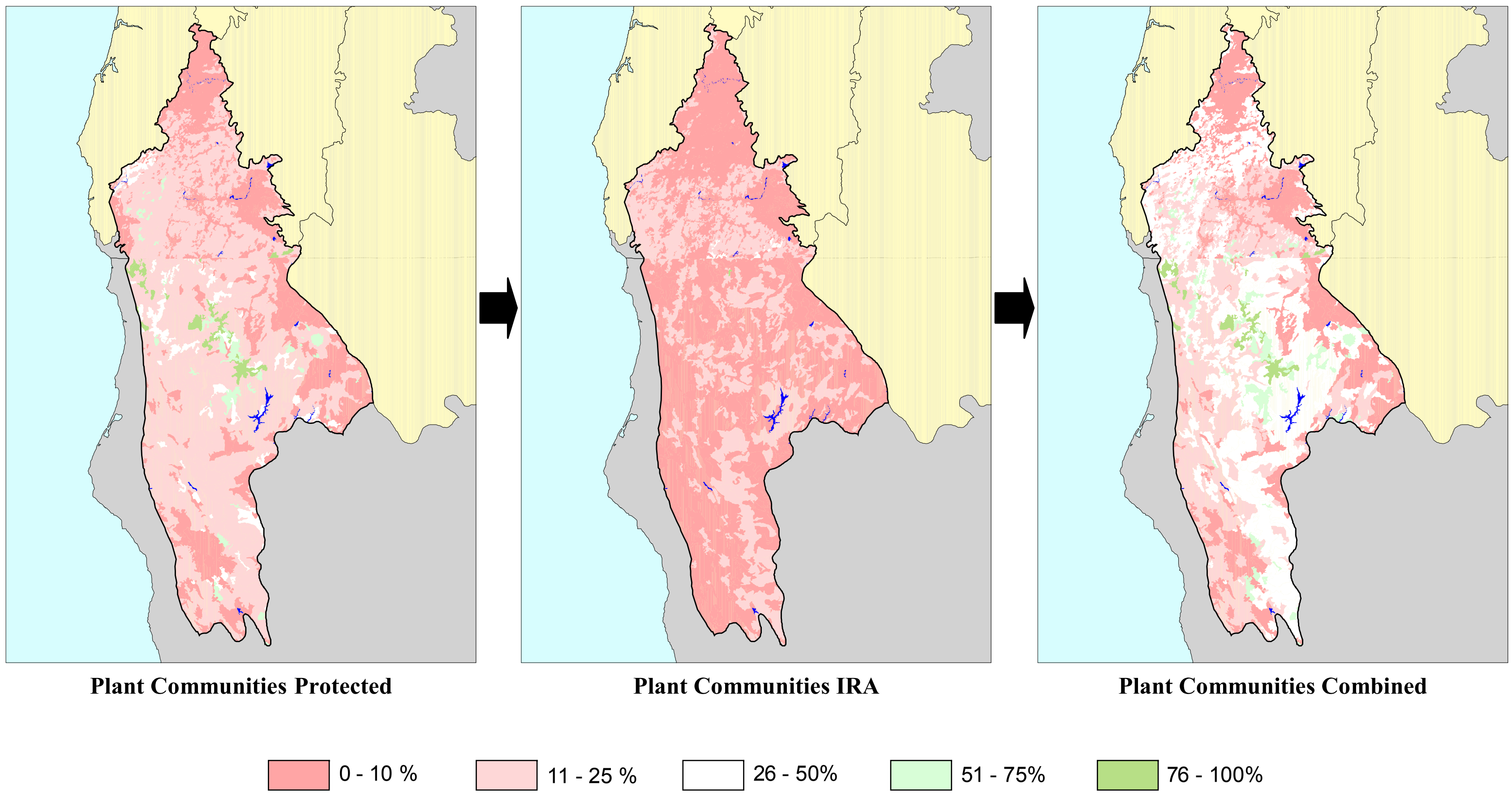


Plate 16. PLANT COMMUNITY REPRESENTATION - ECF

VEGTYPE	Area (ac)	Percent	Protected Area (ac)	Percent	Percent of class	IRA Area (ac)	Percent	Percent of class	Combined Area (ac)	Percent	Percent of class
AGRICULTURE	1,175,680	8.59%	103,509	15.88%	8.80%	41	0.01%	0.00%	103,550	9.49%	8.81%
DEVELOPED	36,508	0.27%	136	0.02%	0.37%	0	0.00%	0.00%	136	0.01%	0.37%
DISTURBED	1,249,088	9.13%	79,062	12.13%	6.33%	30,316	6.89%	2.43%	109,377	10.02%	8.76%
ALKALI MEADOW	3,994	0.03%	1,392	0.21%	34.86%	0	0.00%	0.00%	1,392	0.13%	34.86%
ALPINE PARKLAND	2,737	0.02%	40	0.01%	1.47%	0	0.00%	0.00%	40	0.00%	1.47%
ASPEN FOREST	2,284	0.02%	0	0.00%	0.00%	645	0.15%	28.24%	645	0.06%	28.24%
BARREN	59,106	0.43%	20,940	3.21%	35.43%	14,003	3.18%	23.69%	34,943	3.20%	59.12%
BIG SAGEBRUSH SCRUB	180,638	1.32%	19,047	2.92%	10.54%	16,273	3.70%	9.01%	35,320	3.24%	19.55%
BITTERBRUSH-BIG SAGEBRUSH SCRUB	2,696	0.02%	11	0.00%	0.39%	0	0.00%	0.00%	11	0.00%	0.39%
BUCK BRUSH CHAPARRAL	5,785	0.04%	2,484	0.38%	42.93%	0	0.00%	0.00%	2,484	0.23%	42.93%
BUSH CHINQUAPIN CHAPARRAL	4,187	0.03%	0	0.00%	0.00%	0	0.00%	0.00%	0	0.00%	0.00%
CEONOTHUS CHAPARRAL	13,746	0.10%	0	0.00%	0.00%	3,498	0.80%	25.45%	3,498	0.32%	25.45%
CERCOCARPUS WOODLAND	692	0.01%	0	0.00%	0.00%	0	0.00%	0.00%	0	0.00%	0.00%
DESERT GREASEWOOD SCRUB	4,370	0.03%	2	0.00%	0.04%	0	0.00%	0.00%	2	0.00%	0.04%
DOUGLAS FIR	336,887	2.46%	11,885	1.82%	3.53%	6,338	1.44%	1.88%	18,222	1.67%	5.41%
DOUGLAS FIR-WESTERN HEMLOCK	7,183	0.05%	17	0.00%	0.24%	0	0.00%	0.00%	17	0.00%	0.24%
FRESHWATER WETLAND	466,685	3.41%	49,990	7.67%	10.71%	1,351	0.31%	0.29%	51,341	4.70%	11.00%
GRAND FIR	219,110	1.60%	35,192	5.40%	16.06%	20,616	4.69%	9.41%	55,807	5.11%	25.47%
GRASSLANDS	58,441	0.43%	12,912	1.98%	22.09%	1,590	0.36%	2.72%	14,502	1.33%	24.82%
GREAT BASIN GRASSLAND	13,137	0.10%	3,359	0.52%	25.57%	637	0.14%	4.85%	3,996	0.37%	30.42%
GREAT BASIN MIXED SCRUB	443,244	3.24%	10,981	1.68%	2.48%	36,429	8.28%	8.22%	47,411	4.34%	10.70%
GREAT BASIN WET MEADOW	46,886	0.34%	3,865	0.59%	8.24%	408	0.09%	0.87%	4,273	0.39%	9.11%
HARDWOODS	138,186	1.01%	3,294	0.51%	2.38%	1,213	0.28%	0.88%	4,507	0.41%	3.26%
INTERIOR CYPRESS FOREST	3,484	0.03%	0	0.00%	0.00%	382	0.09%	10.97%	382	0.04%	10.97%
JEFFREY PINE	37,265	0.27%	0	0.00%	0.00%	0	0.00%	0.00%	0	0.00%	0.00%
LODGEPOLE PINE	297,237	2.17%	9,653	1.48%	3.25%	6,760	1.54%	2.27%	16,413	1.50%	5.52%
LOW SAGEBRUSH SCRUB	274,699	2.01%	3,548	0.54%	1.29%	2,343	0.53%	0.85%	5,891	0.54%	2.14%
MANZANITA CHAPARRAL	52,395	0.38%	0	0.00%	0.00%	274	0.06%	0.52%	274	0.03%	0.52%
MIXED CONIFER	746,039	5.45%	9,599	1.47%	1.29%	9,644	2.19%	1.29%	19,242	1.76%	2.58%
MIXED FOREST	187,310	1.37%	9,100	1.40%	4.86%	0	0.00%	0.00%	9,100	0.83%	4.86%
MOUNTAIN HEMLOCK	16,823	0.12%	2,898	0.44%	17.23%	44	0.01%	0.26%	2,942	0.27%	17.49%
MOUNTAIN MEADOW	61,927	0.45%	2,511	0.39%	4.05%	1,310	0.30%	2.12%	3,820	0.35%	6.17%
PONDEROSA PINE	4,433,866	32.39%	75,679	11.61%	1.71%	159,481	36.26%	3.60%	235,160	21.54%	5.30%
PONDEROSA PINE-WESTERN JUNIPER	1,149,238	8.40%	44,685	6.85%	3.89%	58,743	13.36%	5.11%	103,427	9.47%	9.00%
PONDEROSA PINE-WHITE OAK	70,924	0.52%	498	0.08%	0.70%	0	0.00%	0.00%	498	0.05%	0.70%
RABBITBRUSH SCRUB	14,322	0.10%	0	0.00%	0.00%	0	0.00%	0.00%	0	0.00%	0.00%

RED FIR	58,935	0.43%	0	0.00%	0.00%	321	0.07%	0.54%	321	0.03%	0.54%
RIPARIAN	10,638	0.08%	0	0.00%	0.00%	143	0.03%	1.34%	143	0.01%	1.34%
SAGEBRUSH STEPPE	354,301	2.59%	1,931	0.30%	0.54%	463	0.11%	0.13%	2,394	0.22%	0.68%
SHRUBLANDS	191,141	1.40%	15,656	2.40%	8.19%	4,478	1.02%	2.34%	20,135	1.84%	10.53%
SILVER FIR	130	0.00%	0	0.00%	0.00%	130	0.03%	100.00%	130	0.01%	100.00%
SILVER SAGEBRUSH SCRUB	10,306	0.08%	0	0.00%	0.00%	0	0.00%	0.00%	0	0.00%	0.00%
SUBALPINE FIR	140,567	1.03%	14,736	2.26%	10.48%	20,277	4.61%	14.43%	35,014	3.21%	24.91%
TRUE FIR-MOUNTAIN HEMLOCK	96,200	0.70%	17,541	2.69%	18.23%	7,082	1.61%	7.36%	24,623	2.26%	25.60%
WATER	304,940	2.23%	43,514	6.68%	14.27%	184	0.04%	0.06%	43,582	3.99%	14.29%
WESTERN HEMLOCK	4,215	0.03%	0	0.00%	0.00%	14	0.00%	0.33%	14	0.00%	0.33%
WESTERN JUNIPER WOODLAND	348,427	2.55%	2,170	0.33%	0.62%	6,404	1.46%	1.84%	8,574	0.79%	2.46%
WESTERN REDCEDAR-WESTERN HEMLOCK	12,091	0.09%	5,085	0.78%	42.06%	3,102	0.71%	25.66%	8,187	0.75%	67.71%
WET MEADOW	1,282	0.01%	0	0.00%	0.00%	0	0.00%	0.00%	0	0.00%	0.00%
WHITE FIR	317,054	2.32%	33,644	5.16%	10.61%	24,837	5.65%	7.83%	58,481	5.36%	18.45%
WHITEBARK PINE-MOUNTAIN HEMLOCK	18,910	0.14%	0	0.00%	0.00%	0	0.00%	0.00%	0	0.00%	0.00%
WHITEBARK-LODGEPOLE PINE	1,322	0.01%	1,322	0.20%	100.00%	0	0.00%	0.00%	1,322	0.12%	100.00%
Totals	13,687,259	100.00%	651,887	100.00%	4.76%	439,776	100.00%	3.21%	1,091,547	99.99%	7.97%

Number of ECF vegetation types represented at different protection levels.

ECF	Existing Protected Areas	IRAs	Combined
Number 0 - 10%	33	41	28
Number 11- 25%	9	3	7
Number 26-50%	5	3	9
Number 51-75%	0	0	2
Number >75%	1	1	2
Total	48	48	48

LIST OF VEGETATION TYPES THAT DO NOT MEET 25% REPRESENTATION TARGET - ECF

ALPINE PARKLAND
BIG SAGEBRUSH SCRUB
BITTERBRUSH-BIG SAGEBRUSH SCRUB
BUSH CHINQUAPIN CHAPARRAL
CERCOCARPUS WOODLAND
DESERT GREASEWOOD SCRUB
DOUGLAS FIR
DOUGLAS FIR-WESTERN HEMLOCK
FRESHWATER WETLAND
GRASSLANDS
GREAT BASIN MIXED SCRUB
GREAT BASIN WET MEADOW
HARDWOODS
INTERIOR CYPRESS FOREST
JEFFREY PINE
LODGEPOLE PINE
LOW SAGEBRUSH SCRUB
MANZANITA CHAPARRAL
MIXED CONIFER
MIXED FOREST
MOUNTAIN HEMLOCK
MOUNTAIN MEADOW
PONDEROSA PINE
PONDEROSA PINE-WESTERN JUNIPER
PONDEROSA PINE-WHITE OAK
RABBITBRUSH SCRUB
RED FIR
RIPARIAN
SAGEBRUSH STEPPE
SHRUBLANDS
SILVER SAGEBRUSH SCRUB
SUBALPINE FIR
WET MEADOW
WHITE FIR
WHITEBARK PINE-MOUNTAIN HEMLOCK
WESTERN JUNIPER WOODLAND
WESTERN HEMLOCK

Plate 16 (continued) PLANT COMMUNITY REPRESENTATION - ECF

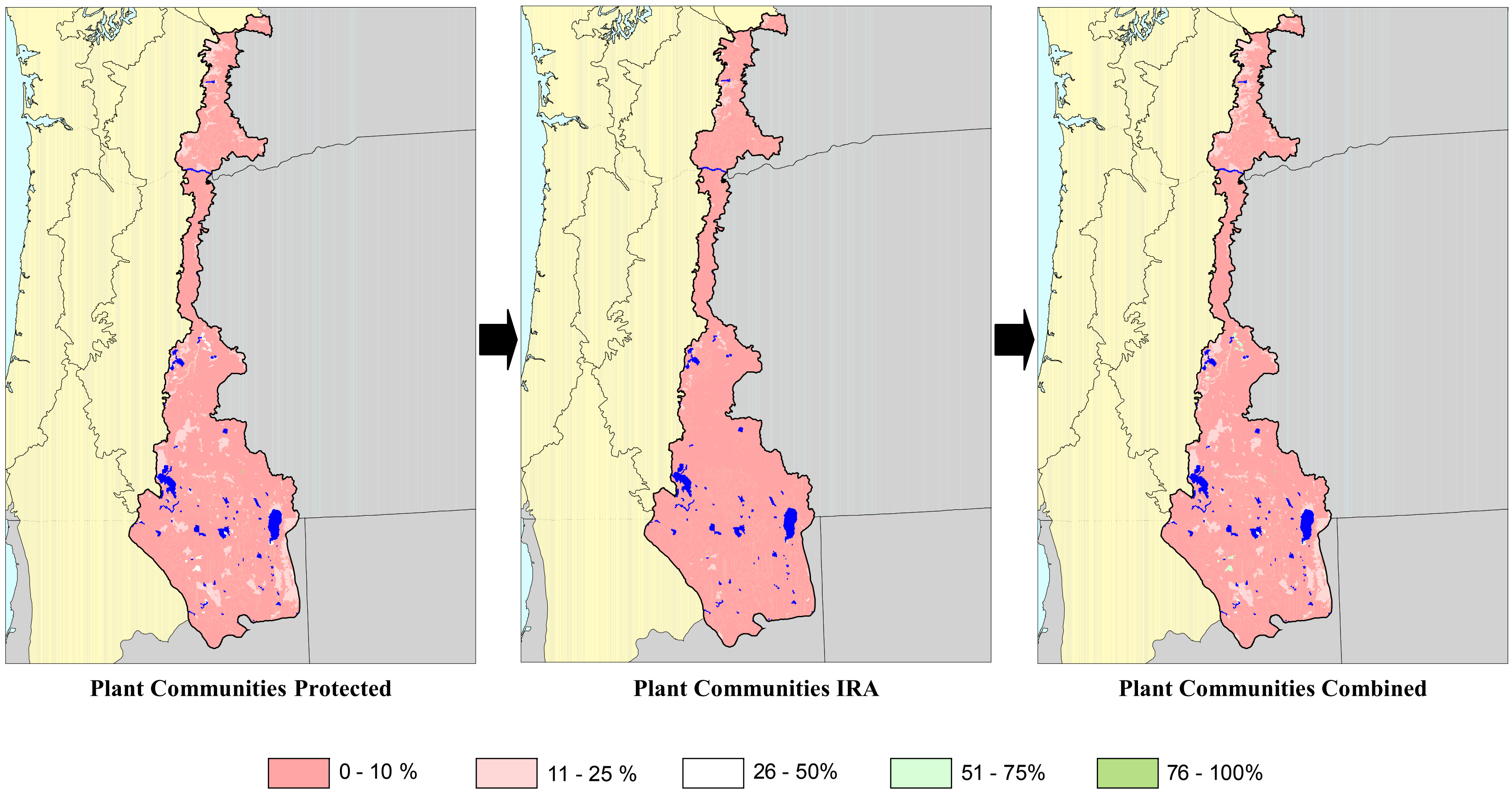


Plate 17. PLANT COMMUNITY REPRESENTATION - CMLF

VEGTYPE	Area (ac)	Percent	Protected Area (ac)	Percent	Percent of class	IRA Area (ac)	Percent	Percent of class	Combined Area (ac)	Percent	Percent of class
AGRICULTURE	28,985	0.26%	0	0.00%	0.00%	653	0.08%	2.25%	653	0.03%	2.25%
DEVELOPED	1,287	0.01%	0	0.00%	0.00%	0	0.00%	0.00%	0	0.00%	0.00%
DISTURBED	593,830	5.36%	75,600	5.63%	12.73%	105,436	12.30%	17.76%	181,036	8.23%	30.49%
ALPINE PARKLAND	44,476	0.40%	31,852	2.37%	71.62%	8,649	1.01%	19.45%	40,501	1.84%	91.06%
BARREN	12,896	0.12%	12,826	0.95%	99.46%	45	0.01%	0.35%	12,871	0.58%	99.81%
DOUGLAS FIR	723,675	6.54%	132,317	9.85%	18.28%	176,522	20.59%	24.39%	308,839	14.03%	42.68%
DOUGLAS FIR-WESTERN HEMLOCK	243	0.00%	10	0.00%	4.13%	0	0.00%	0.00%	10	0.00%	4.13%
GRAND FIR	166,544	1.50%	25,142	1.87%	15.10%	86,602	10.10%	52.00%	111,743	5.08%	67.10%
GRASSLAND	116,621	1.05%	75,351	5.61%	64.61%	34,715	4.05%	29.77%	110,065	5.00%	94.38%
HARDWOODS	8,084	0.07%	5,798	0.43%	71.72%	687	0.08%	8.50%	6,485	0.29%	80.22%
MOUNTAIN HEMLOCK	26,128	0.24%	23,550	1.75%	90.13%	821	0.10%	3.14%	24,371	1.11%	93.28%
PONDEROSA PINE	488,101	4.41%	22,639	1.68%	4.64%	39,096	4.56%	8.01%	61,734	2.80%	12.65%
RIPARIAN	7,708	0.07%	1,901	0.14%	24.67%	17	0.00%	0.22%	1,918	0.09%	24.89%
SHRUBLANDS	720,309	6.51%	354,079	26.35%	49.16%	132,580	15.47%	18.41%	486,659	22.11%	67.56%
SILVER FIR	14,029	0.13%	9,587	0.71%	68.34%	3,281	0.38%	23.39%	12,869	0.58%	91.73%
SUBALPINE FIR	849,610	7.67%	511,171	38.04%	60.17%	241,843	28.21%	28.47%	753,015	34.21%	88.63%
WATER	50,019	0.45%	914	0.07%	1.83%	382	0.04%	0.76%	1,295	0.06%	2.59%
WESTERN REDCEDAR-WESTERN HEMLOCK	102,099	0.92%	61,079	4.55%	59.82%	25,824	3.01%	25.29%	86,905	3.95%	85.12%
Totals	3,954,643	35.71%	1,343,816	100.00%	33.98%	857,153	100.00%	21.67%	2,200,969	100.00%	55.66%

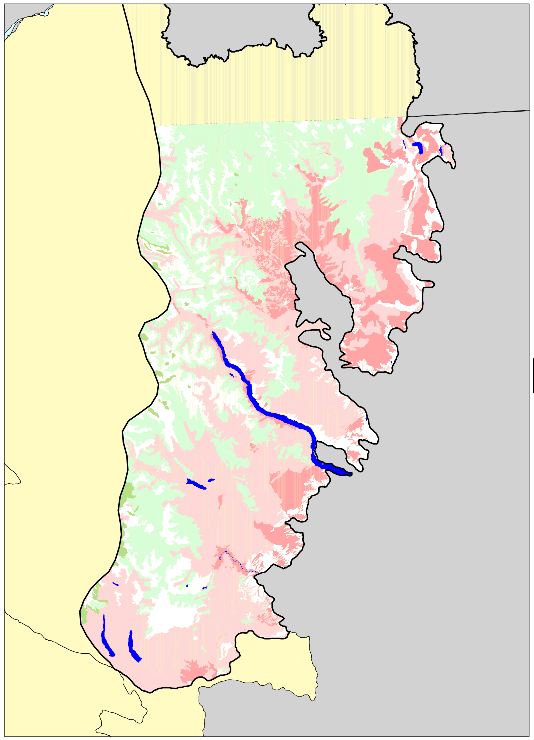
Number of CMLF vegetation types represented at different protection levels.

CMLF	Existing Protected Areas	IRAs	Combined
Number 0 - 10%	1	5	0
Number 11- 25%	3	5	2
Number 26-50%	1	2	1
Number 51-75%	6	1	2
Number >75%	2	0	8
Total	13	13	13

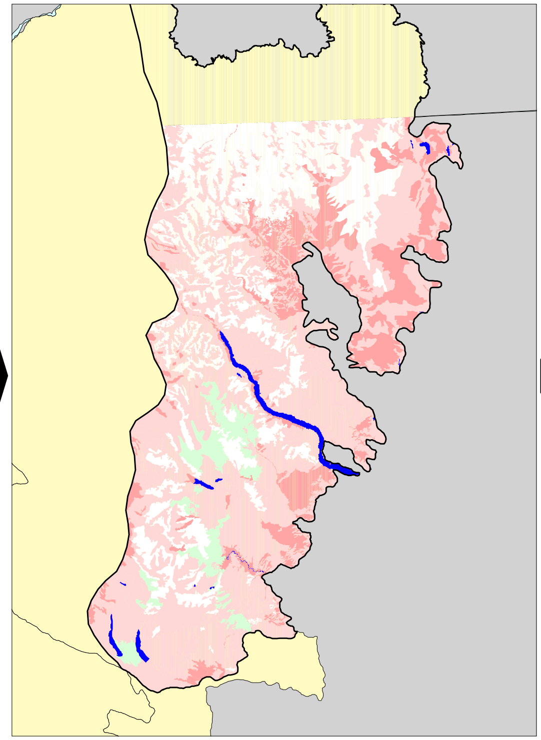
LIST OF VEGETATION TYPES THAT DO NOT MEET 25% REPRESENTATION TARGET - CMLF

RIPARIAN
DOUGLAS FIR

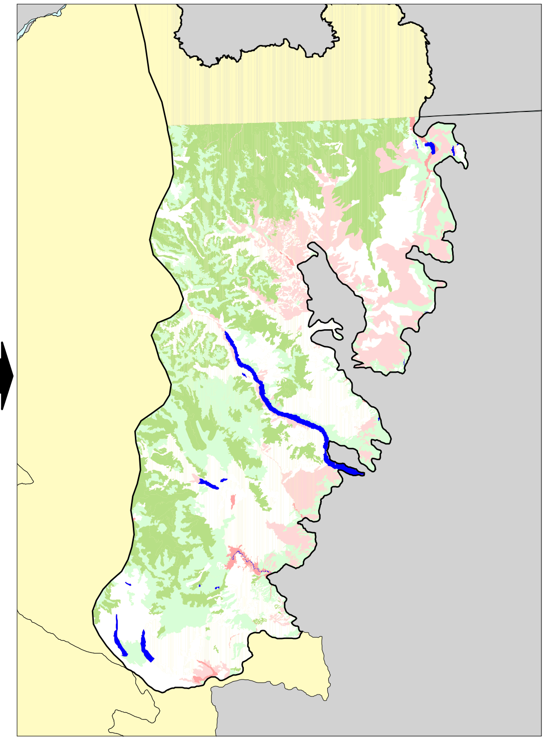
Plate 17 (continued) PLANT COMMUNITY REPRESENTATION - CMLF



Plant Communities Protected



Plant Communities IRA



Plant Communities Combined

0 - 10 % | 11 - 25 % | 26 - 50% | 51 - 75% | 76 - 100%

Plate 18. PLANT COMMUNITY REPRESENTATION - NCF

VEGTYPE	Area (ac)	Percent	Protected Area (ac)	Percent	Percent of class	IRA Area (ac)	Percent	Percent of class	Combined Area (ac)	Percent	Percent of class
AGRICULTURE	19,707	0.62%	0	0.00%	0.00%	0	0.00%	0.00%	0	0.00%	0.00%
DEVELOPED	4,767	0.15%	0	0.00%	0.00%	0	0.00%	0.00%	0	0.00%	0.00%
DISTURBED	605,437	19.17%	19,475	1.53%	3.22%	58,442	14.78%	9.65%	77,917	4.67%	12.87%
ALPINE MEADOW	4,959	0.16%	1,972	0.15%	39.77%	1,782	0.45%	35.93%	3,754	0.22%	75.70%
ALPINE PARKLANDS	41,334	1.31%	30,756	2.41%	74.41%	5,755	1.46%	13.92%	36,511	2.19%	88.33%
ALPINE SHRUBLAND	465,672	14.75%	431,894	33.88%	92.75%	24,899	6.30%	5.35%	456,793	27.35%	98.09%
BARREN	44,567	1.41%	44,670	3.50%	100.23%	0	0.00%	0.00%	44,670	2.67%	100.23%
DOUGLAS FIR	57,717	1.83%	57,496	4.51%	99.62%	0	0.00%	0.00%	57,496	3.44%	99.62%
DOUGLAS FIR-WESTERN HEMLOCK	259,766	8.23%	29,599	2.32%	11.39%	26,006	6.58%	10.01%	55,604	3.33%	21.41%
FRESHWATER WETLAND	2,405	0.08%	1,466	0.12%	60.97%	214	0.05%	8.90%	1,680	0.10%	69.87%
HARDWOODS	113,041	3.58%	10,830	0.85%	9.58%	6,680	1.69%	5.91%	17,510	1.05%	15.49%
MIXED FOREST	138,079	4.37%	7	0.00%	0.00%	331	0.08%	0.24%	338	0.02%	0.24%
MOUNTAIN HEMLOCK	666,292	21.10%	386,251	30.30%	57.97%	155,958	39.45%	23.41%	542,209	32.46%	81.38%
PONDEROSA PINE	95	0.00%	96	0.01%	100.27%	0	0.00%	0.00%	96	0.01%	100.27%
RIPARIAN	45,628	1.44%	3,772	0.30%	8.27%	1,085	0.27%	2.38%	4,857	0.29%	10.64%
SILVER FIR	620,030	19.63%	207,195	16.25%	33.42%	112,330	28.42%	18.12%	319,525	19.13%	51.53%
SUBALPINE FIR	31,021	0.98%	30,547	2.40%	98.47%	0	0.00%	0.00%	30,547	1.83%	98.47%
WATER	27,535	0.87%	12,953	1.02%	47.04%	17	0.00%	0.06%	12,970	0.78%	47.10%
WESTERN REDCEDAR-WESTERN HEMLOCK	9,979	0.32%	5,973	0.47%	59.86%	1,784	0.45%	17.88%	7,757	0.46%	77.74%
Totals	3,158,032	100.00%	1,274,952	100.00%	40.37%	395,281	100.00%	12.52%	1,670,233	100.00%	52.89%

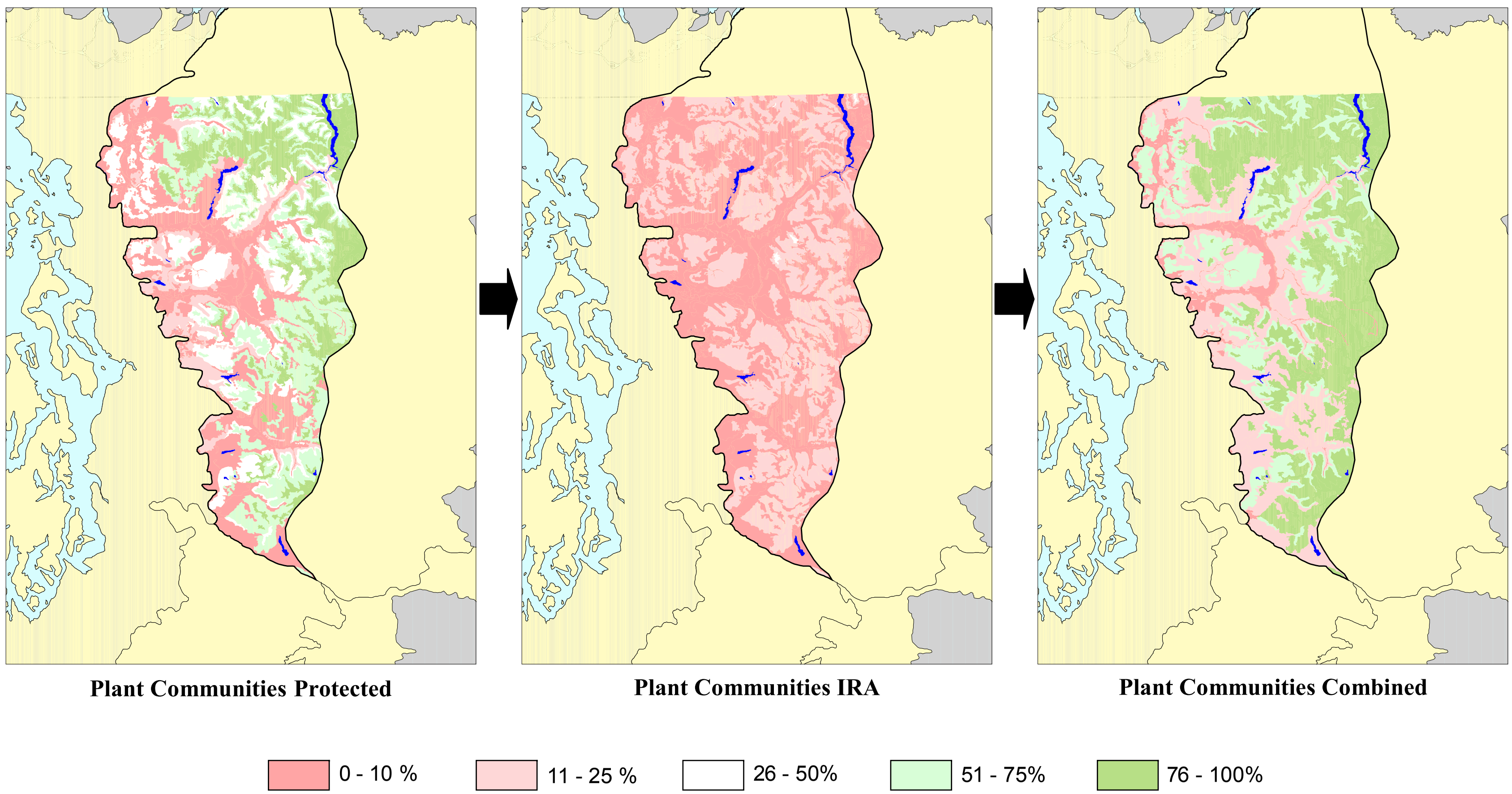
Number of NCF vegetation types represented at different protection levels.

NCF	Existing Protected Areas	IRAs	Combined
Number 0 - 10%	2	9	1
Number 11- 25%	1	4	3
Number 26-50%	2	1	0
Number 51-75%	4	0	2
Number >75%	5	0	8
Total	14	14	14

LIST OF VEGETATION TYPES THAT DO NOT MEET 25% REPRESENTATION TARGET - NCF

MIXED FOREST
HARDWOODS
RIPARIAN
DOUGLAS FIR-WESTERN HEMLOCK

Plate 18 (continued) PLANT COMMUNITY REPRESENTATION - NCF



TONGASS NATIONAL FOREST

SUMMARY

The Tongass National Forest in southeast Alaska has been recognized by World Wildlife Fund as an area of global conservation importance (Ricketts et al. 1999). Roughly ¼ of the world's temperate rainforest occurs in this region, including many of the nation's largest remaining intact watersheds (Ricketts et al. 1999). Despite its global and national significance, however, up to 90% of low-elevation, high-volume, old-growth forests (those with the largest trees) have been logged since the early 1950s (DellaSala et al. 1996). Computer mapping assessments by the Conservation Biology Institute (www.consbio.org) indicate that extensive logging, particularly in low-elevation valley-bottomlands, has fragmented many of the forests in this region. Their analysis indicates the following losses attributed to logging and road building:

- Most protected areas on the Forest, fail to capture low-elevation, high volume old-growth forest, under-representing this important habitat type.
- The Forest contains a large proportion of the nation's intact forests that are vital for maintaining viable populations of many species in trouble elsewhere across their range and the protection of remaining roadless areas is key to population viability.
- The Forest is perhaps the last place in North America where opportunities still exist to combine representation approaches for reserve (i.e., particularly through roadless conservation) with more sustainable timber harvest levels (i.e., by limiting harvest to a ¼ - ½ mile buffer around existing roads).
- Because the Tongass is a humid (i.e., temperate rainforest) environment with high stream densities, reduction in roads is especially beneficial to fish and watershed values particularly since such areas would require the greatest drainage structures to build roads.

BACKGROUND

In the past century, lands in South East Alaska's Tongass National Forest have been harvested at an alarming rate (DellaSala et. al. 1996). Until 1960, extraction was limited to coastal areas due to the lack of road networks. This limit to access of inland tracts of forests changed in the 1960s when logging road construction began to increase (Figure 9).

In the 1980s tribal land consolidation and aggressive resource extraction policy resulted in wide spread harvests. Logging in the 90s continued at a rate slightly under that of the 80s. Sixty four percent of the harvested areas have occurred between sea level and 200 meters (650 feet) in elevation (Figure 7). These areas were targeted for their high value Sitka spruce *Picea sitchensis*. While a large portion of SE Alaska is protected land, the protected land is mostly concentrated above 200 meters. Therefore the majority of timbered lands are not protected. A good portion of roadless areas in the Tongass National Forest also contain harvestable timber (Figure 8).

METHODS

A series of coverages were created showing the progression through time of road building in the Tongass National Forest (Figures 10 and 11). These coverages were developed by selecting logging roads from the "tongasroads" coverage, (1:24,000 logging road coverage for the Tongass National Forest) and putting them in a new coverage for each decade. This process was carried out by displaying the road coverage over the historical logging cut polygon coverage "tongasscut" (1:24,000 clear-cut data for 1900-1999) and determining which decade the road was completed from the year the corresponding unit was cut. Because all subsequent harvests needed access to mills or extraction sites, roads leading to those harvest sites were placed in the decade before the unit was cut.

Prior to 1960, nearly all of the timber extraction was accomplished from the ocean shore. Thus it was determined that the road time series of coverages should begin with a coverage showing roads that were completed prior to 1960. These roads consisted of mining operation and local community transportation systems.

An additional coverage, “pvt_cut1” was used to categorize the year that roads were built to log private areas outside the boundary of the National Forest. “Pvt_cut1” was created by taking a private clear-cut coverage supplied by the Forest Service and erasing the “tongasscut” coverage. This was done to create two distinct coverages showing private and public cuts. All of the private cuts were harvested in either the 1960s or 1980s.

Figure 7

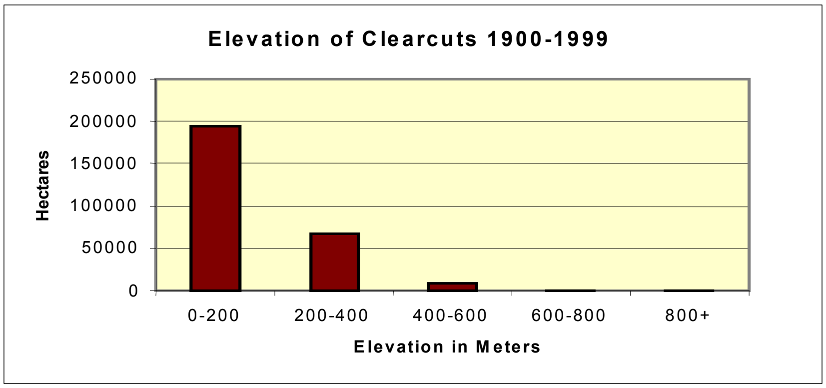


Figure 8

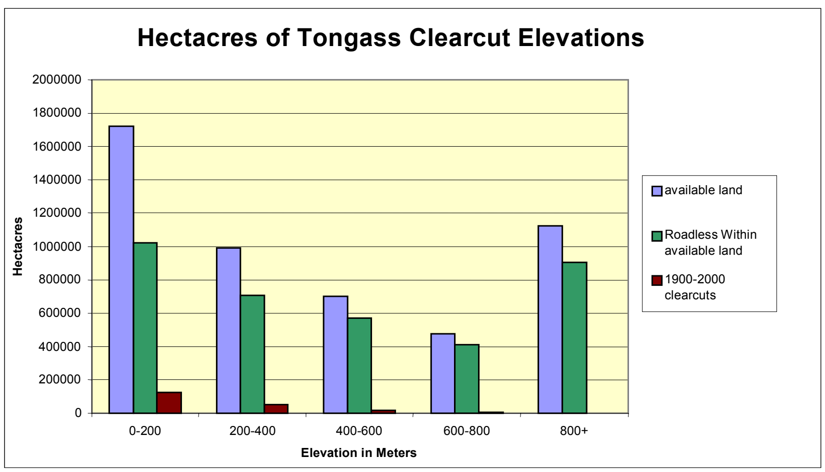
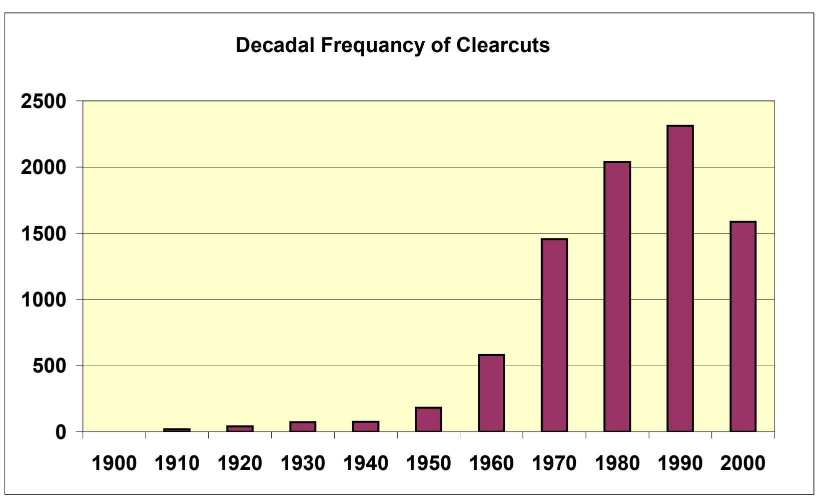


Figure 9



Tongass National Forest
Prince of Wales Island SE Alaska

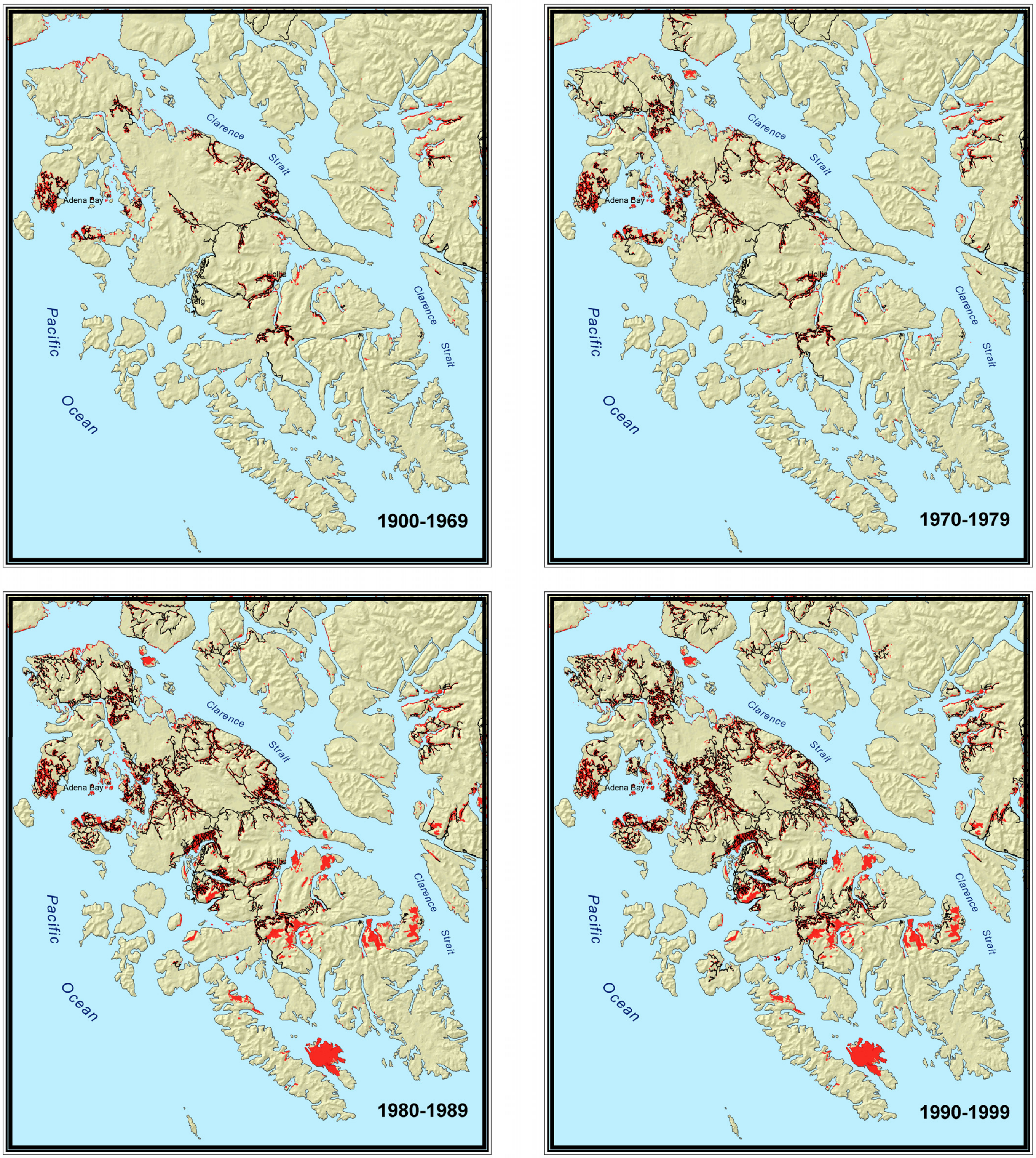
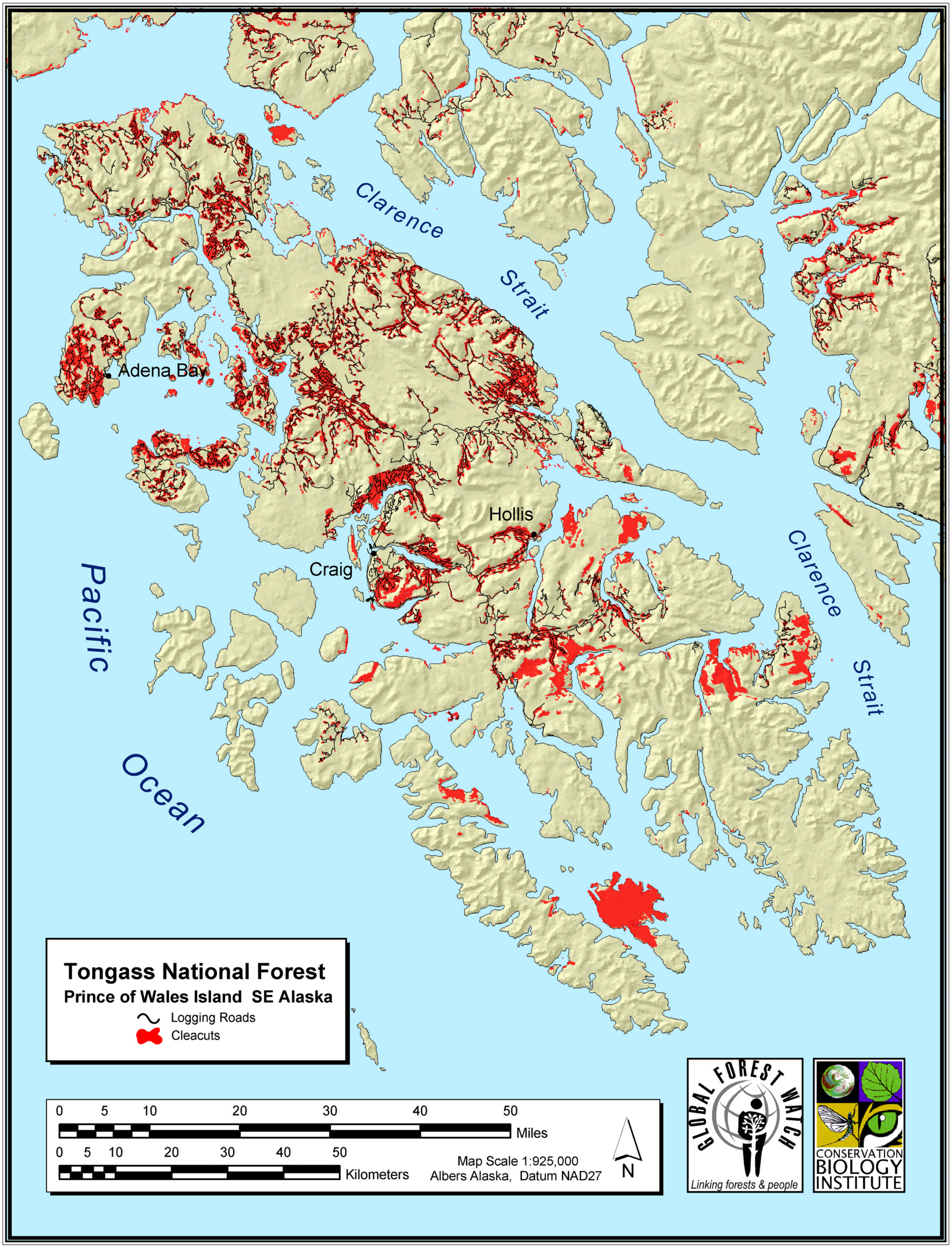


Figure 10



Clarence Strait
Clarence Strait
Pacific Ocean
Adena Bay
Hollis
Craig
Tongass National Forest
Prince of Wales Island SE Alaska
Logging Roads
Cleacuts
0 5 10 20 30 40 50
Miles
0 5 10 20 30 40 50
Kilometers
Map Scale 1:925,000
Albers Alaska, Datum NAD27
N
GLOBAL FOREST WATCH
Linking forests & people
CONSERVATION BIOLOGY INSTITUTE

Figure 11

FIRE, INSECTS, AND DISEASE (from DellaSala and Frost 2001)

Several studies have found that fire risks tend to be greater in intensively managed areas where logging slash and road building contribute to the likelihood of high intensity (i.e. catastrophic) fire events. These studies can be summarized regionally as follows:

- Sierra Nevada Region - according to the Sierra Nevada assessment, "timber harvest, through its effects on forest structure, local microclimate and fuel accumulation, has increased fire severity more than any other recent human activity" (SNEP 1996). The Interior Columbia Basin assessment similarly concluded that "fires in unroaded areas are not as severe as in roaded areas because of less surface fuel….Many of the fires in the unroaded areas produce a forest structure that is consistent with the fire regime, while the fires in the roaded areas commonly produce a forest structure that is not in sync with the fire regime. Fires in the roaded areas are more intense, due to drier conditions, wind zones on the foothill/valley interface, high surface-fuel loading, and dense stands" (Hann et al. 1997). McKelvey and others (1996) and Weatherspoon (1996) also identified timber harvest as the single most important factor responsible for an increase in potential fire severity.

- Interior Columbia River Basin - even within the forest types most altered as a result of fire suppression (such as dry forests with a regime of frequent low-intensity fires), intensively managed forests on Federal lands in the Interior Columbia Basin are more dense and carry higher fuel loads than do roadless areas. Accordingly, intensively managed lands are at higher risk of tree mortality from fire, insects, disease, and other disturbance agents (Megahan et al. 1994, Hann et al. 1997).

- Klamath Mountains (southwest Oregon, northern California) - Weatherspoon and Skinner (1995) found that partial-cut stands with fuels treatment burned more intensely and suffered higher levels of tree mortality than areas left uncut and untreated. Fire and fuel models also suggest that mechanical treatments alone, including silvicultural thinning and biomass removal, are not likely to be effective at reducing fire severity in dense stands (van Wagtendonk 1996).

- Eastern Oregon and Washington - Lehmkuhl et al. (1995) and Huff et al. (1995) reported a positive correlation between logging, on the one hand, and fuel loadings and predicted flame lengths, on the other hand. They attributed the increased fire hazard in intensively managed areas to leftover slash fuels from tree removal activities (including thinning) and to the creation of dense, early-successional stands through overstory removal. A post-fire study of the effectiveness of fuels treatments—including thinning—on previously non-harvested lands on the Wenatchee National Forest in Washington found that harvest treatments likely exacerbated fire damage (USDA Forest Service 1995).

Overall, the scientific literature demonstrates that forests in areas without roads are less altered from historical conditions and present a lower fire risk than forests in intensively managed areas, for three reasons:

1. Timber management activities often increase fuel loads and reduce a forest's resistance to fire, along with its post-fire resilience.
2. Areas without roads have been less adversely affected by fire suppression than intensively managed lands.
3. Road building in intensively, managed-lands raises the risk of human-caused ignitions.

In general, the forests most in need of fuels treatment are not roadless areas but areas that have already been roaded and logged, "where significant investments have already been made" (USDA/USDI 1997). In fact, according to the Forest Service's Draft Environmental Impact Statement (USDA Forest Service 2000), approximately 58 million acres (all ownerships) of forests across the nation are at risk of fire. Of these, 12 million acres occur on the National Forests. A much smaller percentage (~3%) of at risk forests on National Forests are in roadless condition. Thus, the vast majority of forests at risk of fire are in the already roaded and logged portions of the National Forests. It will take decades to restore these forests so they are more resilient to fire, requiring significant investments in fuel reduction treatments and related restoration. Fuels reduction measures (e.g., small diameter thinning, prescribed fire, defensible space) should target forests where the need is greatest first – in the already roaded and logged areas and the urban-wildlands interface (DellaSala and Frost 2001).

Effects of Fire Suppression **-** evidence suggests that fire suppression activities have had a lower impact on roadless areas than on roaded portions of the National Forests (SNEP 1996, Hann et al. 1997). The lower impact might be attributable to limited access and steep terrain, which prevent the application of large, ground-based suppression strategies in roadless areas and increase the potential for severe fire behavior (Schroeder and Buck 1970, Fuller 1991, Agee 1993, Pyne 1996).

Fires in roadless areas tend to be more remote from human habitations than are fires on roaded lands (note - according to USDA Forest Service DEIS 2000 most roadless areas are at least 1-3 miles from the nearest populated area). Accordingly, they are often the lowest priority for suppression during years when firefighting resources are in short supply. Although data are limited, findings from the Interior Columbia Basin assessment apply to other regions as well. This assessment concluded that a "combination of past harvest practices and more effective fire suppression moved the roaded landscapes much further from their unaltered biophysical templates, as measured by dominant species, structures, and patterns, relative to unroaded areas….In general, all forests which show the most change from their historical condition are those that have been roaded and harvested" (Hann et al. 1997). Furthermore, the forests that are most susceptible to moisture stress, insects, disease, and high-intensity fire tend to be at the lowest elevations, which typically border private, State, tribal, or other land ownerships (Everett et al. 1994).

Another reason why fire suppression has had less impact on roadless areas is associated with differences in vegetation and fire regimes. Most roadless areas on the National Forests, particularly in the interior West, are at middle to high elevations (Henjum et al. 1994, Beschta et al. 1995, Merrill et al. 1995). The exceptions are in the eastern United States, where elevational gradients are limited, and the Klamath–Siskiyou ecoregion in northern California and southwest Oregon, where very steep slopes at lower elevations have limited road construction (Strittholt and DellaSala 2001).

Higher elevations are cooler, receive more moisture, and have a shorter summer dry season than lower elevations. They are typically characterized by a regime of low-frequency, high-intensity fires (van Wagner 1983, Baker 1989, Agee 1993). Roadless areas are therefore less likely to have current fire regimes that are significantly different from historical conditions (Beschta et al. 1995, Agee 1997).

For fires in high-elevation forests, weather rather than fuels is often the primary variable determining fire severity and extent (Flannigan and Harrington 1986, Johnson and Wowchuck 1993, Turner et al. 1994, Bessie and Johnson 1995, Agee 1997). Under severe fire weather, the efficacy of fire suppression decreases dramatically in forest types characterized by high-intensity fires (SNEP 1996, Agee 1998). Even substantial investments of financial and human firefighting resources can fail to control many large fires; they are extinguished only when the weather changes (Romme and Despain 1989).

Danger of Human-Caused Ignitions **- r**oadless areas have a lower potential for high-intensity fires than roaded areas partly because they are less prone to human-caused ignitions (DellaSala et al. 1995,Weatherspoon and Skinner 1996, USDA Forest Service DEIS 2000). Roads constructed for timber management and other activities provide unregulated motorized access to most National forestlands and are heavily used by the general public.

In the Western United States, many of the more than 378,000 miles of National forest roads traverse heavily managed forests with the greatest potential for high-severity fire. More than 90 percent of all wildland fires are caused in one way or another by human activity—through smoking, arson, campfires, debris burning, logging equipment, or motorized vehicles (USDA Forest Service 1996, 1998). Due to very limited human access, roadless areas are subject to much lower probabilities of human-caused ignitions.

The Case for Prescribed Fire - the Forest Service should treat roadless areas primarily by reintroducing fire, both natural and prescribed. Restoration of ecological processes is key to ecosystem integrity and biological diversity (Samson and Knopf 1993), particularly in roadless areas. Use of well-managed prescribed fire has been successful in restoring wildland fire regimes to many fire-adapted ecosystems (Wright and Bailey 1982), and a widespread consensus exists that additional burning is necessary (Walstad et al. 1990, Mutch 1994, USDA/USDI 1995, Arno 1996).

Prescribed fire has advantages over mechanical treatments in areas where ecological integrity and biodiversity conservation are important management objectives (Weatherspoon et al. 1992, SNEP 1996, Hann et al. 1997). Prescribed fire also appears to be the most effective treatment for reducing fire severity and rate of spread (van Wagtendonk 1996, Stephens 1998). In addition to reducing fuel loading and continuity, prescribed fire might decrease pest outbreaks, provide germination sites for shade-intolerant species, release nutrients, and create wildlife habitat (Walstad et al. 1990, Agee 1993, Chang 1996, Biswell 1999).

Carefully planned wildland fire use should be fully considered for roadless areas, based on fire regime, expected fire behavior, and other variables, as an alternative to costly firefighting in remote areas where there is little or no danger to lives and property. In 2000, the Forest Service spent more than $91 million fighting two large fires in Idaho, the Burgdorf Junction Fire and the Clear Creek Complex Fire. Together, the fires burned more than 280,000 acres, mostly in remote roadless and wilderness areas (Morrison and others 2000; NIFC 2000a,b). On such fires, wildland fire use might be the most sensible alternative.

Roadless areas could instead benefit from proactive fuels management using fire. Fire management in roadless areas should be based on (1) a standard set of guidelines for identifying and prioritizing roadless areas based on their fire hazard and risk at the national or regional level; and (2) a subsequent step-down process for planning fire treatments at the local level, designed to allow fire to play a more important role while minimizing risks to ecological values (DellaSala and Frost 2001).

ECONOMIC VALUE OF PROTECTED AREAS (from Southwick Associates 2001)

Recent economic research has demonstrated that protecting wilderness, roadless areas, National Parks, and National Monuments is, in fact, not devastating to regional and local economies. Using measures of income, employment, and the location and extent of roadless areas and federally protected areas, Southwick Associates (see www.worldwildlife.org/ forests/ publications) demonstrated that environmental protection does not come at the expense of either income or employment growth in Oregon or in the western United States. Their research points to fundamental flaws in the jobs vs. environment argument and builds on related studies (Rasker 1993, 1994, Rasker and Hackman 1998, Power 1991, 1995, 1996, Niemi et al. 1999a,b). The following is a summary of main findings on the economic values of protected areas:

The contribution that extractive economies make to income and employment is small and declining in Oregon and throughout the west.

- In Oregon, the percentage of total income generated by extractive industries fell from 13.5% in 1969 to 5.1% in 1997 – in other words, while extractive industries were once drivers of the regional economic bus, they now are somewhere in the middle and heading increasingly toward the back (see Niemi et al. 1999a,b).
- Total employment in Oregon grew more than 10 times faster than jobs in extractive industries.
- Counties that are relatively dependent on extractive industries have slower income growth.

- Economic sectors benefiting from the presence of environmental amenities are the new source of economic security in the region – in other words, stop looking into the rear-view mirror to plan regional economies – plan for transition and the future (see Niemi et al. 1999a,b).

The presence of wilderness, National parks, National monuments, and roadless areas does not come at the expense of economic growth. On the contrary, counties containing protected areas grow faster.

- Employment growth in non-metropolitan counties with more than 10% wilderness was more than 1.6 times faster than employment growth in non-metropolitan counties without wilderness.
- Employment growth in non-metropolitan counties with more than 10% roadless areas was 1.4 times faster than employment growth in non-metropolitan counties without roadless areas.
- Of the nine Oregon counties analyzed, income growth rates in seven increased after wilderness designation.
- There is no indication that the presence of roadless areas, wilderness, National Parks, and National Monuments was correlated with slower income growth or slower employment growth.
- The presence of environmental amenities and protected areas promote income growth and employment growth.
- The presence of protected areas (wilderness, National parks, National monuments) and roadless areas does not limit economic growth in western states – on the contrary, these areas are associated with both income and employment growth.
- Even though the employment and income in metropolitan counties grew relatively rapidly during the study period, non-metropolitan counties containing wilderness grew faster than the average western county. Employment in rural counties containing more than 10% wilderness grew 1.6 times faster than all western

counties between 1969-1997. Income in rural counties containing more than 10% wilderness grew 1.3 times faster than all western counties between 1969-97.

As more studies of the economics of protected areas emerge, it is becoming increasingly apparent that a key to economic prosperity is protection (not destruction) of our nation's forests. Coupled with the value that these areas provide in ecosystem services, open spaces, and quality of life amenities, a strategy that truly protects roadless areas is an investment both in sound conservation and sustainable economics. Moreover, when one considers the negative spill over costs of logging and road building in these areas in terms of degraded resource values and current or future ecosystem services (see Niemi et al. 1999a,b), the best strategy for roadless areas is to protect them from additional exploitation. Restoring fish runs and protecting watersheds, particularly those tied to county and state water municipalities, are wise investments in the economic and biological future of the National Forests.

CONCLUSIONS

While our nation prides itself on some of the best National parks in the world, most protected areas are at upper elevations and fail to capture some of the most productive sites for fish and wildlife (Scott et al. 2001). Furthermore, our nation has protected just 5% of its forests in National Parks, Wilderness, and National Monuments (DellaSala et al. 1999). Protection of roadless areas would therefore contribute to numerous conservation goals reflected in this report, including adding approximately 2% to the nation's system of reserves. This additional protection would demonstrate strong leadership in international efforts (e.g., Montreal Process) to balance protection with sustainable resource utilization (Strittholt and DellaSala 2001). However, protection of roadless areas, while providing many ecological and social benefits, is not a end-all to the need for a more representative network of reserves on federal lands-- a fundamental objective of reserve design and conservation biology is to represent at least 25% of ecoregions in protection (Noss and Cooperrider 1994, DellaSala et al. 2001). In addition, reserves (especially small ones) surrounded by highly fragmented landscapes tend to function mainly as isolated islands, losing species that wander out onto inhospitable unprotected lands (Noss and Cooperrider 1994, DellaSala et al. 1999). Therefore, in order to maintain biodiversity and fully functional ecosystems a combination of large, representative protected areas and sustainable resource extraction outside those areas is urgently needed. With 5% of its lands in strict protection, the United States lags behind other developed nation's in completing a representative network of reserves (DellaSala et al. 1999). A national commitment to roadless protection is but one vital step in demonstrating strong leadership to the rest of the world regarding our nation's responsibility to sustainable resource practices (i.e., Montreal Process) and future generations. Protecting roadless areas would contribute significantly toward that goal, capturing many critical ecological attributes at the ecoregional scale, including late-seral forests, strongholds for aquatic species (e.g., salmon); habitat for rare, threatened, and endangered species; and physical, elevational, and habitat representation. With the vast majority of federal and non-federal lands already degraded by road building and designated for "multiple-use management," the remaining 58.5 million acres of inventoried roadless areas and smaller unroaded areas (especially in the eastern US) are key to the future sustainability of federal forests across the nation.

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