Chapter 3&4 — Affected Environment and Environmental Consequences

Introduction

Chapter 3 (Affected Environment) and Chapter 4 (Environmental Consequences) have been combined in this document to more clearly present information to readers. The description of a resource or environmental component appears just before the description of environmental effects to that resource or component. Most environmental impact statements (EISs) place these sections in separate chapters.

This chapter presents information about those aspects of the environment that are likely to be most directly affected by the management prescribed in the alternatives, those whose ecological, Tribal, or product use or function might be significantly affected by POC management. It also presents the direct and indirect effects (or impacts) of management under the alternatives. This constitutes a presentation of the cumulative impacts of each alternative. Together these form the scientific and analytic basis for the Comparison of the Effects of the Alternatives section in Chapter 2.

Incomplete and Unavailable Information

One step in preparing an EIS is to evaluate whether information about effects of a proposed action is incomplete or unavailable and, if so, to disclose that fact and make certain findings about the relevance, importance, and/or costs of acquiring data that could help fill any such gaps.

When encountering a gap in information, the question implicit in the Council on Environmental Quality regulations (40 CFR 1502.22(a)) on incomplete or unavailable information was posed: Is this information

> . . . essential to a reasoned choice among alternatives?

While additional information would often add precision to estimates, the basic data and central relationships are sufficiently well established that any new information would not likely reverse or nullify relationships. Although new information would be welcome, no missing information was identified that is essential to a reasoned choice among the alternatives.

As noted in the Background section of Chapter 2, Port-Orford-cedar (POC) root disease was introduced to the natural range of POC more than 50 years ago, after raising the concern of nursery pathologists in the Seattle, Washington, area for decades previous to that. Scientific study and management experience by the Agencies and others is considerable. Pathologists with the Forest Service, States of Oregon and California, and Oregon State University, have devoted years to the study and management of POC root disease.

The management practices discussed in the alternatives are generally ones with which the Agencies are well experienced. While conclusive research regarding the effectiveness of each specific practice is sometimes weak or lacking, basic studies of disease indicators have been at least minimally studied for nearly every practice, sufficient to make professional judgments regarding their likely effectiveness. For example, while the effectiveness of washing vehicles on reducing the spread of the disease has not been studied directly (because of the numbers of variables involved), washed vehicles have been reexamined, finding that washing reduced inoculum about 95 percent. A reduction in the risk posed by a washed vehicle traveling through uninfested areas is thus appropriately inferred.

Neither are the observed pathology relationships unique to POC. Where conclusions or inferences must be made without complete POC data, scientists rightfully build on data from similar relationships or results with similar pathogens more thoroughly studied. Subsequent new information about POC root disease has historically supported such inferences, although the new data improves precision.

A source of potential uncertainty arises from both the geographic and temporal scales of this analysis. POC mortality under each of the alternatives is projected for 100 years, and is based on several assumptions founded on the past 50 years of study and experience. While these assumptions are reasonable, they are by no means certain to 100 years. Monitoring is prescribed to detect significant departures from predicted disease spread that would trigger further analysis as warranted.

Normally, uncertainty exists when evaluating effects at the programmatic scale (such as this supplemental EIS [SEIS]), because the proposed action neither authorizes nor evaluates any specific management proposal. To the extent such uncertainty might relate to disease spread, it is considered minor. Assumptions in this SEIS about forest management activities, for example, are based on consideration of 50 years of forest management activities. And while the standards and guidelines of the various alternatives provide for site-specific application of various management practices based upon consideration of the conditions at each site, both the language of the standards and guidelines and experience with implementation and with existing forest conditions make reasonable predictions about such application possible. Nevertheless, site-specific effects of management can only be known, with any degree of specificity, at subsequent, site-specific levels of analysis and planning. Effects are projected in broad terms for purposes of the analysis in this SEIS.

Some scoping comments expressed a belief that POC is on its way to becoming extinct or only minimally represented within its natural range, and that only closing access to the forest will save the cedar. The analysis displayed in the following sections does not support such a position. Because the pathogen requires nearly standing water to infect trees, high-risk areas are limited and definable. POC even a few feet away from water or seasonally saturated soils is at little risk regardless of the management strategy imposed. Further, it is possible to make reasonable predictions about the future spread of *Phytophthora lateralis* (hereafter referred to as PL), the disease-causing pathogen. Other than Pacific yew growing with POC, the pathogen affects only POC and does not have an alternate or hidden host, nor does it travel through the air. PL has a narrow genetic range, and so is not likely to adapt to different species or even to resistant POC. Predicting the spread of the disease and the resultant adverse environmental effects is possible, at least to a sufficient degree that the selection of one of the action alternatives will yield a predictable environmental effect.

Considerable precision (and thus, certainty) could be added to this analysis if Agency POC maps were more detailed and then individually analyzed for relevant risk levels and agents. Existing maps are based partly on stand or vegetation-type inventories or stand exam maps and sometimes do not reflect the specific location of included POC. As discussed in the background section, the precise number of acres of POC is unknown, and varies depending upon the mapping criteria used. These details can be correctly relegated to site-specific analysis. The existing information, coupled with existing scientific knowledge of diseases as a whole, is sufficient to establish basic relationships well enough that any new information would not likely reverse or nullify these relationships. There is sufficient information about the pathogen and about the effects of the various alternatives for decision-makers to confidently make a reasoned choice from among the alternatives.

Cumulative Effects

Cumulative impacts to the environment are defined in the Council on Environmental Quality regulations as those that result from the incremental effects of a proposed action when added to other past, present, and reasonably foreseeable future actions, regardless of which agency or person undertakes them (40 CFR 1508.7). Given the programmatic nature and scale of this SEIS, most of the environmental consequences discussed represent a general projection of the accumulated effects of management actions that are reasonably assumed to occur under the various alternatives and in the context of other existing standards and guidelines and practices on the affected Federal lands, and on other Federal and private lands within the range of POC. Spatial and temporal features of the analysis are discussed as follows.

California Portion of the Range

The natural range of POC extends from the planning area into the northwest corner of California. Approximately 10 percent of the POC found on Federal lands is within California, located on the Six Rivers, Klamath, and Shasta-Trinity NFs (and Redwood National Park). These Forests are cooperators in this SEIS, and helped with the analysis. Although the action alternatives do not apply to these Forests, some of the effects sections in this chapter specifically include California because of the possibility of transporting the disease back and forth across the border. Timber hauling, equipment movement, and other factors are discussed within the Pathology and Timber Harvest sections specifically, and do pose a small but potential risk of cross-state infestation. The existing management direction for the California Forests is included in the description of Alternative 1 in this SEIS, and held constant across the action alternatives. As described in the Pathology section, projections for Alternative 1 apply, to the detail of this analysis, to the California Forests. Selection of an alternative that is less or more active in restricting spread of the disease will have a slight but corresponding change in the risk of the pathogen being transported to California. The Avoid Disease Export standard and guideline in Alternatives 2 and 3 is specifically designed to reduce movement of PL offsite, including to California.

Private and Tribal lands account for an estimated 2,000 to 5,000 acres of POC in California. There are no known infestations of PL on California Tribal lands. The Hoopa and Yurok Tribes follow management practices designed to minimize the potential for introduction of PL and to limit its impact if an introduction occurs. Significant populations of POC are present on California State Park land at Jedediah Smith and Castle Crags State Parks. POC along the Sacramento River at Castle Crags State Park is infested with PL where, because of its proximity to Interstate 5, it poses a risk for importation to other parts of the POC range. POC is harvested on other private timberlands in California, with approximately 100 to 200 thousand board feet shipped to Oregon annually for milling or export (see Timber Harvest on Private Land section for further details).

Port-Orford-Cedar Management on Non-Federal Lands in Oregon

There are no requirements for POC management in the "Oregon Forestry Practices Act." A few private landowners in the range of POC have requested information on cedar management from local Forestry Assistance foresters. Usually the information provided is of a general nature, and includes management practices such as operating during the dry season, avoiding sites infested with PL, and avoiding roads and skid trails in stands with a POC component. However, little attention is given to POC by most small-tract landowners. Several private landowners have test plantations of resistant stock provided by the Forest Service's Dorena Genetic Resource Center. There is interest among private woodland groups in the availability of this resistant stock for future plantings.

Non-Federal lands near Coos Bay contain approximately 8,500 acres of non-roadside infestation (compared with 319 acres on the Coos Bay BLM District) and represent a chronic source of PL for export to other lands throughout the range. An infestation in the Sacramento River drainage in California is believed to have been transported on logging equipment from the Coos Bay area. The likelihood of such long-distance spread is discussed in the Pathology section and considered in disease projections.

Timber Harvest on Private Lands within the Range of Port-Orford-Cedar

Silvicultural practices on private lands within the range of POC include commercial thinning and regeneration harvesting and their related treatments of burning, planting, spraying of herbicides, pre-commercial thinning, pruning, and fertilization. Recent declines in Federal harvests, economic conditions, and the increase in mills specializing in smaller material has led to shorter rotations and more regeneration harvesting. Rotation ages average 45 years on the coast, and 60 to 90 years in the interior.

Approximately 70 percent of private timber harvest is done with skyline cable-yarding systems and the balance is done with ground-based systems on slopes less than 40 percent slope. The likelihood of PL spread is substantially reduced with skyline cable-yarding, whether partial or full suspension. Ground-based systems have the highest likelihood for spreading PL, assuming they pass through infested areas. These risks would be greatest during wet soil conditions.

Almost no roadside POC sanitation (clearing to prevent infection starts) occurs on private lands within the range, while some large, private, industrial timberland owners are washing heavy logging equipment for noxious weed control. This equipment washing probably has some benefit in slowing the spread of the POC root disease. Small private landowners typically do not wash heavy equipment.

The percent of each county in the POC range that is private, and the annual volume and estimated acres harvested are shown in Table 3&4-1. Private harvest acres have been estimated using the regional average rotation age, total harvest volume, and proportion of volume coming from regeneration or partial cutting and their respective assumed volumes per acre. Table 3&4-1 includes both clear-cut and partial-cut acres.

Within the natural range of POC, the probable sale quantity (PSQ) on Federal lands is 49 million board feet annually for Oregon, and 23 million board feet for California. Thus, on a yearly average basis, the total timber harvested within the range of POC is about 550 million board feet, with private lands representing 87 percent. The estimated acres cut and its potential contribution to the spread of PL are expected to continue at these relative levels into the foreseeable future. The mill capacity is 700 million board feet/year for southwestern Oregon, with most mills along the Interstate Highway 5 corridor with a few mills along the coast. Approximately 40 million board feet of logs (not counting POC, discussed below) from private lands are shipped annually to mills in southern Oregon from northern California. This represents about 8,000 truckloads of logs.

Management of POC root disease on Federal lands is affected by private land management in several ways. Equipment used to harvest on Federal lands is supplied by private contractors who also work on private lands. This includes logging equipment that moves from sale to sale, and trucks that may haul from different sales in different areas or states from one day to the next. Trucks transporting logs from private lands often travel roads through Federal lands, particularly in "checkerboard" ownerships and on reciprocal right-of-way agreement roads. Also, trucks from various areas or even states are often unloaded at the same loca-

Table 3&4-1.—*Average yearly private harvest levels for all species within the natural range of Port-Orford-cedar, 1995–2001*

County	% private lands [1]	Volume harvested in millions of borad feet [1]	Estimated acres harvested
Oregon			
Coos	70	183	6,700
Curry	84	49	1,790
Douglas	12	42	1,550
Josephine	45	12	970
Total	39	286	11,010
California			
Del Norte	74	36	1,310
Humboldt	14	63	2,320
Siskiyou	14	21	2,080
Trinity	62	49	4,930
Shasta	20	20	2,060
Total	20	189	12,700
Total	29	475	23,710

[1] *Source:* Oregon Department of Forestry Annual Timber Harvest Report for Western Oregon by County and California State Board of Equalization Timber Harvest Tax Records from 1995 to 2001.

tions, often minutes apart; although as noted in the Timber Harvest section, the possibility for spore exchange in this case is very slight. The same possibilities for transport exist from Federal to uninfested private lands, reduced by the PL management requirements implemented on those Federal activities.

Federal administrative units whose POC management practices would be affected most by this level of private timber harvest are Coos Bay, Medford, and Roseburg BLM Districts, located in Coos, Curry, Douglas, and Josephine Counties. The POC lands on these districts are primarily checkerboard, intermixed with private ownership; most of the volume hauled on roads through BLM lands in these areas is from private lands, with little Federal latitude to limit season of use or require vehicle washing. Other Federal administrative units with more contiguous land ownership would experience less likelihood of importing PL from private land management activities.

Although harvest of any species within the range of POC (as discussed above) is indicative of a risk of transporting POC root disease, harvest and transport of POC itself is more likely, in a single event comparison, to result in the transport of root disease. However, annual harvest of POC on private lands varies widely depending upon market conditions. The harvest levels shown in Table 3&4-2 are probably unusually high, based on a peak in demand that drove the price to a high of $12,000 per thousand board feet for top quality logs.

Nearly all POC harvested in California is transported to mills in Oregon or export facilities in Oregon or Washington. This amounts to about 840 truckloads from Humboldt and Del Norte Counties, based on 4.2 million board feet/year (Waddell and Bassett 1996, *Table 29*).

During Fiscal Year 2000 approximately 0.8 million board feet of POC was exported from the northwest to Japan, China, Korea, and Taiwan from the ports of Longview, Coos Bay, Portland, and Seattle. There are no POC export ports in California; all POC harvested for export in California is shipped through Oregon. Recently, POC logs shipped from the Port of Coos Bay in Fiscal Year 2000 averaged 257 thousand board feet (Warren 2002). By 2002, this had dropped to 200 thousand board feet (Green 2003). Overall export trends for POC continue to decline as the overseas demand continues to drop due to economic conditions and the increased production of Hinoki cypress (*Chamaecyparis obtusa*), which is used in Japanese temples.

Several mills in Oregon saw about 4.5 million board feet of POC annually for lumber, paneling, and decking. These mills are located in Bandon, Glide, Myrtle Point, Riddle, and Roseburg. Since the overall export prices for POC have dropped, these mills have been able to purchase more POC. Sources of POC logs include both Oregon and northern California. Approximately 100 to 200 thousand board feet of California POC logs are shipped to Oregon

Table 3&4-2.—*Port-Orford-cedar standing inventory and harvest volume for private lands*

Counties	Standing inventory [millions of board feet]	Annual harvest [millions of board feet]	Years
Coos, Curry, Douglas, Josephine	94	3.5	1995-97 [1]
Humboldt, Del Norte	23	4.2	1991-94 [2]

[1] Tables 8d and 10d in Azuma et al. [2002].
[2] Tables 9 and 11 in Waddell and Bassett [1996].

annually representing 20 to 40 truckloads of logs (5 thousand board feet/truck). Mill production is limited by the supply of POC logs, as their product demand is strong.

Long-distance Spread Associated with Various Federal Forest Activities

To the extent such information is known and quantifiable, sections in this analysis describe the nature and extent of forest activities known to contribute to the spread of PL. The Timber Harvest section specifically addresses the general number and origin of log trucks and other equipment, and the movement of logs within the range. Recreation uses, the collection of forest products, and other uses are also described. These activities are taken into account in the pathologists' predictions of spread, both spatially and over time.

Temporal Effects

The Pathology section predicts mortality percentages at 100 years, and other secondary effects sections address this same time period. As explained in that section, the spread rate in any one area will not be constant, but will follow an "S" curve typical of similar disease infestations and readily recognizable within POC areas exposed to the pathogen for some time (see Pathology section). Monitoring will continue to validate these assumptions.

Relationship of this Supplemental Environmental Impact Statement to the Northwest Forest Plan

The Northwest Forest Plan was adopted April 13, 1994, as an amendment to land and resource management plans within the range of the northern spotted owl (including the plans that would be amended by the action alternatives in this SEIS). The Northwest Forest Plan added standards and guidelines to existing or draft (underlying) management plans for management of habitat of late-successional forest-related species and protection of watersheds. The Northwest Forest Plan did not address POC because it was outside its scope and purview. The management direction addressed in this SEIS is part of the underlying management plans, and no amendment to the Northwest Forest Plan is proposed. Further, none of the alternatives proposed would

> . . . significantly reduce protection for late-successional or old-growth forest related species, or reduce protection for aquatic ecosystems (USDA and USDI 1994b, *p. C-29*).

Therefore no review by the Regional Interagency Executive Committee is required. Nevertheless, an understanding of the Northwest Forest Plan land allocations is helpful to understanding this analysis.

The Northwest Forest Plan amended the land and resource management plans of the various administrative units, primarily by establishing a system of reserves (certain land allocations), and providing standards and guidelines limiting or directing activities within those reserves. Approximately 80 percent of Federal lands were assigned to a reserve land allocation that precludes regularly scheduled timber harvest. This resulted in a reduction in timber harvest levels of about 80 percent, and a reduction in road construction miles of over 90 percent, when compared to levels in the 1980s. Although there have been more restoration projects, and some reserves permit habitat-improving silvicultural activities including commercial thinning, there has been a substantial reduction in the level of management activity and heavy equipment use on Federal lands as a result of the Northwest Forest Plan.

A description of the Northwest Forest Plan land allocations found in the planning area is as follows:

Congressionally Reserved—In the planning area this includes designated wilderness.

Late-Successional Reserves—These areas are managed to protect and enhance conditions of late-successional and old-growth forests. Limited stand management is permitted to improve late-successional and old-growth conditions or protect the areas from wildfire and other large-scale disturbances.

Adaptive Management Areas—These areas are identified, each with an objective to develop and test new management approaches to integrate and achieve ecological and economic health, and other social objectives. Regularly scheduled timber harvest (those contributing to PSQ) may occur in Adaptive Management Areas.

Administratively Withdrawn Areas—These are areas where the underlying direction in existing land and resource management plans precludes regularly scheduled timber harvest. These areas include recreation and visual areas, back country, administrative sites, research natural areas, and areas of critical environmental concern.

Riparian Reserves—These provide an area along all streams, wetlands, ponds, lakes, and unstable and potentially unstable areas where riparian-dependent resources receive primary emphasis. Silvicultural activities are permitted only when watershed analysis shows treatments are needed to achieve watershed objectives.

Matrix—This includes all other lands. Management of these lands is guided by some Northwest Forest Plan direction for Matrix, but primarily by the direction in the underlying land and resource management plans. Approximately 75 percent of the matrix consists of lands suitable for regularly scheduled timber harvest.

In many ways the reserve system of the Northwest Forest Plan created de facto protection areas for POC. Certainly the risk of exposure has been reduced for many POC stands as a result of these allocations. Table 3&4-3 shows gross acres and acres occupied by POC, within each of the land allocations of the Northwest Forest Plan for Oregon.

Table 3&4-3.—*Gross Oregon Federal and presence of Port-Orford-cedar (acres) by Northwest Forest Plan land allocation within the natural range of Port-Orford-cedar in Oregon*

	Congressional/ Administrative Reserve		Late-Successional Reserve		Matrix/Riparian Reserve/Adaptive Management Areas [1]		Total	
Administrative unit/Risk region [2]	Gross [3]	POC [4]	Gross	POC	Gross	POC	Gross	POC
Coos Bay BLM	3,074	229	45,941	18,797	106,101	53,979	155,116	73,005
Powers Ranger District	18,481	1,342	85,841	44,508	20,015	7,393	124,337	53,243
North Coast Risk Region total	21,555	1,571	131,782	63,305	126,116	61,372	279,453	126,248
Roseburg BLM	635	0	45,417	2,056	39,213	2,630	85,265	4,686
Medford BLM	26,829	4,404	119,355	17,277	85,971	2,974	232,155	24,655
Inland Siskiyou Risk Region total	27,464	4,404	164,772	19,333	125,184	5,604	317,420	29,341
Siskiyou Risk Region total [Siskiyou NF, except Powers Ranger District]	256,996	19,735	485,780	71,010	182,332	25,629	925,108	116,374
Grand total	306,015	25,710	782,334	153,648	433,632	92,605	1,521,981	271,963

[1] Riparian Reserves are lumped with Matrix because actual Riparian Reserves are mapped onsite during project planning; about 50 percent of the acres shown are Riparian Reserve, with the other 50 percent being Matrix or Adaptive Management Areas.
[2] For "risk regions" see Pathology section.
[3] Gross acres within the range of POC.
[4] Acres with POC present.

Assumptions and Clarifications

The effects discussions are based on the standards and guidelines of each alternative and their referenced appendices. As indicated by Appendix 2, the Agencies have considerable experience with the management techniques prescribed by the standards and guidelines and the effects of POC mortality, and so are able to estimate the future effects of the various alternatives with some degree of certainty. That experience leads to certain underlying assumptions that are stated here for clarity for the reader, and to assure consistency within the analyses. The following assumptions or clarifications are pertinent to the analysis or to the decision to be made.

- The analysis assumes the Northwest Forest Plan will be implemented as written and intended. Effects to harvest levels, for example, are based on declared PSQ levels rather than the level experienced in the past 3 years when litigation has limited activities. This potentially conservative assumption assures adequate effects analysis if activity levels return to levels anticipated in the Northwest Forest Plan.

- The analysis only considers effects to POC within its natural range. POC has been planted, both as an ornamental and as a forest tree, throughout the world. Plantations outside the range occur in many areas including (unwanted) in parts of the Redwood National Park. The alternatives are not intended to apply to those areas. The effects of the various alternatives on such plantations is inestimable. Local managers may choose to apply management practices suggested in this SEIS, but no such assumptions are made here.

- Private interest in POC will likely increase if resistant stock is available. The species provides valuable products, may be resistant to *Phytophthora ramorum*, the cause of Sudden Oak Death, may help diversify stands to reduce the effects of Swiss Needle Cast in Douglas-fir, can be grown in very wet areas, and is manageable within a wide range of ecological conditions.

- There will be adequate funding to implement the requirements of the selected alternative. If monitoring is required, for example, it will be funded. Funding is not necessarily expected where the writer provides the caveat "to the extent funding is available", or similar language, although such a case would obviously require funding to achieve the specific effect to which that author refers.

- The ability to restrict traffic on lands in "checkerboard" ownerships is severely restricted by the terms of the reciprocal right-of-way agreements governing most roads. Written in the 1950s and 1960s to ensure only one set of roads was built to access both private and Federal lands, the agreements provide intermingled owners with a deeded right to use these roads essentially as if they were their own. The results of court challenges to these roads based on the "Endangered Species Act" have affirmed these rights (see Alternatives Eliminated from Detailed Study in Chapter 2 for more detail).

- Fire suppression activities will follow the standards and guidelines only to the extent they do not jeopardize life and property or do not, as a result of the fire's daily resource analysis, result in more damage to POC than would be expected to occur by more aggressive fire suppression. This issue is specifically addressed in the standards and guidelines of Alternatives 2 and 3, and does not apply to Alternatives 4 and 5. A detailed explanation of fire suppression and root disease control considerations on the Biscuit Fire is included in the Fire/Fuels section.

- Facts, analysis, and conclusions displayed in this SEIS may be different than similar data in the Agency's 2003 "Range-Wide Assessment of Port-Orford-Cedar on Federal Lands" (USDA and USDI 2003a). The Assessment is primarily an internal document that has been several years in the making. Data may be outdated, or analyses not to EIS standards. Generally, where information from the Assessment has been incorporated into this SEIS, it has been incorporated in its entirety with appropriate references, and therefore stands alone.

- Legal compliance by the public, and the effectiveness of Agency law enforcement, will be reasonable but not absolute. Gates and other area closures will be respected most of the time. Public information efforts will continue to be successful. Firewood and other forest product collectors will stay out of closed areas most of the time, and violators will sometimes, but not always, be caught and cited. Occasional violations of area closures are specifically acknowledged in the Pathology and Botany sections.

- Within Alternatives 2 and 3 is a risk key containing a decision criteria reading "2. Will the proposed project introduce significant risk of infection to these uninfected POC?" This question does not consider the level of POC in the project area—those levels are already covered by earlier questions. (Question 2 may, however, consider the location of the POC relative to the risk-producing activities.) Question 2 focuses only on the possibility or likelihood (risk) that the proposed activity will introduce the pathogen to the area in sufficient quantities to begin an infestation. "Significant" in this context does not mean "any". It means that a reasonable person would recognize enough risk to believe mitigation is warranted and would make an appreciable or important difference.

Port-Orford-Cedar Background

Port-Orford-cedar (*Chamaecyparis lawsoniana* [A. Murr.] Parl.) is the largest species of its genus and the largest representative of the family Cupressaceae in North America. It is a valued timber tree and is also planted worldwide as an ornamental (USDA-FS 1965).

Species Range

POC is a regional endemic, native only to southwestern Oregon and northwestern California. The range of POC includes portions of the Oregon Coast Range, Siskiyou Mountains, California Coast Range, and Klamath Mountains. The northern limit of the species occurs on coastal dunes north of North Bend. The southern end of the species' range is in Humboldt County. Longitudinal distribution is greatest in California (see Figure 1-1). The range narrows south and north of this area. Range limits in the south and east coincide roughly with the 1,000-mm isohyet. Disjunct populations are associated with areas of locally high precipitation about 93 miles inland, near the headwaters of the Trinity and Sacramento Rivers (Hawk 1977).

Autecology

POC is restricted in geographic range but has a wide ecological breadth, occurring in many diverse habitats (Zobel et al. 1985). POC has moderately high shade tolerance, and is more tolerant than incense-cedar, sugar pine, Douglas-fir and western white pine, and less tolerant than Shasta red fir, Brewer spruce, white fir, Sitka spruce, grand fir, western red cedar, and western hemlock. Other studies show POC able to reproduce well in all but the darkest microsites, including late-successional stands. Zobel and Hawk (1980) found POC to survive under shade as well or better than all its competitors except western hemlock.

In addition to being shade tolerant, POC is tolerant of repeated fire (Hawk 1977). Even as pole-sized trees, POC has a good chance of surviving fires (Zobel et al. 1985). Fire resistance is less than that of Douglas-fir, but greater than that of the true firs or western hemlock. POC is often the first species to reinvade after fire.

POC occurs over a wide variety of soil types (Hawk 1977). The species outcompetes most of its competitors on ultramafic soils, but is not restricted to these soils and grows better in laboratory studies on other soil types. At low elevations, POC is frequently associated with ultramafic soils. Higher elevation sites occur on a wider array of soil types (Zobel et al. 1985).

POC is characterized as having fairly low drought resistance (Zobel et al. 1985), and its requirements for moisture during the growing season may limit its distribution. POC is considered more drought-tolerant than western hemlock and Sitka spruce, but is less tolerant than Douglas-fir, Jeffrey pine, incense cedar, sugar pine, and most other trees found in its range (Zobel et al. 1985).

Geomorphic Position

POC occurs in all physiographic locations from sea level to 6,400 feet elevation on the seaward slopes of the Coast Range and Klamath Mountains (Hayes 1958). POC forests occur most frequently on northwestern aspects; 82 percent of plots collected by Hawk (1997) were on aspects 200 to 45 degrees azimuth (Zobel et al. 1985). Most of the POC communities identified by Hawk (1977) were in midslope landscape positions.

Moisture Regime

The climate in much of the range of POC usually has wet winters, dry summers, relatively uniform temperatures, high relative humidity, and frequent summer fog. Away from the coastal influences, in the south and east portion of its range, rainfall, relative humidity, and summer fog are decreased, while the temperature fluctuations in both the summer and winter are greater (USDA-FS 1965).

Moisture regime strongly influences plant community development within the range of POC. POC seems largely restricted to moist sites where the regionally common species (Douglas-fir and western hemlock) grow poorly. To most populations of POC, a consistent abundance of water seems a critical necessity (Zobel et al. 1985). Where Douglas-fir is present it outcompetes POC for water. Only in the northern part of the range does the ratio of available water to evapotranspiration compensate for this competition (Zobel et al. 1985). POC may outcompete Douglas-fir in areas with low macronutrients, or cold or saturated soils.

Summary of Limitations on Distribution

POC is restricted in geographic range but has a wide ecological breadth, occurring in many diverse habitats (Zobel et al. 1985). Zobel et al. (1985) suggest limitations on POC distribution acting at four levels: microenvironmental, geomorphic surface, regional, and geographic scales. At the microenvironmental scale, moisture near the surface and high water potential in summer, absence of extreme shade, and mineral soils may be essential to seedling success. At the geomorphic surface-scale, POC seems generally limited to landscape positions that assure a consistent supply of groundwater. These include high water table and seep areas, streams or lakeside areas, slumped areas, and positions with significant watershed area above to maintain soil moisture.

At the regional scale, geology and climate affect distribution. For example, the importance of ultramafic substrates is clear. Higher humidity in coastal zones can compensate for low soil moisture locally. Finally, at the geographic scale, Zobel et al. (1985) suggest changes in precipitation/evapotranspiration ratios and decreases in ultramafic substrates traveling south and east, and increased competition with other conifers in the northern portions of the range.

Several factors mitigate the above-described constraints. North-facing aspects and areas experiencing summer fog also maintain microsite conditions supporting POC in upper slope positions without significant seeps. Also, lithology (bedding tilt) can frequently produce localized wetted soils within meters of local ridgelines. Thus, POC is frequently found in positions at or above midslope, and should not be considered a riparian species, but a mesic-to-moist microclimate-dependent species.

Life History

Some trees start to bear cones within 8 years under natural conditions and earlier in greenhouse conditions. Cone bearing becomes general by 20 years, is best at about 100 years, and continues for the life of the tree. Seed crops are frequent; heavy crops are produced every 4 to 5 years and some seed is usually produced every year. Squirrels do not commonly use POC seeds as food unless other species of seed are scarce. Most seed germinates soon after falling. Seedfall begins in September, reaches a maximum in winter, and continues through spring (USDA-FS 1965).

Natural reproduction is successful if there is a bare, mineral soil seedbed and sufficient moisture. POC survives well in plantations if animal browsing and competition from other vegetation is avoided (USDA-FS 1965).

In the most abundant portion of the range, POC is common in mixed stands up to 20 to 25 years old, after which it is usually overtopped and grows slowly. Once established, the species is relatively shade tolerant and long lived. It retains to an old age the capacity to respond if released from surrounding Douglas-fir and other overstory trees. POC is capable of moderately rapid growth if it not overtopped by other trees. Mature trees can reach 4 to 5 feet in diameter and 200 feet tall. Mature trees are generally older than 200 years (USDA-FS 1965).

POC is subject to windthrow. It has no taproot, and the numerous lateral roots are usually of a small diameter. The tree has a tendency to grow multiple stems at any height (USDA-FS 1965).

Distribution Across the Range

POC can be found with a variety of species with differing ecological requirements. These species differ across the range of POC. The wide ecological range of POC is reflected in the climatic diversity of the ecoregions and subsections in which it is distributed. These ecological units are defined based on their biotic and environmental factors that directly affect ecosystem function (McNab and Avers 1994). Ecoregions and subsections are used in the Ecology and Botany sections of this SEIS because they directly apply to various POC/other plant relationships.

Another approach for conceptualizing the distribution of POC across its range is used in the Pathology section. In this section, the range has been classified into three "risk regions," North Coast, Inland Siskiyou, and Siskiyou, based on the percentage of POC that is on sites at high risk for pathogen spread. While these classifications have some general relationship to the ecoregion and subsection approach, they do not match completely. The relationship between POC acres using the two approaches is show in Table 3&4-4. Following are basic descriptions of the existing conditions within the risk regions.

Table 3&4-4.—*Port-Orford-cedar acres on BLM and FS lands grouped by ecoregion and pathology risk regions, Oregon and California*

	Pathology Risk Regions					
	Oregon			California		
Ecoregions	North Coast Region	Inland Siskiyou Region	Siskiyou Region	Siskiyou Region	Disjunct California	Totals
Northern Coast	124,070	1,543	22,464			148,077
North Inland	291	20,367	17,909	13,724		52,291
Mid-Coast	1,887	5,273	50,120			57,280
Mid-Range		2,158	25,881	16,951		44,990
Southern Range				3,001		3,001
East Disjunct California				1,142	1,142	1,142
Totals	126,178	29,341	116,374	33,676	1,142	306,781

North Coast Risk Region

The North Coast region is part of the Oregon Coast Range. This is an area of low mountains with high rainfall and dense coniferous forests. It has moderately sloping, dissected mountains and sinuous streams. The most important characteristic in terms of species composition is the occurrence of western hemlock as a dominant or codominant species. The Federal administrative units that basically cover this region are the Siuslaw NF, Oregon Dunes National Recreation Area; Coos Bay BLM District; and the Siskiyou NF, Powers Ranger District.

Oregon Dunes National Recreation Area (FS)

The natural range of POC extends into the southern end of the Coos Bay dune sheet and the Oregon Dunes National Recreational Area of the Siuslaw NF.

Approximately 50 acres of old-growth POC are isolated by dunes and are managed to maintain, restore, or enhance its condition. These stands are 150 to 350 years old and appear to be healthy and free of PL infection. Off-highway vehicle use and a number of other activities within and adjacent to these POC stands is prohibited.

Approximately 40 additional acres of POC are found on the Oregon Dunes National Recreational Area as generally scattered individual trees or small pockets of younger trees with PL infection known or suspected within the area. Most are adjacent to roads, railroad tracks, or private lands, and about half are in areas open to off-highway vehicle use.

Coos Bay BLM District

Land ownership patterns within the Coos Bay District are checkerboard and scattered parcels of public domain lands interspersed with both private industrial forestlands and private individual landowners. All drainages on the Coos Bay District consist of mixed ownerships.

PL has been present within the Coos Bay BLM District boundary for over 50 years with the first POC trees exhibiting symptoms of PL in 1944 at the Oregon Marine Biological Station in Charleston, Oregon. The first confirmed sites were identified in Coos Bay, Oregon, near Mingus Park, just north of the North Bend McCullough Bridge, and in Charleston, Oregon (Roth et al. 1957).

According to the District's GIS database, there are 82,410 acres of POC on the Coos Bay BLM District with 319 acres of non-roadside PL infestations and 2,391 acres of roadside considered infested.

POC grows throughout the forest landscape and is only a minor component of local riparian habitats. Most of the PL infections within the area occur on private lands from Lakeside, Oregon, to Gold Beach, Oregon, along the coast. Healthy POC is found throughout the landscape away from roads and streams. The vast majority of POC and PL on Coos Bay BLM District lands is in the south half of the district, south of the North Fork Coquille and Coos River drainages. Nearly all drainages within the Coos Bay District are infested with PL. A few uninfected 7th field watersheds are at the northern most end of the natural range. These areas have small scattered populations of POC intermixed with stands of Douglas-fir, western hemlock, and western red cedar.

Planting of POC seedlings as part of the species mix has occurred on all regeneration harvest units since Fiscal Year 2000. Planting, annual maintenance, and precommercial thinning of plantations preserve minor species, including POC, in areas away from roads and streams.

Siskiyou National Forest, Powers Ranger District

The Powers Ranger District has the greatest concentration of POC in the world, from the South Fork of Coquille River to Iron Mountain. This district is also unique in having stands with compositions of POC up to 70 to 80 percent. Included within the district are the Port-Orford-cedar Research Natural Area, Big Tree Viewing Area, which includes the largest POC in the world at nearly 12 feet in diameter, and the Coquille River Falls Research Natural Area.

The district has been active in the inventory of POC through district-wide road surveys in 1964, 1972, 1983, 1992, and 1999. Since 1999, individual road segments connected to project proposals have been surveyed. These surveys, combined with extensive aerial photo and ground verification surveys in 1997, have identified a total of 62,323 acres of POC present on the district, of which 9,447 acres are infested with the PL root disease. Based on survey information and observations, there are few acres of new infestation appearing with each new survey. Most of the roads on the district have been open to the public since their construction and have already become infested.

Private Lands in the Region

With the prolific seed production of the species and excellent POC growing conditions along the coast, the corridor of lands along the Highway 101 from Lakeside in the north to Port-Orford, Oregon, in the south, is a rich environment for PL infestations. There are approximately 880,000 acres of non-Federal lands within the Coos Bay BLM District boundary within the POC range (from the range map), with an estimated 50,000 of these acres containing POC. Aerial photography interpretation indicates there are approximately 8,500 acres of non-roadside PL infections on these lands. In 1953 these private lands contained 69 percent of the total POC timber in Oregon, 15 percent on BLM, and 16 percent on NFs (Peattie 1953). The low coastal terraces and abundant standing water in this area result in a high percentage of POC being on sites at high risk for PL infection. The mortality rate calculated from forest inventory plots is consistent with aerial photo disease mapping done by the Coos Bay BLM District.

Inland Siskiyou Risk Region

This region has a high diversity of conditions, which is reflected in the vegetation. POC in this region is often associated with ultramafic soils, and co-dominates the timber stands on these soils with Jeffery pine and incense cedar. The vegetation on other soil types is dominated by the Douglas-fir with scattered POC. POC grows on Federal lands intermingled with private landholdings. It exists as occasional large trees with many seedlings growing underneath. The Federal administrative units that basically cover this region are the Roseburg and Medford BLM Districts.

Roseburg BLM District

Overlapping the northeastern-most portion of the native range of POC, the Roseburg BLM District has approximately 5,000 acres of forestland occupied by this species. The POC on the district grow in the Coast Range west of the Umpqua River, south to the southern area of Camas Valley, then crossing Highway 42 into the Twelve-Mile drainage. POC grows sporadically along Buck Springs Ridge and Cow Creek and its tributaries, and also in the west fork of Middle Creek.

Less than 100 acres have some level of the root disease, primarily adjacent to highly visible roads. Infestations occur on interspersed private lands as well.

About 63 percent of the trees are less than 80 years of age. POC makes up generally less than 5 percent of the overstory of the stands in which it is found.

PL has probably been present on Roseburg BLM District since the early 1960s. Extensive road construction on both Federal and private lands probably facilitated the introduction of the disease during this period.

Medford BLM District

The natural range of POC extends into the western part of the Medford District. Of the four resource areas on the district, POC is natural in the Grants Pass Resource Area and the Glendale Resource Area. The Grants Pass Resource Area contains the majority of POC. Most of the POC on the Medford District is contained in the Williams Creek, Rogue River/Horseshoe Bend, Silver Creek, Rogue River/Hellgate and Deer Creek Watersheds. Surveys in these and other 5^{th} field watersheds show 25,485 acres of healthy POC and 2,340 acres of infested stands.

The habitats in which POC is found are very diverse. POC on the district is often associated with riparian areas, but does occur in the uplands and on ridges. There are inclusions of coastal plant communities associated with POC as well as high elevation associations with Shasta red fir and Alaska yellow cedar. POC can be found on serpentine-influenced (ultramafic) soils that include western white and Jeffrey pine series.

Siskiyou Risk Region

This region includes the Coastal Siskiyous, Siskiyou Mountains, and Gasquet Mountain ultramafics located in Oregon and California. In the northwest part of the region, the Coastal Siskiyous have highly dissected mountains and high gradient streams, as well as a few, small, alpine glacial lakes. The climate is wetter with more maritime influence than the Siskiyou and Klamath Mountains to the south. The Coastal Siskiyou area has tanoak, Douglas-fir, and some POC. Western hemlock is present but not a dominant overstory species. This region has a high diversity of ecological conditions, which is reflected in the vegetation.

In the middle of the region, the Siskiyou Mountains are higher, steeper terrain than the other portions of the cedar's range in Oregon. It has a high diversity of conditions, which is reflected in the vegetation. The vegetation is dominated by Douglas-fir at low elevations, Jeffrey pine on ultramafic soils, and white fir and red fir series at higher elevations.

In the south portion of this region, populations of POC are highly scattered across the landscape and within many vegetation types. Marine air moderates temperatures in the western portion of this area, creating a temperate to humid climate near the coast. Douglas-fir and tanoak are the predominate trees in this part of the region. The southern extreme of this region stretches to southwest edge the Klamath Mountains into the northern California Coast Range. Many of the isolated populations of POC in this part of the region are often found on ultramafic soils.

The Federal administrative units that basically cover this region are the Siskiyou NF, Illinois Valley, Galice, Gold Beach, and Brookings Ranger Districts; Six Rivers NF; Klamath NF; Shasta-Trinity NF; Oregon Caves National Monument (FS); and Redwood National Park.

Siskiyou National Forest, Illinois Valley, and Galice Ranger Districts

Many of the POC within the Illinois Valley and Galice Ranger Districts range in age from 200 to 400 years old and are 20 to 60 inches in diameter. POC root disease has been present along the Oregon side of the Grayback Road going toward Happy Camp, California, since about 1960. Sanitation removals were implemented on the California side to reduce the potential for further disease introduction. So far, the root disease has not been found on the California side of the Grayback Road. In contrast, there has been considerable spread along this route and subsequent downstream movement in the years following introduction. The disease has spread to many stands, mostly along roads and down streams, east of Highway 199 on the Illinois Valley Ranger District. PL has infested the Grayback/Sucker Creek drainage near the Oregon Caves National Monument. The Wild and Scenic Illinois River and Briggs Valley area have a 6 to 40 percent stand composition of POC and are uninfested. Other major drainages in the Illinois Valley have scattered distributions of uninfested POC amidst steep topography.

POC is most often found in riparian areas within the Illinois Valley and Galice Districts. Generally, POC is within 100 feet of the stream; however, small groves of POC can be found on alluvial fans and benches along these streams. Crown closure in the streamside areas are from 10 to 50 percent.

There are upland populations on the many different soil types, including serpentine. POC is mixed with Douglas-fir, true firs, pines, and incense cedar up to approximately 4,500 feet elevation. In these mixed conifer stands, POC crown closure is generally 5 to 20 percent. Before the Biscuit Fire, POC on serpentine soils could be found from Josephine Mountain south to the Oregon boarder, where POC was scattered with white, knobcone, and lodge pole pines. In other serpentine areas, POC can be found with incense cedar and Douglas-fir. In these areas, POC crown closures are less than 2 percent.

Siskiyou National Forest, Chetco and Gold Beach Ranger Districts

POC can be found from Iron Mountain on the northern boundary of the Gold Beach District south to Mineral Hill. From there south, it is sparsely distributed and found only on the east side of the Chetco Ranger District. POC grows from near sea level, up to approximately 4,700 feet at Chetco Peak in the Kalmiopsis Wilderness.

POC is mostly found within 100 feet of the streams, but is also present in upland areas on many different soil types, including serpentine. POC is mixed with Douglas-fir, true firs, pines, and incense cedar. In the mixed conifer stands POC crown closure is generally 5 to 20 percent, but can be up to 80 percent in small isolated areas. Many of the POC within these districts are 200 to 400 years old and 20 to 60 inches in diameter.

PL has occurred along forest roads since about 1960. The disease has spread to many stands, mostly along roads and streams, following introduction.

Six Rivers National Forest

The Six Rivers NF includes the greatest extent of POC on Federal and State lands in California. These acres are spread over the northern portion of the forest and decrease in extent toward the south. The Gasquet Ranger District has about 67 percent of the POC on the Forest, primarily in the Smith River drainage. The Orleans Ranger District has about 30 percent of the POC on the forest, all in the Klamath River drainage. The southern-most POC in the natural range is on the Lower Trinity Ranger District. About 77 percent of the POC on the Six Rivers NF is found in riparian landscape positions.

POC root disease was noted on the Gasquet Ranger District by 1980 and has slowly spread to over 2,800 acres. The Orleans Ranger District has 157 infested acres and the Lower Trinity Ranger District has no recorded infestation to date. Most infestations are found in riparian habitats.

Klamath National Forest

There are no known PL infested stands or infected trees on the Klamath NF.

The distribution of POC on the Klamath NF is mostly limited to the Dillon, Clear, and Indian Creek Watersheds within the Siskiyou Mountains. On the Klamath NF, POC stands usually consist of small isolated pockets or narrow stringers and are nearly always confined to riparian areas. Most acres fall within the Riparian Reserve land allocation. The majority of POC acres are located within the Siskiyou Wilderness. Many of the POC stands in Matrix lands are generally in more accessible areas, but with limited direct road access to stands due to steep topography and riparian position.

Currently, the closest known infested sites are on the Illinois Valley Ranger District of Siskiyou NF and Orleans Ranger District of Six Rivers NF. The Illinois Valley site is close, via the popular Grayback Road, to uninfested sites within the Indian Creek Watershed of Klamath NF.

The 100-acre Sutcliffe Creek Botanical Area, which contains a stand of old POC, is located in the upper Indian Creek drainage of the Happy Camp Ranger District. Many stands of POC on the Klamath NF are greater than 300 years in age, with some individuals reaching ages of over 700 years. There are three locales within the Siskiyou Wilderness where POC and Alaska yellow cedar are found in very close proximity.

Oregon Caves National Monument (FS)

POC is the dominant tree on approximately 40 acres of the 480-acre Monument, and occurs in stands in about half the Monument. There is no PL in the Monument but it is surrounded by it, even upslope. There are foot trails coming to the Monument from adjacent infested FS lands that are used by people and, illegally, by horses.

Redwood National and State Parks

Of the 110,000 acres in the Park, naturally-occurring POC occupies only about 200 acres at the north end of the Park in the Smith River drainage near Jedediah Smith State Park. POC is found in various pockets generally as a component of stands, but also within a few POC-dominated stands. There are few infestations of PL, with one infestation notably along a main trail. There is no formal public access to other infestations, and generally little access to uninfested stands, except at Jedidiah Smith State Park Campground.

Biscuit Fire

The Biscuit Fire, located within this region, began on July 13, 2002 and reached 499,965 acres (471,130 acres in Oregon and 28,835 acres in California). Estimated to be one of Oregon's largest fire in recorded history, the Biscuit Fire encompassed most of the Kalmiopsis Wilderness. The boundary of the Biscuit Fire stretches from 10 miles east of the coastal community of Brookings, Oregon, south into northern California, east to the Illinois Valley, and north to within a few miles of the Rogue River.

Private Lands

There are 2,000 to 5,000 acres of non-Federal POC in California (see discussion of California early in this chapter). This includes lands in both the Siskiyou and Disjunct California Regions.

Disjunct California Risk Region

Scattered populations of POC grow in this region in the southeastern corner of the Klamath Mountains and Scott Mountains. The primary trees in this part of the region are Jeffrey pine, ponderosa pine, White fir, and Douglas-fir. The Federal administrative unit that covers this region is the Shasta-Trinity NF.

Shasta-Trinity National Forest

Approximately 1,150 acres of POC occur on lands managed by the Shasta-Trinity NF. These are located within portions of the disjunct southeast interior POC population. Occurring as small discontinuous groupings of trees, the POC populations on the Shasta-Trinity NF are almost entirely limited to the riparian zones of the Upper Sacramento and Trinity River drainages. Much of this POC occurs in areas under checkerboard land ownership. There are additional sites with POC on privately-owned land, as well as at Castle Crags State Park. The 1,160-acre Cedar Basin Research Natural Area has isolated patches of large POC as a distinguishing feature.

Although there are several areas of POC root disease infestation along the upper Sacramento River from Shasta Retreat (just north of Dunsmuir) to the mouth of Shotgun Creek, only one infestation is present on the Shasta-Trinity NF. This small infestation was discovered in September, 2001 at Scott Camp Creek, approximately 3 miles upstream from Lake Siskiyou.

Port-Orford-Cedar Acreage Data

Geographic Information System

The geographic information system (GIS)-mapped data for POC and PL infestation was developed over the last decade by the various administrative units (Table 3&4-5). On the Siskiyou NF, roadside survey observations, for both healthy and diseased POC locations, were collected and put into GIS in 1992. Intermittent updates have been made since. The theme is composed entirely of estimated locations as seen from roads with geographical areas being estimated for the presence of healthy and diseased POC. The Siskiyou NF Powers District intensively mapped PL infestations using aerial photo interpretation and on-the-ground verification sampling in 2002.

On the BLM districts the FS standards for roadside surveys and aerial photo interpretation with on-the-ground verification sampling were utilized for mapping the presence of POC and the PL infestations. This data was entered into GIS on the three BLM districts in 1998. On the Roseburg and Medford BLM Districts, only the federally-administered lands were generally mapped for PL infestations. At Coos Bay, Federal and private lands within the boundary of the district were mapped for PL infestations. However, the PL infestations mapped on private lands were not field verified and private lands are not included on Table 3&4-5. The Coos Bay BLM District completed an extensive revision of the POC presence data in early 2003. Continual revisions have been made on a project-by-project basis on the Roseburg and Medford BLM Districts. The Roseburg District remapped its PL infestations in 2002.

On the Klamath, Shasta-Trinity, and Six Rivers NFs in California, the healthy POC and PL infestations were estimated using detailed ecological mapping and plant association plot information. Some non-Federal lands have also been mapped.

Biscuit Fire Acres. Of an estimated 95,000 acres of POC within the perimeter of the Biscuit Fire, an estimated 55,400 acres of uninfected POC stands, and 1,400 acres of PL-infested POC stands were assumed killed, based on overlaying the 75 percent top-kill burn intensity map with the pre-fire POC GIS maps. To get a reasonable estimate of current conditions, those acres were removed from all acres displayed in this analysis. This does not mean those acres will not reseed naturally or be replanted. Indeed, 26,000 disease-resistant POC seedlings have been already sown for out-planting within the burn within the next 6 to 18 months. These restoration efforts are expected to begin restoring the total acres of POC back toward pre-fire levels.

On a potentially positive note, the heat from the Biscuit Fire and resultant altered microclimate may have removed PL from some burned areas. Hansen and Hamm (1996) found that after one week, bags of soil and organic matter that had reached temperatures of 104 degrees

Table 3&4-5.—*Geographic information system-mapped Port-Orford-cedar and* Phytophthora lateralis *infestation acreage on BLM and FS, post-Biscuit Fire*

	Congressional Reserves/Administratively Withdrawn		Late-Successional Reserves		Matrix/Riparian Reserves/Adaptive Management Areas		Total		
Risk Regions	Uninfested	Infested	Uninfested	Infested	Uninfested	Infested	Uninfested	Infested	% Infested
Oregon									
North Coast	1,351	220	57,128	6,177	60,209	1,163	118,688	7,560	6
Inland Siskiyou	4,317	87	18,182	1,151	5,060	544	27,559	1,782	6
Siskiyou	18,829	906	62,474	8,536	22,617	3,012	103,920	12,454	11
Total	24,497	1,213	137,784	15,864	87,886	4,719	250,167	21,796	8
California									
Siskiyou	17,188	1,782	10,641	741	3,013	311	30,842	2,834	8
Disjunct California	371		173		598		1,142		0
Total	17,559	1,782	10,814	741	3,611	311	31,984	2,834	8
Total	42,056	2,995	148,598	16,605	91,497	5,030	282,151	24,630	8

F for 4 hours each day no longer supported the pathogen. A low-intensity prescribed burn will achieve temperatures of 200 to 300 degrees C (392 to 572 degrees F). Many areas of the wildfire were much hotter. Based on the literature, there is good potential for this amount of heat to have negative impacts on PL populations. Questions remain about how deep into the soil profile PL goes (depth of roots) and how deep the pulse of heat extends into the soil.

Port-Orford-cedar Map. Map 2 compiles the GIS maps of POC and PL with the Northwest Forest Plan land allocations. PL infestations are shown in red; POC presence is depicted by all other colors—the colors themselves indicate the underlying Northwest Forest Plan land allocation. Areas not colored do not have POC. The map also shows the FS inventoried roadless areas (cross-hatched) and the Biscuit Fire perimeter (heavy dashed line).

Current Vegetation Survey

The FS maintains a National System of Current Vegetation Survey (CVS) sample plots to acquire basic vegetative resource information tri-annually at the regional scale. This information allows resource specialists and others to assess the current vegetation condition and assess changes in the ecosystem, spatially and temporally. BLM in western Oregon maintains inventory plots to the same establishment and remeasurement standard as the FS, in order to be able to combine data sets for landscape, provincial, and regional analysis.

In general, the acquired dataset represents a collection of basic, statistically-designed, and quality-assured vegetation resource measurements. The strength of the survey includes: the ability to set a benchmark of the vegetative condition on NF and BLM lands, providing a basis for change estimation (i.e., trend analysis), and accommodating monitoring through remeasurement.

Data is collected on nested subplot radii within a one hectare (2.47 acre) plot. The plots are located on a 1.7 mile statewide grid and each plot represents approximately 1,750 acres. The plots are divided into 0.2 hectare areas that contain concentric fixed area subplots that vary for each diameter class being sampled. The intensity of 1.7 miles is not usually useful for evaluating minor species such as POC within limited landscapes. In Table 3&4-6, data is compiled only for larger geographic areas. Other survey methods can be used to assess presence of minor species or incidence of forest diseases, and the results of those surveys could be different based on their intensity when compared to CVS.

Similar inventory plots, forest inventory, and analysis (FIA) are maintained on private lands by the research branch of the FS. Forest inventory and analysis inventory data estimates that there are a total of 54,550 acres (standard error 14 percent) of POC on Oregon's private lands with 9,820 acres (standard error 59 percent) of those lands containing dead POC. This estimate is not considered as reliable as the mapping method used for determining infested acreage on Federal lands and shown in Table 3&4-5, but is the only available estimate of Oregon private lands with POC. The inventory plots are considered accurate for displaying individual tree mortality percentages for both Federal and private lands.

Table 3&4-6 provides tree numbers and mortality information from the most current CVS and forest inventory and analysis data in the range of POC. CVS data shows an additional 40 million POC less than 1 inch dbh (diameter at breast height) on Federal lands in Oregon that are not shown on the table.

Table 3&4-6—*Current Vegetation Survey: Summary from Forest Inventory Plots of live and dead POC trees*

Area [1]	Diameter group dbh [inches]	Live trees	Dead trees	% live	% dead
Oregon					
Federal:	1-7	7,826,100	1,074,600	88	12
Coos Bay	7-20	1,618,300	436,100	79	21
BLM/Powers	>20	361,600	159,600	69	31
Ranger District [2]					
Federal:	1-7	5,863,900	239,100	96	4
other than above [3]	7-20	1,428,500	417,300	77	23
	>20	435,100	138,200	76	24
Total Federal [4]	1-7	13,690,000	1,313,700	91	9
	7-20	3,046,800	853,400	78	22
	>20	796,700	297,800	73	27
Private [5]	1-7	11,767,200	8,722,200	57	43
	7-20	2,134,400	1,631,000	57	43
	>20	102,900	263,200	28	72
California					
Federal [6]	1-7	4,677,000	23,400	99	1
	7-20	1,096,000	4,800	99	1
	>20	379,600	5,600	99	1

[1] Oregon Federal lands were grouped to match "risk regions" described in the Pathology section and lumped to provide statistically significant results.
[2] Standard error 19-33%.
[3] Standard error 18-41%.
[4] Standard error 13-24%.
[5] Standard error 7-115%; these are from FIA plots [see text].
[6] Standard error not calculated.

Aerial Mortality and Defoliation Surveys — Oregon

The State of Oregon, Department of Forestry, and USDA-FS have been jointly conducting aerial sketch mapping of forest insects and disease pathogens for more than 50 years. The survey protocol identifies clumps of at least five dead trees that have been killed within last year and assigns a causal agent. In 2001, the survey system began using real-time global positioning to digitally construct its electronic maps (USDA-FS and Oregon Department of Forestry 2002). The aerial survey observations for southwestern Oregon contain POC root disease as one of the causal agents in its report. Table 3&4-7 summarizes POC root disease results for 2000 through 2002.

Resource Elements That Address Issues

Introduction

With the identification of the Purpose and Need in Chapter 1, and following scoping, a list of issues was developed upon which a decision to select one of the Alternatives would be based. These issues are addressed in the various resource topic discussions in this chapter. These

Table 3&4-7.—*Summary of aerial mortality and defoliation survey results for Port-Orford-cedar in Oregon, 2000–2002*

	2000		2001		2002	
Land ownership	Acres	Dead trees	Acres	Dead trees	Acres	Dead trees
Bureau of Land Management	87	64	123	89	169	70
Forest Service	480	239	257	182	213	74
Private	4,615	4,779	5,835	4,882	5,522	6,963
State of Oregon	1	1	64	58	43	43
Wilderness/National Monuments	68	28	0	0	24	5
Total	5,251	5,111	6,279	5,211	5,971	7,155

discussions cover the ecological, Tribal, and product uses or functions potentially affected by POC management, and provide the basis for the Comparison of Alternatives in Chapter 2.

The issues are affected by two distinct kinds of effects. First, to the extent the standards and guidelines themselves have a direct effect on access or use of the forest and the harvest of forest products, there is a direct effect. Direct effects include potential reductions in non-POC timber harvest because of direct prohibitions in certain areas or stands; reductions in POC bough harvest because of direct prohibitions, and reductions in recreation opportunities because of road closures or prohibitions on off-highway vehicle use.

Second, to the extent that application of the standards and guideline maintains POC, there is a secondary effect on related resources. Such effects include the degree to which stream shading is maintained or lost, thereby changing temperature, wildlife habitat changes related to the loss of future snags, genetic resources retained, or visual resources affected. Both of these kinds of effects are described in the specific resource Effects of the Alternatives sections.

The keystone for the secondary effects analyses is the Pathology section. The available science and experience has been summarized and synthesized, and brought to bear on the various elements of each alternative. The result is a 100-year infection percentage estimate for each of the alternatives. These percentages, which vary for different "risk regions" within the planning area depending upon various risk factors, are converted to acres and used to predict secondary effects.

Pathology

Introduction

POC root disease is caused by the pathogen *Phytophthora lateralis* (abbreviated in this document as PL). PL is an oomycete belonging to the family Pythiaceae. Formerly considered to be true fungi, it is now generally accepted that oomycetes constitute a separate kingdom from the fungi (Cavalier-Smith 1986; Dick 1995; Erwin and Ribeiro 1996; Parker 1982).

All *Phytophthoras* exist primarily as hyphae, or thin threads of fungus-like material adjacent to and within their host. Aggregations of hyphae are known as mycelia. Mycelia, if fragmented or transported along with pieces of the host plant, can serve to move the pathogen to new locations. Mycelia are somewhat fragile and die when exposed to drying conditions. Several spore types form as specialized structures attached to *Phytophthora* mycelia. Although there are four spore types identified for PL, two are important enough in disease spread to be discussed here.

When PL is mature, and generally in the presence of free water, zoospores are released. Zoospores lack cell walls, are very delicate, and have two flagella. They can swim for several hours before forming cysts, but can only travel an inch or two in standing water (Carlile 1983). Zoospores also have the ability to detect compounds released by a host and swim in the direction of the host. Upon contact with a host rootlet, the zoospore will attach itself and germinate. If a host rootlet is not found, other surfaces are contacted, or agitation occurs, a zoospore will form a cyst. When encysted, it can be carried considerable distances in running water. In contact with a host, the cyst can germinate and form a mycelium that infects the host, or it can form a sporangium and release more zoospores.

Chlamydospores are thick-walled vegetative spores. Chlamydospores are somewhat resistant to drying and temperature extremes. They can germinate directly and form infective mycelia or, in the presence of water, they can form sporangia and release zoospores. Ostrofsky et al. (1977) showed that, under laboratory conditions, PL populations detected by baiting (intentionally planting POC seedlings around infected trees) decreased substantially when unfavorably warm, dry conditions typical of summer months in the range of POC occurred. However, the pathogen survived at a reduced level as chlamydospores in organic matter, especially in small roots on infected trees and fragments of roots in the surrounding soil. Hansen and Hamm (1996) have demonstrated that PL can survive in infected POC roots and root fragments for up to 7 years under favorable conditions. PL chlamydospores are incapable of direct movement, but their structure provides protection during passive movement in infected roots or organic material in soil and mud.

Affected Environment

How the Pathogen Spreads

Phytophthora lateralis (PL) spreads in several ways (Hansen et al. 2000; Zobel 1985):

1) Over long distances via resting spores transported in infested plant material or soil;
2) locally via waterborne spores moving in ditches, streams, or overland flow; or
3) via mycelia growing across root contacts and grafts between infected and uninfected POC.

Initiation of infestation into new areas involves 1, above, which is most commonly associated with deposition of infested soil along a road or trail. Vehicles, equipment, animals, or humans on foot transport inoculum from previously infested areas (Hansen et al. 2000; Jules et al. 2002; Kliejunas 1994; Roth et al. 1972). A susceptible POC fairly close to the actual site where inoculum is deposited is essential—this is usually a POC growing close to the road (within 10 feet) or a cedar with its roots in the water along the first 50 feet of a stream in a case where the introduction involves deposition of inoculum directly in water. In addition to

POC, Pacific yew is infected by PL on infrequent occasions (Kliejunas 1994). Observations and laboratory trials show that Pacific yew is much less susceptible than POC. Where it has been found infected, Pacific yew was growing in close association with many previously infected POC (Murray and Hansen 1997).

Once PL is successfully established, subsequent spread mostly involves number 2 listed previously. Under proper environmental conditions for the pathogen, spores produced on the initially infected POC are released and move downslope in overland water flow or streams, infecting additional trees whose roots are within the sphere of influence of the infested water (Hansen et al. 2000; Jules et al. 2002).

Root to root spread, number 3 listed previously, occurs in some cases (Gordon and Roth 1976), but is thought to be of much less significance in the epidemiology of the pathogen than spore spread in soil or water. It occurs in heavily stocked stands with substantial POC components (many POC quite close together).

Infection by PL is greatly favored by cool conditions and requires the presence of water around POC roots for at least several hours (Zobel et al. 1985). Optimal temperatures for infection are between 50° and 68° F (Trione 1974). Most POC are infected by the pathogen in the cool, wet parts of the year. Very little infection occurs in the dry, warm summer months.

Certain kinds of sites and microsites foster conditions especially favorable for spread and infection by PL (Goheen et al. 1999; Hansen et al. 2000; Roth et al. 1987). These high-risk sites are low-lying wet areas (infested or not) that are located downslope from already infested areas or below likely sites for future introductions, especially roads. They include streams, drainage ditches, gullies, swamps, seeps, ponds, lakes, and concave low-lying areas where water collects during rainy weather. Areas not influenced by the wet conditions or periodic water flow that occur in high-risk sites are low-risk sites. Cedars near streams or bodies of water whose roots do not extend below the high water mark for flooding are at low risk of infection. Riparian Reserve widths along a stream (as defined in the Northwest Forest Plan by site tree heights) often extend well beyond the high-risk widths for POC.

Probability of Long Distance Spread and Establishment of *P. lateralis* in New, Previously Uninfested Areas

As already mentioned, long distance spread of PL involves movement of resting spores. These spores can survive in infected POC roots and root fragments in the soil for as long as 7 years after the host POC's death under ideal conditions (Hansen and Hamm 1996). Movement of spores with transport of nursery stock in infested soil was probably how PL was originally introduced into the natural range of POC (Roth et al. 1957). Long distance spread in the forest today primarily involves movement of resting spores in soil adhering to vehicles or clinging to the feet of humans or animals.

When evaluating the likelihood of long distance spread to and establishment of PL in a new area, we need to consider the probabilities that: (1) viable inoculum will be picked up at an infested source; (2) the inoculum will be carried to a particular uninfested area; (3) the inoculum will remain viable during transit; (4) the inoculum will be deposited in the new site; and (5) the inoculum deposited will infect a POC and disease establishment will result. A number of factors influence inoculum accession, spread, and establishment of PL, especially:

- Character of site of origin;
- type of carrier;
- time of year of transport event;
- distance traveled and associated time elapsed;
- effectiveness of management techniques applied to slow or prevent spread or prevent establishment of PL in new areas;
- character of site and stand conditions where the potential introduction occurs; and
- number of potential transport and introduction events.

Exact figures for determining the influence of each factor on the probability of long distance spread and establishment are available in very few cases. However, relative probabilities between 1 (very low) and 10 (very high) have been determined for each factor. Based on the literature, and the professional judgments of forest pathologists with substantial amounts of experience evaluating PL in the laboratory and the field, it is suggested that probabilities of an event having the result under consideration are as follows.

1 = 0 to 2 percent	6 = 10.1 to 20 percent
2 = 2.1 to 4 percent	7 = 20.1 to 30 percent
3 = 4.1 to 6 percent	8 = 30.1 to 40 percent
4 = 6.1 to 8 percent	9 = 40.1 to 50 percent
5 = 8.1 to 10 percent	10 = 50.1 to 100 percent

The following is a discussion of each of the factors:

Character of site of origin. Potential carriers of PL entering a possible inoculum source area are more likely to pick up soil that contains viable inoculum in some kinds of sites than others. Inoculum clearly will not be available on a site with no infection while areas with obvious infection of POC where certain kinds of wet conditions prevail are the most likely places for inoculum to be acquired. Suggested probability figures for the likelihood of potential carriers picking up viable inoculum on different kinds of sites are:

Site with no evidence of root disease within the local drainage = 1;

site with no evidence of root disease in the area entered by the potential carrier but evidence of root disease nearby (within 300 feet) in the same drainage = 2;

site with local evidence of root disease where the potential carrier does not enter water = 5;

site with local evidence of root disease where the potential carrier enters flowing water = 7; and

site with local evidence of root disease where the potential carrier enters a swamp, seep, or any-sized body of standing water = 10.

Type of carrier. Vehicles (both motorized and nonmotorized), equipment, humans on foot, and animals (especially cows, horses, and elk) have been implicated in carrying PL. Probability of successful spread is greater with the larger carriers, those that transport greater amounts of soil, those most likely to access infested areas, and those that can rapidly travel to new sites. Suggested figures for the probabilities that different kinds of carriers could pick up and transport infested soil are:

Earth moving equipment = 10;
large transport equipment = 9;
all-terrain vehicles = 8;
passenger vehicles = 7;
humans on foot or using nonmotorized vehicles = 5; and
large animals = 5.

Time of year of transport event. Likelihood of acquiring inoculum, successfully transporting it, and establishing disease at a new site are greatly favored by cool temperatures, and probability of infection is much greater during wet periods than dry ones. Also, inoculum is most likely to be picked up from an infested site during a wet period when infested soil is muddy and prone to adhere to the carrier. Probability of spread and establishment of new infections is greater with soil movement in late fall, winter, and early spring than summer, and is greater in rainy rather than dry weather. Suggested probability figures are:

Movement between October 1 and May 31 during wet weather = 10;

movement between June 1 and September 30 during dry weather = 1;

movement between October 1 and May 31 during a dry period that lasts at least a week before and continues during the time of the movement = 3; and

movement between June 1 and September 30 during a rainy period sufficient to form puddles on a road or cause roadside ditches to flow = 6.

Distance traveled by carrier. Probability of successful delivery of viable inoculum from one site to another decreases with distance traveled and associated time elapsed since inoculum was picked up. Suggested probability figures are:

For vehicles, less than 0.5 mile = 10;
0.5 to 1 mile = 9;
1 to 5 miles = 8;
5 to 10 miles = 5;
10 to 20 miles = 3;
20 to 50 miles = 2;
greater than 50 miles = 1.

For animals and human foot traffic, less than 0.5 mile = 4;
0.5 to 1 mile = 2;
greater than 1 mile = 1.

Effectiveness of management techniques applied to prevent spread or prevent establishment of *P. lateralis* in new areas. A number of management techniques are recommended for preventing spread of PL or protecting uninfested areas (Betlejewski 1994; Goheen et al.

1997; Goheen et al. 1999; Hadfield et al. 1986; Hansen et al. 2000; Hansen and Lewis 1997; Kliejunas 1994; Roth et al. 1987). Techniques that can be used and suggested probabilities associated with each include:

Exclusion — This involves protecting uninfested areas by excluding vehicle entry. It can be done by permanently closing existing roads and/or by not building roads into uninfested drainages or upper portions of drainages. Cross-country travel or trail use by animals or humans on foot or in off-highway vehicles can still result in introductions, but probability is low, especially if the distance to the closest infested area is greater than 1 mile. The suggested probability figure if this management approach is used is 1.

Temporary road closure — This involves closing roads with gates or barriers to regulate timing and amount of use. Roads are closed when weather conditions are favorable for PL spread and may be open during other seasons of the year. Gates can be driven around, forced open, or destroyed by vandals, but most remain intact and prevent road use. In a sampling of gated closures done by the Southwest Oregon Forest Insect and Disease Service Center in November of 2000, 90 percent were intact and apparently effective in preventing entry (unpublished data). The suggested probability that a currently uninfested area will be protected if this management approach is used is 2.

Washing — This involves washing vehicles used in projects to remove infested soil before they are moved out of an infested area or before they are moved into an uninfested area. In some instances, tools and boots are also washed. One case study has demonstrated that normal washing can remove most of the inoculum on a vehicle or worker's feet (Goheen et al. 2000). Level of viable inoculum was reduced 92 percent by washing of a road grader, 91 percent by washing of a pickup truck, and 96 percent by washing of a worker's boots. Limitations on washing include the possibility of picking up new inoculum on an infested road after washing and the inability of the Agencies to require vehicle washing of numerous vehicles that use the roads but are not controlled by the Agencies. The suggested probability figure if this management approach is used by itself is 4.

Roadside sanitation — This treatment involves removing POC in buffer zones along both sides of roads. Objectives are either to (1) eliminate or minimize the amount of inoculum readily available for vehicle transport from already-infested roadsides, or (2) prevent/reduce new infections along roadsides in currently uninfested areas. The basis for this kind of treatment is the fact that PL only infects living POC roots (Zobel et al. 1985). PL can survive for a time in already infected roots after a POC dies, but it cannot colonize the roots of already dead POC. The objective of the treatment is to create a zone along roads where live POC roots are absent. Preliminary results from an analysis of roadside sanitation treatments being done by the Southwest Oregon Forest Insect and Disease Service Center (Marshall and Goheen 1999) show sanitation treatments reduce the amount of inoculum available for transport when done along infested road sections. Some decrease in inoculum was observed within 1 year of treatment while statistically significant declines were observed 3 years or more after treatment (after 3 years the amount of inoculum on average was reduced by 60 percent). The suggested probability figure to decrease inoculum if this management approach alone is used on already infested roads is initially 8, dropping to 5 in 3 years after the treatment. Probability can increase again if roadsides are not monitored and treated again if POC regenerates on the site. However, if POC exclusion is successfully carried out, the probability drops to 1 after 7 years. Use of sanitation treatments at probable introduction sites in uninfested drainages has not been evaluated. However, if all cedar are removed from roadsides before any inoculum is deposited, it seems reasonable that probability of establishment of the pathogen in the roadside area should be substantially reduced, perhaps to a probability figure of 2.

Integrated management — Employing a planned combination of treatments can reduce probability of long distance spread more than single kinds of treatment. An integrated treatment program that uses a combination of sanitation treatments, vehicle washing treatments, road drainage improvements, timing of activities during dry seasons, using certified clean or Clorox-treated water, scheduling treatments in uninfested before infested areas, regulation of special use activities such as cedar bough collecting, and public education efforts has a suggested probability of 3. If such treatments are combined with road closures, the suggested probability is 1. Probabilities with an integrated management approach would be slightly higher in situations where some of the management techniques could not be used (for example, in a situation where a large wildfire was burning and safety and suppression success considerations prevented use of some of the techniques that might normally be used).

Character of site and stand conditions where the potential introduction event occurs. Introduction of inoculum and establishment of disease in a new, previously uninfested site is influenced by site characteristics as well as occurrence, numbers, and distribution of POC. If carriers deposit viable inoculum on a wet site with POC nearby, and when there are numerous additional cedars downslope in high-risk sites, probability of disease establishment is high. Clearly, depositing inoculum in sites with no POC and no mechanism for moving the inoculum to any POC is low (1). When inoculum is deposited along a road, probability is highest when there are wet conditions and at least some POC within 10 feet (8). When cedars occur more than 10 feet from the road, but less than 50 feet away, predicted probability drops to 4. When inoculum is introduced directly into water at a stream crossing or ditch, probability of establishment is high (8) if there are POC with their roots in water downstream within 50 feet. For similarly situated POC between 50 and 100 feet from the road, probability would be 4. Jules et al. (2002), in their dendrocronological study, indicated that there was evidence of initial infections well beyond 160 feet down a stream; however, by the nature of their study, they were unable to evaluate small trees that had died many years before and were no longer detectable on the sites. It is possible that what they viewed as a single spore infection event actually was a several-stage event initially involving small trees closer to the road. We suggest a probability of 2 for potential introductions in stream crossings if there are no POC in the first 100 feet, but cedars do occur in the subsequent 500 feet.

Number of potential transport and introduction events. The probability figures provided above can be used together to evaluate the relative likelihood of various long distance PL spread/establishment scenarios involving individual potential carriers. Number of potential transporting events should also be taken into account when evaluating possibility of new introductions. Very low probability events become more likely to occur when they are repeated, and especially so if they are repeated many times.

No formula is suggested here for ranking activities or projects, although the general relationships could be used to help guide future site-specific analyses, including use of the POC Risk Key that is a part of Alternatives 2 and 3 in this SEIS. The concepts described above, coupled with known levels of activity (see Background and various Affected Environment sections), conditions on surrounding lands, and other factors described in the SEIS and its references, were designed to serve as part of the analysis needed to make predictions about disease spread for the alternatives considered in this SEIS.

Disease Progression Once the Pathogen is Introduced

Figure 3&4-1 shows the progression of POC root disease within a drainage after PL is introduced and becomes established.

The curve is a disease epidemic curve similar to those of many other plant diseases (Van der Plank 1975). PL is introduced at time 0. At least one POC is infected as a result of the introduction which involves infested soil falling off a vehicle or the feet of an animal or human.

Rate of disease increase is low at first (area *a* on diagram); there are relatively few spores produced because only one or a very few POC close to the site of introduction are infected. Inoculum production increases as more POC are infected (area *b* in diagram). Spore levels in water flowing downslope in drainages during the wet season and in streams increase to high levels. POC trees on high-risk sites downslope from the source of introduction are exposed to this inoculum, are infected, and produce more inoculum in turn. This leads to rapid spread and high levels of mortality of a large proportion of POC growing in the high-risk sites.

Eventually, amount of new mortality and rate of spread within the drainage decreases substantially (area *c* on diagram). Most original POC on the sites with characteristics favorable for the pathogen have been infected and killed by this time. Spread to POC growing on unfavorable sites is very slow and sporadic if it occurs at all (when it does happen it typically involves animals or humans moving infested soil directly onto the roots of individual POC trees during cool, rainy weather). Inoculum levels often remain high on the high-risk sites due to reseeding of POC and chronic infection of small trees.

Percent of trees infected at various points in Figure 3&4-1 are:

Stage	Time	% trees infected
a	2–10 years	<0.1
b	5–20 years	90 (high-risk sites)/0.1 per year (low-risk sites)
c	>20 years	Chronic infection/regeneration (high-risk sites)/0.1 per year (low-risk sites)

There are substantial differences in PL spread and impacts within infested drainages in different parts of the range of POC. These mainly reflect (1) different distributions of POC across the landscape in different areas; (2) different proportions of sites in different areas that have conditions favorable for spread and infection by PL (high-risk sites); (3) different histories of PL occurrence; and (4) different positions on the disease progression curve in different areas. Differences by major area or “risk regions” are discussed as follows.

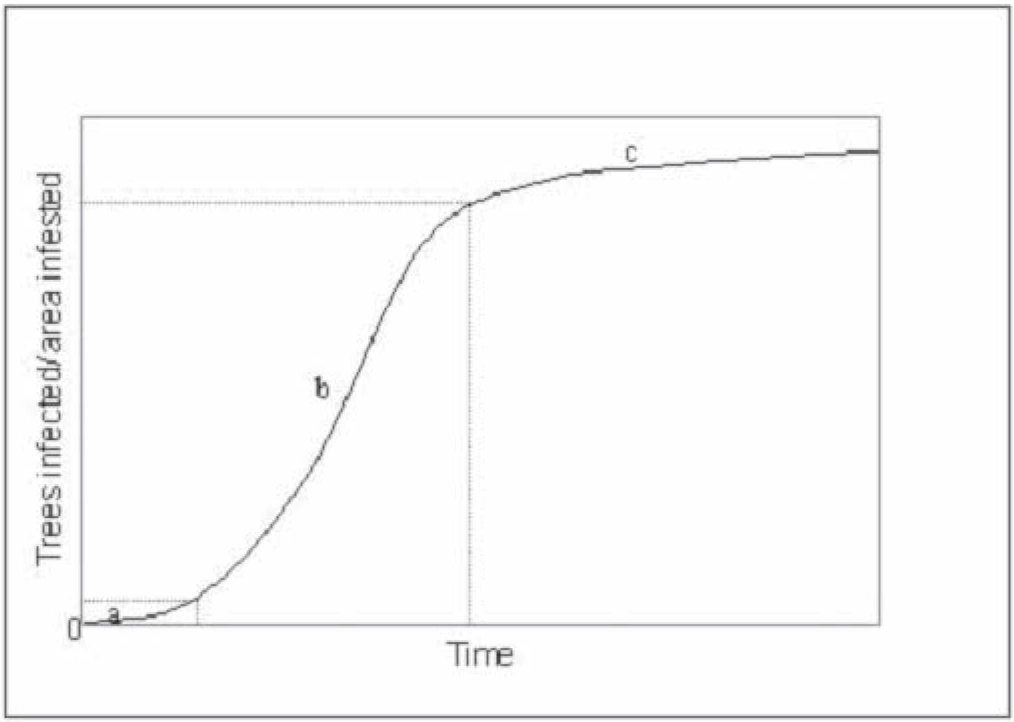

Figure 3&4-1.—*Progression of Port-Orford-cedar root disease within a drainage after* Phytophthera latralis ***is introduced and becomes established***

North Coast Risk Region (Northern/Coastal Portion of Range: Powers Ranger District, Siskiyou NF, and Coos Bay BLM District). POC is distributed widely across the landscape. On average 20 percent of the area is comprised of high-risk sites. The pathogen has been present in this area for considerable time. Mapping and forest inventories indicate that about 15 percent of the area (or 75 percent of the 20 percent in high-risk sites) is infested, and most drainages are at level *c* on the disease progression curve. Most originally-occurring cedars in infested high-risk sites have been killed (general estimate is 90 percent). There is chronic mortality of small cedars regenerating on high-risk sites that are infested. Low-risk sites (80 percent of the area) are little impacted. Non-Federal lands near Coos Bay contain approximately 8,500 acres of non-roadside infection and represent a chronic source of PL for export to Federal and other lands here and throughout the range.

Siskiyou and Disjunct California Risk Regions (Southern Portion of Range on NFs: other districts on Siskiyou NF and districts on the Six Rivers, Klamath, and Shasta-Trinity NFs). POC occurrence is much more tied to riparian zones and wet areas here than is the case in the northern part of the range. On average about 40 percent of the area is in high-risk sites. PL has not been present in this part of the range for as long as it has been further north. Mapping and forest inventories indicate that about 9 percent of the area (or nearly 25 percent of the 40 percent in high-risk sites) is infested. A substantial number of drainages or the upper parts of drainages have not had introductions of the pathogen. Some infested drainages, including major ones in the south, are still at level *b* on the disease progression curve and exhibit high levels of current infection. Ultimately, the amount of mortality in infested high-risk sites is predicted to reach the same levels observed in the northern part of the range. Some drainages are even at area *a* on the disease curve such as the Lower Sacramento River and Scott Camp Creek drainages where PL infection has only been recently observed. These too will suffer high levels of mortality in high-risk sites unless eradication treatments prove successful.

Inland Siskiyou Risk Region (inland portion of Range in Oregon, Medford, and Roseburg BLM Districts). The discussion for this area is similar to that for the southern part of the range on FS land, except that on average about 60 percent of this area is in high-risk sites (the larger number reflects contribution of higher road density to risk coupled with the occurrence of POC here being mostly tied to creeks and wet areas). Position of infested drainages on the disease progress curve are divided between *b* and *c*.

Effects of Alternatives

Introduction

PL does not threaten POC with extirpation. In fact, considerable areas within the range of POC are on low-risk sites or in drainages that remain uninfested. Some estimates of current proportion of area within the range of the POC on Federal lands where uninfected POC occur include 91 percent from the mapping exercise done by the FS and BLM for the recent POC range-wide assessment, 89 percent for FS lands in California based on plant association mapping (Jimerson data), and the same figure for CVS data, and 76 percent for large trees based on inventory data for Federal lands in Oregon (from Table 3&4-6).

There is little spread of PL on low-risk sites even when the pathogen is already established nearby. It is estimated that on average 0.1 percent of the cedars on low-risk sites are infested per year in infested drainages. In most situations, additional cedar regeneration and/or growth of other, uninfected cedars more than offsets this loss in POC trees. Data suggest that 80 percent of the area in the northern coastal portion of POC range, 60 percent in the southern part of the range, and 40 percent in the inland portion of the range are in low-risk sites.

PL does indeed have major effects in high-risk sites, especially in streams and riparian areas. Within these areas that are especially favorable for spread and infestation by PL, it is estimated that on average 90 percent of the POC present before introduction are killed by the pathogen, usually in only a few years after the pathogen is established (5 to 20 years; usually closer to the shorter end of this range). Data indicates that 20 percent of the area in the northern coastal portion of POC range, 40 percent in the southern part of the range, and 60 percent in the inland portion of the range are in high-risk sites. Large cedars are especially prone to infection and mortality on these sites. Natural reseeding maintains POC at some level on many of these sites, but chronic infestation insures that few if any of the cedars regenerating on a high-risk site after it is infested attain large size.

To maintain POC in high-risk sites requires either:

1) Excluding PL from being introduced into the area in the first place;

2) deployment of disease resistant POC planting stock (this will replace large trees only after many years); or

3) reestablishing cedar after eradicating PL from infested sites (a difficult and problematic approach that also results in the loss of the large cedars at the time of treatment).

Port-Orford-Cedar Root Disease and the Alternatives Considered in the SEIS

Low-risk sites. The influence of POC root disease on low-risk sites is likely to be similar under all of the alternatives being considered in the SEIS. Hosts on these kinds of sites will suffer 0.1 percent per year disease-caused mortality. The few trees that are infected and killed each year will be spread among all diameter classes and will be replaced by new POC regeneration and/or growth of nearby surviving POC. It is predicted that there will be little or no change in disease occurrence and expression in the next 100 years on low-risk sites regardless of which alternative is selected. This would be consistent with what has been observed on low-risk sites in the first 50 years of the disease's occurrence in the natural range of POC.

High-risk sites. In contrast, establishment, spread, and effects of the root disease on the existing POC in high-risk sites that have not yet been infested is likely to differ substantially with alternative chosen. When PL is established in a formerly uninfested drainage or portion of a drainage, rapid disease spread and 90 percent mortality of the existing POC growing in downslope high-risk sites can be expected in the subsequent 5 to 20 years.

While it is impossible to give a precise figure of the proportion of today's uninfested drainages or drainage portions that will become infested with selection of each of the 5 alternatives, consideration of the factors and circumstances discussed above permit estimates of infestation rates for the next 100 years (Table 3&4-8).

The following assumptions were made in arriving at these estimates:

1) PL will continue to act as it has in the first 50 years of its presence in the range of POC.

2) The same kinds of spread scenarios and the same kinds of associated transport and establishment probabilities will exist in the next 100 years.

3) Overall activity levels in the forest by humans and animals will remain similar to the levels of today (though there probably will be shifts in the relative levels associated with different kinds of activities).

4) The Federal agencies will continue to be involved in a variety of management activities on the lands they administer (though the proportions of Federal projects in different categories may change).

5) The de facto protection provided by reserve and other land allocations on Federal lands will remain in place.

6) Private forest lands within the range of POC will continue to be managed primarily for forest products.

7) Few significant attempts will be made to limit spread and intensification of PL on private lands.

Table 3&4-8.— *Percent of currently healthy drainages (uninfested high-risk areas) predicted to become infested within 100 years by alternative*

Alternative	% uninfested high-risk areas to become infested
1	40
2	35
3	20
4	80
5	80

Rational for 100-year infestation predictions made for each alternative follow.

Alternatives 4 and 5

These alternatives have the highest estimates for future infestation of high-risk sites within the area covered by the SEIS (80 percent in the next 100 years). These alternatives have no provisions for reducing the spread of PL on Federal lands and are thus the least likely of the alternatives to slow introduction and establishment of the pathogen on currently uninfested high-risk sites. Though it is likely that timber harvest, other extractive activities, new road building, and miles of drivable road will decrease in the next 100 years on Federal lands when compared to the past 50 years, Federal management projects that involve vehicle transport and use of machinery will still be done at levels described in the Northwest Forest Plan, and a substantial number of roads will be maintained. Timber harvesting and related activities will continue on private lands and will influence PL spread on Federal lands, especially those that are near to or interspersed with the private lands. Recreational use of the forest is likely to increase substantially with increased populations. Also, use by entrepreneurs interested in special forest products will likely increase. Many recreationists and forest products entrepreneurs are very mobile, readily use roads of low standards as well as improved roads, and sometimes employ off-road vehicles to travel into areas where there are no roads at all. Others travel into areas away from roads on foot. Under Alternatives 4 or 5, no actions will be taken by Federal managers to prevent pick-up of inoculum at already infested sites or along travel routes by any forest users, nor will actions be taken to prevent entry into uninfested areas.

During the first 50 years of PL's presence in the native range of POC, the pathogen infested about 36 percent of the high-risk sites in all of the area under consideration in this SEIS. It infested about 75 percent of the high-risk sites in the northern coastal part of POC's range closest to where the original introduction of PL occurred. All spread subsequent to PL's introduction was from closely associated sites near Coos Bay at the northwestern edge of the host's range. During the last 25 years, there were numerous attempts to retard spread and intensification through disease-management activities on many Federal lands. In the next 100 years, a period twice as long as our 50 year experience of the past, spread will be from numerous infested areas already distributed widely across the area covered by the SEIS. In Alternatives 4 and 5, it is estimated vehicle transport of PL will be similar to or increase from what it has been in the past, though it will involve different kinds of vehicles in many cases. Spread into currently uninfested areas would be substantial in the next 100 years, though not all uninfested areas would be affected. It is predicted that most of the remaining uninfested high-risk sites in 100 years under either of these alternatives (estimated as 20 percent of those existing today) will be located in unroaded remote areas where land allocations prevent or strongly discourage entry by vehicles.

Alternative 3

This alternative has the lowest estimate for future infestation of high-risk sites of the alternatives included in the SEIS (20 percent in the next 100 years). This alternative includes a risk key to consistently determine where site-specific management practices should be applied to reduce the risk of PL spread. These would include roadside sanitation, vehicle washing, scheduling activities during dry seasons, road closures, and public education, among other activities. These activities are effective to various degrees in reducing probability of picking up and transporting PL inoculum, especially when used together in integrated strategies. Education, as well as road closures and sanitation treatments applied strategically, will affect the component of future spread involving increased public use of the area within the range of POC in the next 100 years. This alternative also includes additional measures for POC stands (core areas) and surrounding buffers in 32 uninfested 6^{th} field watersheds. Road occurrence and use and earth-disturbing activities would be reduced, or eliminated altogether, in POC cores and buffers.

Though it provides considerable protection, there is still a probability that in some cases PL could be spread into currently uninfested watersheds under Alternative 3. Even in the uninfested areas provided maximum protection with the POC core and buffer system, there is a probability, albeit low, that PL can be introduced by animals or human foot traffic or vehicles. The introduction of PL into the Little Chetco River in the Kalmiopsis Wilderness provides an illustration from the past of disease spread into an unlikely remote area. In uninfested sites not located in the 6^{th} field watersheds with POC cores and buffers, the risk key should lead to implementation of an appropriate set of management practices to reduce the likelihood of introduction. Also, the risk rating system will be used in planning agency activities and projects. But no management technique is 100 percent effective (see probabilities in section on long distance spread of PL). In situations where no projects or activities are being planned in an area, use of roads by the public or other entities not controlled by the Federal agencies (in checkerboard ownership, for example) may not have been considered in the risk key and thus, lack treatments. Even where the risk key is used on Federal lands near or especially interspersed with private timber lands, there will likely be more inoculum than in block ownerships. Some kinds of management activities such as roadside sanitation and vehicle washing will be less effective in reducing probability of spread in these cases then would be the case in areas where the agencies have block ownerships. It is estimated that sanitation and vehicle washing would influence likelihood of long distance spread less than a quarter as much along roads in “checkerboard” ownerships than in areas where all the land is managed by the agencies. Treatments would be most likely to affect long distance spread if done along roads leaving areas of mixed ownership.

Alternative 2

This alternative has an estimate for future infestation of high-risk sites within the area covered by the SEIS (35 percent in the next 100 years) that is higher than that for Alternative 3 but much lower than those for Alternatives 4 or 5. This alternative has provisions for limiting spread of PL through consistent use of the same risk key described under Alternative 3. Alternative 2 has a somewhat higher estimate of future infestation of uninfested high-risk areas than Alternative 3 because it lacks the additional management direction for the 32 currently uninfested 6th field watersheds in Alternative 3. Under Alternative 2, management practices in these large uninfested areas would depend only upon results of using the risk key.

Alternative 1

Alternative 1 has an estimate of future infestation of high-risk sites within the area covered by the SEIS (40 percent in the next 100 years) that is slightly higher than Alternative 2 but is still considerably lower than Alternatives 4 or 5. This alternative retains the current management direction. Like Alternatives 2 or 3, it also emphasizes use of various management practices effective in reducing probability of spread of PL but instead of the risk key, it depends on project specific analyses to determine appropriate treatments. Its higher risk estimate reflects a less consistent analysis approach than that expected to be provided by use of the risk key in Alternatives 2 and 3.

Alternatives 1, 2, 3, and 4 to a greater degree, and Alternative 5 to a lesser degree, have provisions for deployment of PL-resistant POC planting stock. The first four alternatives also emphasize resistance breeding to varying degrees with Alternative 4 especially stressing an accelerated breeding effort. If POC stock with durable, long-term resistance becomes available, high-risk sites where most of the cedar has been killed in the past as well as high-risk sites that become infested in the future can be replanted with resistant trees. Development and deployment of genetically resistant stock has proven to be a successful method for maintaining hosts on sites favorable for infestation in cases involving other *Phytophthora*-caused plant diseases (Erwin and Ribeiro 1996; Umaerus et al. 1983). Differences in effects of selecting each of the five alternatives on development and deployment of resistant POC are addressed in the Genetics section of this document.

Cumulative Effects

Even though probabilities were low and it was very unlikely to happen, there is evidence that PL has indeed been transported on occasion over particularly long distances (even over 50 road miles) and into areas that were thought to be unlikely candidates for infestation because of their remoteness. Disease establishment in the Little Chetco River in the Kalmiopsis Wilderness, along the Smith River Drainage, Lower Sacramento River Drainage, Potato Patch Creek, and Fish Lake are known examples. The latter three of these occurrences probably involved inoculum carried on vehicles driving or being transported on roads (in the Lower Sacramento River case, a piece of equipment that had been used in Oregon may have been responsible). The Smith River occurrence is believed to have involved travel by vehicle and on foot by cedar bough collectors, and the Chetco River case remains a mystery though it may have been associated with mining activity (dredging).

There is a possibility that a small number of currently uninfested high-risk sites in California may be infested in the future as the result of inoculum transport from Federal lands in Oregon even though the probability is much lower than the probability that new infestations in California could result from inoculum transport within California. The probability of spread from Oregon to California would be low under any of the alternatives considered in the SEIS. It would be higher under Alternatives 4 and 5 than under Alternatives 1, 2, and 3. It is impossible to provide exact figures. However, given the fact that there have been four documented cases of long-distance transmission in California in the last 25 years (Smith

River, Potato Patch Creek, Fish Lake Creek, and the lower Sacramento River), additional long-distance spreads are likely to happen under any alternative, and each will have the potential to open the disease to a large, currently uninfested area.

Long-Term Mortality

Using the percent mortality predictions shown in Table 3&4-8, and the mortality information in Tables 3&4-5 and 3&4-6, the acres and overall percentage of POC expected to survive at the landscape scale can be calculated for each alternative. While the effects of long-term mortality are not evenly distributed over the landscape, and may impact some habitats more than others, it is a useful consideration for some impacted resources. How the calculations are derived from those tables necessitates some explanation. The calculations just include Oregon, since that is the area directly affected by the alternatives.

For comparison of data and further discussions portions of Table 3&4-5 and Table 3&4-6 have been combined into Table 3&4-9.

In this case, the CVS numbers for trees are a more accurate statistical measure of the POC tree population and mortality than GIS. GIS is primarily designed to give spatial representations of data, while CVS is, by design, a population sampling scheme. The GIS maps may suffer from two sources of bias: Smaller (less than 7 inches diameter at breast height) infected trees are difficult to detect on aerial photos in the dense forests on the North Coast; and, mapping in the southeast part of the range is done at stand levels, while POC may be confined to wet areas within the stands. Given some of the inherent overestimates and underestimates of the GIS mapping data, the CVS percent mortality calculation is considered more useful for projecting the long-term POC mortality in each region for each alternative. Using 15 percent mortality for the North Risk Region and 9 percent for the Siskiyou and Inland Siskiyou Risk Regions, assuming this mortality is virtually all on high-risk sites, and applying the pathology predictions contained in Table 3&4-8 to remaining uninfested sites, the following table (Table 3&4-10) can be derived to project long-term POC infestation for Oregon.

The total area predicted to be infested at 100 years varies between 16 and 29 percent (from 12 percent today) depending upon alternative (Table 3&4-10, shaded column). The percent of high-risk areas predicted to be infested in 100 years is also displayed on Table 3&4-10 because some effects, such as water temperature, are dependent more on the percent of PL infestation near streams, not the percent infestation on the entire landscape. The percent of

Table 3&4-9.—*Infested and infection estimates, Oregon*

	Geographic information system [acres]			Current vegetation survey
Risk regions	Uninfested	Infested	% infested	% infected
North Coast	118,825	7,560	6	15
Inland Siskiyou	27,555	1,782	6	9
Siskiyou	103,787	12,454	11	
Total	250,167	21,796	8	

Table 3&4-10.—*100-year infestation prediction for Oregon by alternative*

Alternative	% of risk region high risk	Currently infested high-risk area [as % of risk region] [1]	Uninfested high-risk area [as % of risk region]	% of uninfested high-risk areas predicted to become infested [new] in 100 years [2]	Uninfested high-risk areas predicted to become infested [as % of risk region] [3]	Total [new and current] area to be infested in 100 years [as % of risk region]	Total [new and current] area to be infested in 100 years [in acres] [4]	Total [new and current] area to be infested in 100 years [as % of high-risk areas only]
North Coast Risk Region *[126,248 acres]*								
1	20	15	5	40	2	17	21,450	85
2	20	15	5	35	2	17	21,450	85
3	20	15	5	20	1	16	20,200	80
4 & 5	20	15	5	80	4	19	23,990	95
Siskiyou Risk Region *[116,374 acres]*								
1	40	9	31	40	12	21	24,900	52
2	40	9	31	35	11	20	23,100	50
3	40	9	31	20	6	15	17,690	37
4 & 5	40	9	31	80	25	34	39,330	85
Inland Siskiyou Risk Region *[29,341 acres]*								
1	60	9	51	40	20	29	8,630	48
2	60	9	51	35	18	27	7,880	45
3	60	9	51	20	10	19	5,630	32
4 & 5	60	9	51	80	41	50	14,670	83
Totals *[271,963 acres]*								
1				40		20	54,990	61
2				35		19	52,120	58
3				20		16	43,520	49
4 & 5				80		29	77,930	87

[1] All infestation is assumed to be within the high-risk areas.
[2] From Table 3&4-6.
[3] Previous two columns multiplied together.
[4] Mortality in infested areas is expected to be about 90%; table does not include replacement with resistant stock.

high-risk areas predicted to be infested in 100 years varies between 49 and 87 percent (from 36 percent today), depending upon the alternative (Table3&4-10, last column). In both cases, the 100 year infestation percentage varies by risk region.

Ecology and Plant Associations

Affected Environment

Introduction

POC is found from southwestern Oregon to northwestern California, primarily in the Coast Ranges and Siskiyou and Klamath Mountains, with a small disjunct population in the Scott Mountains of California (Figure 1-1).

The following discussion of the affected environment is organized at two scales: the local scale of plant associations (grouped here for clarity), and the broad landscapes of ecosystems. Organizing affected environments at multiple scales has proven a useful analysis tool, because it more fully captures the range of environmental diversity and ecosystem functions.

Local Scale

Although POC has a narrow geographic range, it occupies many different environments. The species is found at elevations from sea level to 6,400 feet, in glacial basins, along streams, on terraces, and on mountain side-slopes from lower to upper one-third slope positions. POC shows adaptability to a wide range of summer evapo-transpiration stress, from very high humidities along the coast to very low summer humidities inland. Soils where POC is found are derived from many parent materials, including sandstone, schist, phyllite, granite, diorite, gabbro, serpentine, peridotite, and volcanics.

Of these, serpentine- and peridotite-generated soils form a distinct group known as ultramafics. Ultramafics are generally droughty environments distinguished by a soil imbalance of the magnesium-to-calcium ratio—an environment is associated with rare plant species. POC is among the few tree species that can grow on these soils; in some cases it is the only tree species tolerating this peculiar environment.

POC plant associations therefore characterize the broad range of habitats in which POC is found. These plant communities display some of the richest plant species diversity of all forest types in the region (Jimerson and Creasy 1991).

POC can be found with a variety of species with differing ecological requirements. These species differ across the range of POC. For instance, in the northwestern portion of the range, POC is found in association with western hemlock (*Tsuga heterophylla* (Raf.) Sarg.), in the southwest with coastal redwood (*Sequoia sempervirens* (D. Don) Endl.) and tanoak (*Lithocarpus densiflora* (H. & A.) Rehd.), in the central portion with Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco.), and at higher elevations in the eastern portion of its range with white fir (*Abies concolor* (Gord. & Glend.) Lindl.), western white pine (*Pinus monticola* Dougl.), Shasta red fir (*Abies magnifica* var. *shastensis*) and mountain hemlock (*Tsuga mertensiana* (Bong.) Carr.). POC has been noted as a major or prominent component of 90 plant associations in Oregon and California (Atzet et al. 1996; Jimerson and Daniel 1994; Jimerson et al. 1995; Jimerson et al. 1996; Jimerson and Creasy 1997).

The estimate of 306,781 acres of POC occurring throughout its range was derived using GIS mapping of all stands containing POC regardless of stocking level. This section of the SEIS, however, focuses on the 64 plant associations where POC is prominent in the overstory. This includes all POC plant associations (those with POC in their name), and as well as a few others where POC is common. The area covered by these plant associations is approximately 130,000 acres, or about 42 percent of the total mapped POC acres. Unless otherwise noted, discussion in this section covers only those acres.

Ecoregions/Subsections

The wide ecological amplitude of POC is also reflected in the broad ecoregions and subsections in which it is distributed. At this scale, climate and geomorphology, rather than vegetation or soils, are the primary environmental variables used to delineate ecological units (McNab and Avers 1994; Jimerson et al. 2003; Winthers et al. 2003).

Two types of ecological units were used to describe the distribution of POC, level IV ecoregions in Oregon (USEPA 1998) and subsections in California (USDA 1997). These are the lowest division of regional ecosystems mapped in the two states. Ecoregions and subsections are configured and delineated differently because they are based on two different methods of mapping ecosystems. Land use or human disturbance is used as a factor in separating ecoregions (USEPA 1998), while subsections are separated by differences in attributes of the environment (Winthers et al. 2003). The ecoregions and subsections are shown on Map 3 and characterized in the following section. Note in the discussion that follows the ecoregions/subsections have been grouped into six larger geographic areas.

Northern Coast Geographic Area

Mid-Coastal Sedimentary and Southern Oregon Coastal Mountains Ecoregions. The Northern Coast geographic area is composed of the Mid-Coastal Sedimentary and Southern Oregon Coastal Mountains Ecoregions. Part of the Oregon Coast Range, these ecoregions are in low elevation mountains with high rainfall and dense coniferous forests. It has moderately sloping, dissected mountains and sinuous streams. The most important characteristic in terms of species composition is the occurrence of western hemlock as a dominant or codominant species. Ten plant associations with POC were identified in these ecoregions, and five were found only in these ecoregions.

North Inland Geographic Area

Inland Siskiyous and Siskiyou Mountains Ecoregions. The Inland Siskiyous and Siskiyou Mountains Ecoregions together form this geographic area. This area has higher, steeper terrain than the others. The North Inland has a high diversity of conditions, which is reflected in the vegetation. The vegetation is dominated by the Douglas-fir Series at low elevations, Jeffrey Pine Series on ultramafic soils, and White Fir and Red Fir Series at higher elevations. Sixty-two plant associations with POC were identified in this ecoregion and subsection, and many are exclusive or have their greatest extent here.

Mid-Coast Geographic Area

Coastal Siskiyous Ecoregion. This geographic area is located in Oregon and features highly dissected mountains and high gradient streams, as well as a few, small, alpine glacial lakes. The climate is wetter with more maritime influence than elsewhere in the Klamath Mountains Bioregion, but drier than the Northern Coast. This area has tanoak, Douglas-fir, and some POC. Western hemlock is less well represented here than in the Northern Coast. Nine plant associations were identified in this ecoregion that contain POC, with a high frequency of plant associations on serpentine soils.

Mid-Range Geographic Area

The Serpentine Siskiyous/Gasquet Mountain Ultramafics Ecoregion. This ecoregion is dominated by the Tanoak-Port-Orford-cedar Subseries (POC is codominant with tanoak). In Oregon, the White Fir Series and the Port-Orford-cedar-White Fir Subseries are fairly common and occur at relatively high elevations (up to 4,800 feet) and a long distance inland (up to 45 miles). The Port-Orford-cedar-Douglas-fir and Port-Orford-cedar-Western White Pine Subseries are more common in California, the latter being correlated with ultramafic rock. This ecoregion is highly diverse.

The Western Jurassic Subsection. Marine air moderates temperatures in the western portion of this subsection creating a temperate to humid climate. The Douglas-fir and Tanoak Series dominate this subsection. Twenty-two plant associations with POC are described in this subsection, none are found only here. This subsection has the second highest amount of POC of all subsections in Northern California.

Note: In the discussion and tables presented in this document, the Mid-Range and North Inland geographic areas are separated into Oregon and California components so that the effects of the alternatives are more clearly presented.

East Disjunct California Geographic Area

Some of the POC plant associations in East Disjunct California are found nowhere else.

Eastern Klamath Mountains. This subsection is located on the farthest southeastern corner of the Klamath Mountains. It has two plant associations with POC; neither is unique to this subsection.

Lower Scott Mountains. This subsection comprises the low elevation portion of the Eastern Klamath geologic belt of the Klamath Mountains. Ultramafic rocks of the Trinity Terrane and intrusions of granitic rocks dominate the geology of this area. The Jeffrey Pine, Ponderosa Pine, White Fir, and Douglas-fir Series are the dominant vegetation in this subsection. Five POC plant associations are present.

Upper Scott Mountains. This subsection comprises the high elevation portion of the Eastern Klamath geologic belt of the Klamath Mountains. The geology is the same as the Lower Scott Mountains Subsection. Thirteen plant associations with POC are found here, seven are unique to this subsection, and three additional POC plant associations are predominantly found here.

Southern Range Geographic Area

POC occurs only along the border of these subsections with the Mid-Range and North Inland geographic areas.

The Eastern Franciscan. The Eastern Franciscan Subsection represents the high elevation portion of the northern California Coast Ranges. There are 16 POC plant associations in this subsection. None of the plant associations are unique to the subsection, and most are extensions of what is found in the Gasquet Mountain Ultramafics, Western Jurassic, and Siskiyou Mountain Ecoregions and Subsections.

Pelletreau Ridge. This subsection is a narrow, arcuate strip of land along the southwest edge of the Klamath Mountains. POC stands here are 20 miles south and 50 miles west of the nearest other stands of POC, although there are no unique plant associations here. The vegetation in this region is dominated by Douglas-fir and Tanoak Series, with White Fir Series at higher elevations (Miles and Goudy 1997).

Rattlesnake Creek. This is also an arcuate subsection that is within the Western Paleozoic and Triassic Belts of the Klamath Mountains. The Douglas-fir, White Fir, and Ponderosa Pine Series dominate this subsection, with Jeffrey Pine Series on serpentinized peridotite (Miles and Goudy 1997). This subsection has a very small amount of POC. There are no POC plant associations that are unique or reach their greatest extent here.

Ecosystem Functions of Port-Orford-Cedar

Biodiversity is the variety of life and its processes. This section discusses these processes; the next section focuses on the diversity of POC ecosystems.

The 64 documented plant associations with POC as a major component can be grouped by key ecosystem processes (Table 3&4-11). The first useful division is ultramafic versus nonultramafic soils. These can be further divided into riparian (adjacent to watercourses, including ephemeral streams) sites and upland sites. A summary of these plant association groups can be found in Table 3&4-11, and their estimated acreages in Table 3&4-12. Note that *plant association group* here is defined somewhat differently than in conventional plant

Table 3&4-11.—*Number of plant associations containing Port-Orford-cedar by geographic area and plant association group*

	Geographic area						
Plant association group	Northern Coast	Mid-Coast	Mid-Range Oregon	North Inland (OR/CA)	Mid-Range California	Southern Range	East Disjunct California
Upland	10	4		16	2	2	1
Ultramafic upland	1	5	17	9	19	11	
Riparian [1]				1	7	1	6
Ultramafic riparian			1	1	11	6	3

[1] Riparian zones were not specifically sampled to develop the plant association classification in Oregon, hence the paucity of riparian associations for Oregon.

Table 3&4-12.—*Estimated acreages of stands with Port-Orford-cedar prominent in the overstory by geographic area and plant association group* [1]

	Geographic area							
	Oregon				California			
Plant association group	Northern Coast	Mid-Coast	Mid-Range	North Inland	North Inland	Mid-Range	South-ern Range	East Disjunct
Upland	24,863	6,072	920	3,082	1,150	1,196	69	92
Ultramafic upland	5,561	9,380	10,854	5,695	2,010	2,010	1,005	201
High-risk riparian	13,243	3,526	0	3,403	1,107	1,107	82	164
High-risk ultramafic riparian	2,100	8,600	7,800	8,300	2,700	2,700	1,000	70
High-risk upland [2]	6,085	6,181	4,710	5,266	1,896	1,282	430	117
High-risk total	21,430	18,310	12,510	16,970	5,700	5,089	1,512	351
% of total infected	47	66	64	83	82	73	70	67
Area totals	45,767	27,578	19,574	20,480	6,967	7,013	2,156	527
Grand total								130,062

[1] See text for discussion of how acreages were estimated; grand total estimated area is 130,062 acres [42% of total acres with at least one POC].
[2] Included in upland or ultramafic upland.

association group maps. In the latter, plant association groups are grouped more as a unit of vegetation classification, and less by landforms/geology. Acreages were estimated overlaying the GIS map of POC locations with the ecoregions/subsections (Map 3), and then subtracting the areas where POC is not prominent in the overstory. The proportion of riparian versus upland plant association areas uses estimates developed by Don Goheen (see Relation of Environmental Processes to *Phytophthora lateralis* Infection section that follows), and the acreage of plant associations for ultramafic versus nonultramafic is based on the number of plant associations tallied.

POC comprises on average 27 to 50 percent of the overstory cover in plant associations where it is prominent in the overstory (Table 3&4-13). Usual cohorts on non-ultramafic sites are Douglas-fir and tanoak, although red fir, incense cedar, western hemlock, or other species

Table 3&4-13.—*Average abundance (as indicated by percent cover) of Port-Orford-cedar in plant association groups where Port-Orford-cedar is prominent in the ovestory*

Plant association group	% POC overstory cover	% total overstory cover	POC as % of total overstory cover	% POC understory cover	% total understory cover	POC as % of understory cover
Upland	27	78	27	15	27	56
Ultramafic upland	30	80	38	3	16	19
Riparian	37	87	43	4	14	29
Ultramafic riparian	37	74	50	6	15	40

are also possible. On ultramafic sites, cohorts are usually limited to Jeffrey pine, tanoak, or western white pine. POC trees are very long lived. Jimerson and Daniel (1994) found an average age of 352 years on study plots, with most trees in the 326-to-425-year age-group. Disturbance (other than from PL) is from infrequent fire events, because of the continually wet environment.

Tree understory abundance of POC is generally low in northwestern California (averages 4 percent cover) and greater in southwestern Oregon (averages 31 percent cover). Abundance varies with available moisture, with greater cover in moister environments.

Ultramafic Functions

Ultramafic POC ecosystems make up varying portions of the seven geographic areas, ranging from 17 percent of the major POC plant associations in the Northern Coast geographic area to 95 percent of the Mid-Range Oregon geographic area (the primary ultramafic region). POC on average makes up 38 percent of the overstory on ultramafic upland sites and 50 percent of ultramafic riparian sites (Table 3&4-13).

POC is associated with rare plants of ultramafic systems. Because it is often one of the few, or only, tree species that can tolerate these sites, POC probably has a key role in maintaining their function through shading and stabilizing soils. POC also recycles calcium on these sites, making it more available to other species (Zobel et al. 1985).

POC lost to PL in riparian zones would gradually be replaced by those of other conifer species in some riparian areas, and not in others. Down wood recruitment of POC into streams would increase as areas become infested, because tree mortality would accelerate, but eventually be lost in infested areas because large POC trees would eventually die out.

Riparian Functions

POC has a keystone role in many riparian ecosystems. Where present, it plays a role in maintenance of water quality. In some cases it is the only tree species contributing to woody structure in streams; in others it occurs in a mix of species. It can provide shade and thereby lower stream temperatures. It may also provide bank stability, and when it dies and falls into the stream, aquatic structure. These factors are key elements of habitat for fish, amphibians, aquatic insects, and other organisms. Since POC is highly resistant to decay, it may be expected to have a longer residence time in streams than other associated conifers. This may be especially important on serpentine soils where POC may be the only, or most abundant, tree species growing on a site.

Terrestrial Woody Material

In additional to its role in aquatic ecosystems, woody material also has a terrestrial role: it provides habitat for scores of animal species, notably insects; facilitates mycorrhizal development; and serves as a long-term nutrient source for soil development. Standing woody material (snags) provide habitat for some bird and mammal species. Woody material, both standing and down, also moderates the immediate microclimate by serving as a moisture source in warm, dry environments. This is important for the establishment of some species.

Natural (not infected with PL) snag and down wood levels for all species are presented in Table 3&4-14. Ultramafic sites showed the lowest density of snags. Upland non-ultramafic sites had the greatest density of down wood. California sites (all associations combined) has the least amount of down wood but the greatest amount of snags, perhaps because of their recent death from PL infection.

In California, the down wood was composed primarily of Douglas-fir and POC, with 13 additional species represented at low percentages. Oregon species composition is probably similar, except in the Coast Range, where western hemlock snags are prevalent.

Because of their resistance to decay, dead POC would be expected to remain in an ecosystem for a longer period of time than most other conifers when the frequency and extent of wildfires are controlled. Because the wood is decay-resistant, woody material is expected to persist longer than that of softer species. This makes their value in riparian zones persist over time, but also means they are less valuable than softer species for wildlife snags, because the harder wood means fewer wildlife cavity excavations.

Relation of Environmental Processes to *Phytophthora lateralis* Infection

Although POC occurs in a wide range of environments, the highest risk of infection is associated with wetlands and riparian zones. PL moves through water easily; on dry sites or in droughty conditions its spores lay dormant. The zone of high risk, however, is restricted to a narrow strip along streams affected by water level in the soil profile. Typically this is 10 to 25 feet on either side of the stream (see Pathology section for further discussion.) POC growing in upland situations usually escapes infection even when the pathogen is established in nearby drainages or wetlands.

The Pathology section describes the percent of POC at high risk, and the 100-year infestation prediction, by risk region. The relationship of the ecoregions and geographic areas to the risk regions is shown in Table 3&4-15, by acres. The risk levels can be generally equated to the geographic areas and ecoregions as follows.

Northern Coast: POC is distributed widely across the landscape. High-risk portions of riparian zones comprise 33 percent of the area where POC is prominent. This area was infested beginning about 50 years ago; the pathogen is widespread, and the infestation rate has nearly stabilized. There are pockets of uninfested POC on high-risk sites (Betlejewski

Table 3&4-14.—*Snags and downed woody material by plant association group* [1]

	Woody material		
Plant association group	Snags per acre	Down wood (ton/acre)	Downed wood (pieces/acre >20" diameter)
Ultramafic upland	6	3.5	1
Upland cool, dry	26	42.3	27
Upland moist	23	56.7	18
California (all associations)	31.4	40.2	17

[1] Data are for Oregon unless other noted; data for riparian associations are not available; values are means.
Source: "Port-Orford-CedarRange-wide Assessment", Ecology chapter [Jimerson et al. 2003].

Table 3&4-15.—*Relationship of ecoregions/geographic areas to Port-Orford-cedar risk regions, in acres for plant associations with Port-Orford-cedar prominent in the overstory*

	Risk Regions [1]					
	Oregon			California		
Ecoregion/geographic area	North Coast	Siskiyou	Inland Siskiyou	Siskiyou	Disjunct California	Totals
Northern Coast						
Mid-Coastal Sedimentary	24,553	1,403	477			26,432
Southern Oregon Coastal Mountains	13,794	5,540				19,335
Total	38,347	6,943	477			45,767
North Inland						
Inland Siskiyous	119	6,041	9,317			15,477
Siskiyou Mountains		1,986	224	7,064		9,274
Umpqua Interior Foothills			229			229
Rogue/Illinois Valleys		57	112			170
Red Butte		1,212	808	3		2,023
Other	34	103		137		275
Total	153	9,400	10,690	7,204		27,447
Mid-Coast						
Coastal Siskiyous	909	24,131	2,539			27,578
Total	909	24,131	2,539			27,578
Mid-Range						
Serpentine Siskiyous		14,170	1,253			15,423
Gasquet Mountain Ultramafic		14		4,215		4,229
Western Jurassic		1,110	22	5,803		6,935
Total		15,117	1,275	10,017		26,587
Southern Range						
Eastern Franciscan				1,662		1,662
Pelletrean Ridge				436		436
Rattlesnake Creek				65		65
Total				2,156		2,156
East Disjunct California						
Eastern Klamath Mountains					1	1
Lower Scott Mountains					83	83
Upper Scott Mountains					443	443
Total					527	527
Grand totals	39,409	55,591	14,981	19,377	527	130,062

[1] See the Pathology section.
[2] Percent high risk is from the Pathology section.

and White, *personal communication*), but it seems only a matter of time before most are infected. Most original cedars in infested high-risk sites have been killed (general estimate is 90 percent). The rest of POC on this landscape (67 percent) can be considered upland, and about 6,000 acres of this is high risk.

Mid-Coast, Mid-Range in Oregon and California, Southern Range, and East Disjunct California. PL has not been here as long as in the North/Mid-Coast. Many POC areas, particularly those in the upper part of drainages, have not yet been infested. POC is more closely associated with riparian zones than in the northern part of its range.

North Inland (Siskiyou Mountains). Riparian areas cover about 55 percent of the POC area where POC is prominent in the overstory, but in much of this area about 85 percent of the area is at high risk. The additional risk comes from the relatively dense road network of this ecoregion. Roads facilitate spread of PL by mud adhering to vehicles, horses, and wildlife.

Diversity

Plant species diversity. As with the classification and mapping of ecosystems, diversity can also be organized at multiple scales. When POC plant association data for the entire range are considered, species diversity within POC stands is exemplified by the high number of species found per layer.

In the overstory tree layer alone, 29 species are identified. The shrub layer included 93 species, and the forb layer 446 species. The total of 568 is considered the rangewide species richness (number of species) in the 90 plant associations in which POC is prominent. Members of the tree and shrub layers are considered indicator species (meaning that they are closely and consistently associated with environmental thresholds where moisture, elevation, etc., changed and were associated with different ecosystems). Species found in the shrub and forb layers help define the major and minor environmental gradients (changes in environmental variables over space) and are used in the plant association classifications.

This high species diversity is typified by the wide ecological gradients in which POC and its associated species are found. Data analysis has shown elevation, ultramafic soils, microposition, moisture, temperature, and solar radiation to all have correlations with distribution of POC.

The wide environmental gradient included within the POC communities is indicated by the work of Millar et al. (1991) (see Genetics section) using allozyme research to represent genetic diversity. The wide range of associated species help to define the major environmental gradients used to describe vegetation series and subseries.

Plant series and plant association diversity. POC has a wide ecological amplitude (that is, it occurs over a wide range of environments). The species overlaps with portions of the ranges of Douglas-fir, White Fir, Jeffrey Pine, and Western White Pine Series and in portions of the environmental range of the Tanoak, Western Hemlock, and Shasta Red Fir Series.

Multivariate statistical analyses of data from plots in Oregon and California from the Port-Orford-cedar Series have resulted in a classification with 64 plant associations with POC as a major overstory species (Atzet et al. 1996; Jimerson and Daniel 1994; Jimerson, et al. 2000).

Vascular plant species richness (number of species) is presented by plant association group and geographic area in Table 3&4-16. The table also shows the within-plant association-group richness as a percentage of regional species richness.

POC plant associations occur in environments where POC is better adapted to survival than other tree species. The overall range of POC, however, includes plant associations from other plant series: western hemlock, Douglas-fir, Jeffrey pine, tanoak and white fir. The species itself is more widely distributed than would be suggested by examining only the series distribution.

Port-Orford-Cedar Plant Associations with Unique Species and Regional Endemic, Rare, or Sensitive Plants

POC plant associations contain unique species and regional endemic, rare, or sensitive plants. At least 30 plant species considered sensitive in FS Regions 5 and 6, of special status to the BLM, or rare by the California Native Plant Society (Skinner and Pavlik 1994) and the Oregon Natural Heritage Program (2001), are found in plant associations that contain POC. (In addition to the discussion below, sensitive, listed, and other rare species are discussed in the Botany section in this chapter, or in the draft biological evaluations in Appendix 7.) Eleven of these rare or unique plant species are found only within POC plant associations, predominantly on wetland/seep or riparian areas. Plant associations with the highest diversity of rare plants are those that capture microhabitat extremes, from continually wet soils to dry soils in exposed sites. The plant association with the highest number of rare plants is Port-Orford-cedar-California Bay/ Evergreen Huckleberry.

A majority of rare or sensitive plants in POC associations occupy habitats with surface (perennial or intermittent) or sub-surface water in the form of spring or seep flow. The

Table 3&4-16.—*Species richness of plant associations containing Port-Orford-cedar by geographic area and plant association group (in average number of plants)*

Plant association group	Geographic Areas [1]						
	Northern Coast	Mid-Coast	Mid-Range Oregon	North Inland	Mid-Range California	Southern Range	East Disjunct California
Upland	26.7 [101]	23 [210]	21 [88]	32.0 [480]	22.5 [67]	No data	24.7 [14]
Ultramafic upland	No data	29.0 [93]	22.6 [308]	24.6 [382]	23.4 [248]	23.9 [284]	No data
Riparian	No data	No data	No data	No data	30.7 [17]	24.2 [31]	25.5 [15]
Ultramafic riparian	No data	No data	No data	23.0 [30]	15.3 [169]	20.0 [51]	21.6 [24]

[1] The first four geographic areas listed are in, or partly in, Oregon; the remaining are in California. Riparian zones were not specifically sampled to develop the plant association classification in Oregon; hence, the lack of data for these groups.

unique California pitcher plant (*Darlingtonia californica*) is the most commonly noted hydrophytic species, followed by California lady's slipper (*Cypripedium californicum*). These species are endemic to serpentine wetlands (fens, riparian areas, seeps) and are represented in various associations across the range of POC.

In comparison to the California pitcher plant and California lady's slipper, there are other wetland species associated with POC that are more localized in their distribution. For example, the narrow endemic Western bog violet (*Viola primulifolia* var. *occidentalis*) occurs in fens and other serpentine wetland habitats in the Gasquet Mountain Ultramafic Subsection in California and Oregon. The large-flowered rush lily (*Hastingsia bracteosa*) is a narrow endemic found in the Eight Dollar Mountain area of the Siskiyou Mountain Ecoregion of Oregon. It occurs in riparian and wetland settings along with Oregon willow herb (*Epilobium oreganum*) (Kagan 1990a, 1996). Waldo gentian (*Gentiana setigera*) is found in the gently-sloping serpentine wetlands across the Gasquet Mountain Ultramafic Subsection, Coastal Siskiyou Ecoregion of Oregon, and the Siskiyou Mountain Ecoregion of Oregon. Waldo gentian is also found in two, high elevation associations: Port-Orford-cedar-Shasta-Red Fir-Brewer's Spruce/Sadler Oak-Huckleberry Oak and Port-Orford-cedar-Shasta Red Fir/Sitka Alder-Sadler Oak. This occurrence of Waldo gentian in montane habitats has been noted by Kagan (1990b) in his management guide for this species. POC plant associations in the Lower and Upper Scott Mountain subsections of eastern California support rare plants distinctive to this area including Scott Mountain phacelia (*Phacelia dalesiana*), showy raillardella (*Raillardella pringlei*), and crested potentilla (*Potentilla cristae*).

Effects of the Alternatives

Because infection with PL eventually leads to death of POC, the reduction of this species will have effects on ecosystems. Overstory trees will be killed in infested areas. Jimerson and Daniel (1994) found the average age of most overstory trees to be 326 to 425 years, so replacement of "in kind" dead overstory will take a long time. Understory POC trees are likely to persist over time, but it is unlikely they will grow into the overstory in infested areas unless they are resistant to PL.

Table 3&4-17 illustrates the anticipated infestation, in acres, of POC from ecosystems in each of the six geographic areas. Estimates are further segregated by plant association group, to illustrate the effects on ultramafic and riparian areas. The acres shown are only for those plant associations where POC is prominent in the overstory. Additional infestation acres (see Pathology section) are not included here.

In this section, the projected acreage losses by alternative are presented, followed by their effects on key ecosystem functions.

Note: Regarding riparian zones—PL has a higher rate of infestation in riparian zones than in other areas. The zone of high risk, however, is restricted to a narrow strip along streams affected by water level in the soil profile. Typically this is 10 to 25 feet on either side of the stream. For all purposes in this effects section, this is the riparian zone referred to, not broader zones as in Northwest Forest Plan documentation. Areas in Table 3&4-17 are also based on this definition. See the Pathology section for further discussion.

Table 3&4-17.—*Predicted infestation acres in 100 years by subdivisions of plant association groups* [1]

	Geographic area								
	Oregon				California				
Plant association group	Northern Coast	Mid-Coast	Mid-Range	North Inland	North Inland	Mid-range	South-ern Range	Disjunct California	Totals
Existing condtions									
Upland	18,778	6,072	920	3,082	1,150	1,197	69	92	37,444
Ultramafic upland	5,561	9,380	10,854	5,695	2,010	2,010	1,005	201	36,716
Riparian	13,243	3,526	0	3,403	1,107	1,107	82	164	22,632
Ultramafic riparian	2,100	8,600	7,800	8,300	2,700	2,700	1,000	70	33,270
High-risk upland [2]	6,085	6,181	4,710	5,266	1,896	1,282	445	117	25,982
Total high risk	21,428	18,307	12,510	16,969	5,703	5,089	1,527	351	81,884
High risk as % of total	47	66	64	83	82	73	70	67	63
Area totals	45,767	27,578	19,574	20,480	6,967	7,013	2,156	527	130,062
Alternative 1									
Upland	0	0	0	0	0	0	0	0	0
Ultramafic upland	0	0	0	0	0	0	0	0	0
Riparian	12,233	2,085	0	1,873	829	235	35	76	17,366
Ultramafic riparian	1,963	5,125	4,580	4,558	2,007	2,895	470	32	21,630
High-risk upland	1,208	1,477	1,087	1,709	350	235	200	53	6,319
Total infested	15,404	8,687	5,667	8,140	3,186	3,365	705	161	45,315
Percent of total infested	34	31	29	40	46	48	33	30	35
Alternative 2									
Upland	0	0	0	0	0	0	0	0	0
Ultramafic upland	0	0	0	0	0	0	0	0	0
Riparian	11,744	1,954	0	1,729	783	222	34	78	16,544
Ultramafic riparian	1,885	4,803	4,397	4,211	1,896	2,736	451	33	20,412
High-risk upland	1,160	1,384	1,044	1,579	331	222	192	55	5,967
Total infested	14,789	8,141	5,441	7,519	3,010	3,180	677	166	42,923
Percent of total infested	32	30	28	37	43	45	31	31	33

	Geographic Area								
	Oregon				California				
Plant association Group	Northern Coast	Mid-Coast	Mid-Range	North Inland	North Inland	Mid-range	South-ern Range	Disjunct California	Totals
Alternative 3									
Upland	0	0	0	0	0	0	0	0	0
Ultramafic upland	0	0	0	0	0	0	0	0	0
Riparian	10,362	1,592	0	1,378	647	185	31	71	14,266
Ultramafic riparian	1,663	3,913	3,461	3,355	1,569	2,274	407	30	16,672
High-risk upland	1,023	1,128	822	1,258	274	185	173	50	4,913
Total infested	13,048	6,633	4,283	5,991	2,490	2,644	611	151	35,851
Percent of total infested	28	24	22	29	36	38	28	29	28
Alternatives 4 & 5									
Upland	0	0	0	0	0	0	0	0	0
Ultramafic upland	0	0	0	0	0	0	0	0	0
Riparian	15,177	3,181	0	2,934	1,209	336	42	97	22,976
Ultramafic riparian	2,436	7,820	7,107	7,145	2,930	4,133	557	41	32,169
High-risk upland	1,499	2,253	1,688	2,680	512	336	237	69	9,274
Total infested	19,112	13,254	8,795	12,759	4,651	4,805	836	207	64,419
Percent of total infested	42	48	45	62	67	69	39	39	50

[1] Does not include acres restored with resistant stock.
[2] Included in upland or ultramafic upland.

Riparian zone acres in Table 3&4-17 are proportional to the estimate of the relative abundance of riparian plant associations in the geographic areas, based on sample sizes of the plant associations in Atzet et al. (1996) and Jimerson and Daniel (1994).

Effects Common to All the Alternatives

Because implementation of this SEIS would not directly affect areas in California, for these areas all alternatives are expected to show the same effects as for Alternative 1 (the current course of action). As discussed in the Cumulative Effects section earlier in this chapter, slight increases or decreases from these numbers could be expected if the Oregon units select an alternative substantially different than the current direction in California. Those differences are too small to be reflected in this analysis.

Alternative 1

This alternative is the current course of action under existing standards and guidelines. Based on the assumption that 15 percent of the Coos Bay/Powers administrative areas are currently infested, and 9 percent of all other areas are infested, it is estimated 25,700 acres of stands where POC is prominent are infested within the range of POC. the range of POC are infested. Under Alternative 1, the estimated area infested in 100 years would be 45,300 acres, or 35 percent of the acres where POC is prominent. The estimated acreage for each geographic area under Alternative 1 (as well as the other alternatives) is displayed in Table 3&4-17. Acreage estimates are based on the assumption of moderate to heavy (depending on geographic area) percent of area affected in riparian zones, versus little or no infestation on upland areas (see Pathology section). Infestation estimates are primarily based on the density of streams and roads, and in California, by the closer relationship of POC to riparian zones. The North Coast and Mid-Coast areas have relatively high rainfall and stream densities compared to the other areas. The Mid-Coast, Mid-Range, and North Inland (in Oregon) areas were assumed to have high road densities, and hence, more areas affected by PL.

Alternative 2

This alternative adds a risk key to add more consistency to the application of prescribed mitigation measures. The projection of the infested acres 100 years from now is 42,900 acres, or 33 percent of the acres where POC is prominent, not substantially different from the 35 percent estimated infestation for Alternative 1. This is true for all the geographic areas as well.

Alternative 3

This alternative includes the standards and guidelines from Alternative 2 and adds additional direction for activities in 32 currently uninfested 6th field watersheds, primarily in the North Inland geographic area. The projection of the infested acres 100 years from now is 35,850 acres, or 28 percent of the acres where POC is prominent. This alternative is the most effective at maintaining the diversity and abundance of plant associations of the alternatives considered. Alternative 3 will provide the highest probability of retaining intact POC ecosystems with all ages of trees represented.

In Oregon, this alternative would have little additional effect on the Northern Coast geographic area (when compared with Alternative 2) because there are no uninfested 6th field watersheds in this area. Throughout the other Oregon geographic areas, reductions in infested areas averaging 6 to 8 percent would be effected (when compared with Alternative 2) if this alternative is adopted.

Alternatives 4 and 5

Alternatives 4 and 5 remove active POC management measures, and variously rely on the use of genetically-resistant POC stock for restoration planting. These alternatives are projected to lead to the greatest infestation of POC—64,400 acres at 100 years, or 50 percent of the acres where POC is prominent. As with other alternatives, the least effect would be on the Northern Coast, projected to receive a 2 percent decrease in POC, relative to Alternative 1. Effects on the Mid-Coast, Mid-Range, and North Inland in relation to Alternative 1 would be larger: 12 percent, 12 percent, and 17 percent, respectively, above the amount projected with Alternative 1.

In general, Alternative 3 would lead to the least reduction of POC from ecosystems, Alternatives 4 and 5 the most, and Alternatives 1 and 2 would be in between. This pattern follows for all the effects on ecosystem functions that follow. These effects do not consider replanting with resistant stock.

Effects on Ultramafic Ecosystems

Ultramafic POC ecosystems make up varying portions of the seven geographic areas, ranging from 17 percent of the North Coast to 95 percent of the plant associations where POC is prominent in the Mid-Range Oregon geographic area (the primary ultramafic region). POC on average makes up 38 percent of the overstory on ultramafic upland sites and 50 percent of ultramafic riparian sites (see Table 3&4-13). Alternative 3 would lead to the most conservation of these areas, Alternatives 4 and 5 the least, and Alternatives 1 and 2 somewhere in between.

Where there is a reduction of POC, particularly in riparian zones, there would be a change in ecosystems. On ultramafic sites, POC is much less likely to be replaced by other tree species (White, *personal communication*; Ollivier, *personal communication*). Instead the shrub layer would be expected to increase. The POC roles of providing shade for understory plants and providing downed wood for a long-term source stream structure would be reduced. Because the species is very long-lived, replacing old trees with seedlings could require hundreds of years to achieve the same level of forest structure where POC is lost from the ecosystem.

Riparian Effects

Loss of POC would affect downed wood structure in streams. As stated in the previous section, other species are not likely to replace all POC, particularly on ultramafic sites and those that might be less valuable as riparian downed wood. Study sites along the Smith River in California showed increased amounts of red alder following the death of POC. This would provide abundant shade in the short term. Alder downed wood, however, decays relatively rapidly and is typically of small diameter. Alder logs typically persist 1 to 2 years, while those of conifers last for decades. (Ollivier, *personal communication*). In areas where alder did not invade rapidly, stream shade would be reduced, possibly leading to increased stream temperatures in streams not snow-fed. This in turn might have deleterious effects on fish, including anadromous salmonids where present. The potential for such effects is discussed in detail in the Water and Fisheries section.

Large conifer downed wood in the Smith River was found to provide much of the habitat complexity for amphibians and other organisms (Ollivier, *personal communication*). Presumably this is also true throughout the range of POC.

When POC is logged to reduce spread of PL, other merchantable trees are also often removed. This can set back recruitment of large conifer downed wood for decades (Ollivier, *personal communication*). Current aquatic conservation strategy guidelines, however, would prohibit logging in most riparian zones with POC.

Loss of POC in the aquatic ecosystem would be most deleterious in the Mid-Coast, Mid-Range Oregon, and North Inland Oregon geographic areas where the highest proportion of riparian areas feature POC. These areas also have a high proportion of ultramafic areas, where POC is particularly important because other tree species are often less available. It would be least deleterious in the Northern Coast, where western redcedar may be able to fulfill some of the downed wood role. Western redcedar is not abundant in the other geographic areas.

Snags and Downed Wood

Snags and downed wood have largely been detailed in the previous Riparian Effects section. The value of POC snags for terrestrial wildlife is probably less than other conifer species, because of the hard nature of the wood. Its primary value is in providing downed wood for aquatic systems.

Plant Diversity

Effects on plant diversity are detailed in the Botany section. One note, however, is the presence of the Port-Orford-cedar/Shasta-red-fir/Brewer's spruce/Sadler oak-Huckleberry oak association in the North Inland geographic area. Tests have shown the POC in this association to have the highest percentage of resistant trees (Betlejewski, *personal communication*). Conservation of this association, which is known to occur on only a few high elevation sites, would have value as a potential source of material for producing disease-resistant seedlings.

Structural and Landscape Diversity

Species loss is driven by habitat loss. Reduction of POC in high-risk areas across the landscape will reduce diversity at both local and broad scales, leading to a more homogeneous landscape. Such a landscape is less resilient (if POC is greatly reduced on the landscape, species or ecosystems may be less resilient to change) (Lindenmayer and Franklin 2002). For example, if western redcedar were to replace POC on some sites, and redcedar itself one day becomes vulnerable to a pathogen (such as Sudden Oak Death), the ecosystem will be more affected than if POC were still present.

Botany

Affected Environment

POC is found from southwestern Oregon to northern California, primarily in the Coast Range, Siskiyou and Klamath Mountains. There is a small disjunct population in the Scott Mountains of California (see Figure 1-1). The following discussion is organized by the same geographic grouping of plant associations as the Ecology section, to capture the range of threatened and endangered species, plant diversity, and ecosystem functions. POC has a narrow geographic range, and occupies variable and different habitats.

Northern Coast comprises the mid-Coastal Sedimentary and Southern Oregon Coastal Mountains Ecoregions. This area has lower elevation, higher rainfall, and dense coniferous forests. *Lilium occidentale* (western lily) is found in openings within stands of POC (Brian [Date.]; Segotta [Date.]). *Note:* See accompanying biological evaluation for identification of which species in this discussion are state or federally listed as threatened or endangered.

North Inland includes the Inland Siskiyou and Siskiyou Mountains Ecoregions. Conditions here are highly varied, and the area has high species diversity. Many rare plants are endemic or have their greatest extension here, such as *Castilleja miniata* ssp. *elata*, *Epilobium oreganum, Darlingtonia californica, Cypripedium californicum, Gentiana setigera, Hastingsia bracteosa* var. *atropurpurea, Hastingsia bracteosa* var. *bracteosa, (*Lang and Zitka 1997), *Viola primulifolia* var. *occidentalis,* and *Smilax jamesii* occur from Smith River to Eight Dollar Mountain with the highest number of rare species along Josephine Creek and Eight Dollar Mountain. *Note:* Rare in this context includes unique, locally endemic, narrow ecological amplitude, Agency sensitive, and state or federally listed as threatened or endangered. These sensitive species share *Darlingtonia* fens or streams in ultramafic soils with POC.

Mid-Coast comprises the Coastal Siskiyou located in Oregon; it is an area with rugged mountains and high gradient streams, and a few alpine glacial lakes. This area has higher precipitation rates, with *Darlingtonia californica, Cypripedium californicum,* and *Gentiana setigera* associated with serpentine wetlands from Gasquet Mountain Ultramafics, Serpentine Siskiyous to Coastal Siskiyous.

Mid-Range includes the Serpentine Siskiyou/Gasquet Mountain Ultramafics of California Ecoregions and the Western Jurassic subsection. POC is found at higher elevation in this highly diverse ecoregion. POC here is also found in drier peridotite soils, which is also the preferred habitat of *Arabis macdonaldiana* (Vorobik), endangered rock cress. *Arabis macdonaldiana* grows in the barest unoccupied peridotite rock, at the most sharing these microsites with Idaho fescue and sedums. Jeffrey pine does well in this habitat type, and could increase its presence in the absence of POC (Brian). These ecoregions have extensive fens, from very small seeps to hanging fens that run for more than a mile on the side of the mountain, especially on Oregon Mountain and Rough and Ready Creek.

The Western Jurassic subsection is moderated by marine air creating a temperate to humid environment, making this subsection the second highest in POC abundance. *Arabis macdonaldiana* occurs on peridotite in openings within POC stands.

East Disjunct California includes the Eastern Klamath Mountains and Lower Scott Mountains subsections where sensitive species like *Balzamorhiza sericea*, *Chaenactis suffrutescens, Epilobium oreganum, Erythronium citrinum* var. *rodereckii, Ivesia pickeringii, Penstemon filiformis, Phacelia leonis,* and *Smilax jamesii* occur*;* and the Upper Scott Mountains subsection which is home to *Arctostaphylos klamathensis, Epilobium siskiyouensis*, *Minuartia stolonifera, Phacelia dalesiana*, *Phacelia greenei, Potentilla cristae, Raillardella pringlei,* and *Smilax jamesii* (Nelson). The three areas share the same geologic pattern.

Southern Range includes the Eastern Franciscan, the Pelletreau Ridge, and Rattlesnake Creek subsections. The first represents the higher elevation coastal, the second stands alone, and the third is on peridotite with a small population of POC. The Rattlesnake Creek Terrane is home to *Epilobium oreganum* which here occupies stream areas, meadows, and seeps without *Darlingtonia californica* as an associate species.

There are no federally or state-listed threatened or endangered plants that occur in the riparian zone. The BLM and FS sensitive and other rare plants that occupy and share habitats with POC in general are in good overall condition. Some of them are affected by other activities such as grazing, mining, recreation (especially off-highway vehicles), wildfire, noxious weeds, timber harvesting, roads, and fire suppression (Frost).

Because fire suppression, previously more open fens and some of the riparian areas have been encroached by shrubs and trees that compete with rare vascular plants for space and moisture. This is most evident on the Oregon Mountain and Rough and Ready Creek fens. The upper reaches of Josephine Creek were burned in 1994 by the Mendenhall Fire and back-fired during the 2002 Biscuit Fire. POC's highest benefit to rare vascular plants appears to be providing soil stability and shade. The Days Gulch fen, for example, was affected by the Biscuit Fire and had been burned under prescription twice previously. Erosion was evident because the grass, pitcher plant, and shrubs have been burned without enough time in between the last prescribed fire, Mendenhall, and the Biscuit back-firing to allow for regrowth. Sediment was deposited within the fen, burying a small population of *Epilobium oreganum* where a road culvert slowed runoff.

POC is a prolific seed producer with an estimated 40 million seedlings within the range in both states (Goheen, *personal communication*). However, large old POC trees have a higher value than seedlings to the environment in general, and rare plants in particular. In some areas, POC is a barrier between the recreating public and rare plants, especially off-highway vehicle users. The growth form of POC creates a fence-like barrier with boughs that prevents the public from seeing vulnerable ecosystems like fens or seeps in some areas.

POC forms endomycorrhizae with some fungi (Zobel 1985); most herbaceous plants are endomycorrhizal, but the relationship between POC and vascular plants has not been studied (thus a connection has not been established).

Arabis macdonaldiana occupies peridotite openings in the Gasquet Mountains/Serpentine Siskiyou Ecoregion, sharing similar soil conditions but separate habitats than POC. A dependent relationship has not yet been studied or established.

Effects of the Alternatives

Potential effects to species listed under the "Endangered Species Act" are also discussed in the draft biological evaluation in Appendix 7.

Alternative 1

This alternative is the current management direction for BLM districts and the Siskiyou NF. It seeks to reduce or prevent introduction of the pathogen into disease-free areas by closing roads into these areas during the rainy season to prevent carrying the spores from infested to uninfested areas, analyzing the risk of introduction to disease free areas, developing mitigation measures at the project level, informing the public about the reason for these measures (see Appendix 2), and other provisions.

The effects of Alternative 1 to the botanical environment are varied. The areas with the highest presence of rare plants appear to be free of infestation, with the exception of Whiskey Creek, narrow bands on lower Josephine Creek, and Middle Illinois River. Seasonal road closures prevent the introduction of noxious weeds to rare plant areas when soil conditions are optimal for seed germination. Another positive effect from this alternative to rare plant habitats is vehicle and equipment washing. Washing substantially reduces he probability of introducing noxious weeds. Gates help prevent off-highway vehicle recreation, which has a positive effect on rare plants by decreasing soil disturbance at a time when soil moisture is high and vulnerable to erosion and compaction.

Alternative 2

This alternative is similar to Alternative 1, except that practices currently implemented or recently developed are better described, and a risk key is included for clarification of the environmental conditions that would trigger additional control or mitigation measures. Implementation of disease-mitigating practices is expected to be more consistent because of the key.

The effects of Alternative 2 are similar to Alternative 1. Implementation would reduce the rate of spread of the disease when compared to Alternative 1. Continued development of resistant stock would make stock available for timely replacement in important habitats. Alternative 2 would help maintain a lasting presence of POC in unique plant communities, which seem to be more abundant in high-risk areas.

Alternative 3

Alternative 3 adds additional protection measures to 32 uninfested 6th field watersheds that have at least 100 acres occupied by POC. It divides these watersheds into POC cores and buffers and applies additional standards and guidelines to each to lessen introduction of infection to the POC core areas.

The effects of Alternative 3 are the same as Alternative 2, with the exception of effects within the 32 uninfested watersheds. In these watersheds, the prohibition of harvest and discretionary uses in POC cores would increase the probability of a lasting presence of POC in unique plant communities in these areas. Unique plant communities seem to be more abundant in high-risk areas. Closing roads and lessening off-highway vehicles and other disturbances to rare plant communities would provide other benefits to rare plants through decreased disturbance and decreased weed introductions throughout the watersheds.

Alternatives 4 and 5

Alternative 4 would remove all preventive measures that are currently in place and would speed up the resistance-breeding program to more quickly replace POC killed by the disease with resistant seedlings. Alternative 5 would remove all preventive measures and discontinue development of the resistant-breeding program. Existing resistant seed orchard trees would continue to be used to reforest areas of mortality in breeding zones for which resistant stock is already developed.

The effects of Alternatives 4 and 5 are similar, differing only in the mid and long term where Alternative 4 would deter advancement of the disease by increasing the introduction of resistant stock. Alternative 5 would allow POC to depend on natural resistance to the pathogen, which it has, but at low rates.

These alternatives would allow for faster advancement of the disease compared to the current direction in high-risk areas (see Pathology section). The effect of this high mortality on rare plants is unpredictable. POC is a large component of riparian habitats in areas where it is the largest tree species. It would be logical to infer that the loss of shade and stream bank stability that would result from the loss of POC would have a negative effect on the sensitive and rare plants that are adapted to stream microsites.

In all, there are negative effects to plant communities if POC is killed by PL, yet negative effects of the loss of POC to threatened and endangered plants cannot be determined from the known information.

Water and Fisheries

Affected Environment

The POC range includes southern Oregon coastal watersheds, northern California coastal watersheds, and upper portions of the Willamette Basin, Rogue Basin, and Klamath Basin.

High-Risk Sites

High-risk sites for transmission of PL infestation include water flowing in linear channel features and direct water influence zones including connected off-channel areas and flood-plains. Included are road ditches that link with the stream network and gullies formed from cross-drain runoff that continues downslope until a drainageway is met. Standing water such as lakes, fens, bogs, and topographic depressions with soils exhibiting persistent high water tables may have lower transmission rates, but are in the category as high-risk. The high-risk zone is directly associated with water and is almost always much narrower than the North-west Forest Plan Riparian Reserves.

POC is not normally infected more than 40 feet downslope from roads or trails, except where streams, culverts, wet areas or other roads are present to facilitate further movement (Goheen et al. 1986). As was stated in the previous section on Pathology, the probability of infection downstream is highest when PL inoculum is introduced directly into water at a stream crossing or a ditch and POC with their roots in the water are present downstream within 50 feet. Although a recent dendrochronological study provides evidence of infection beyond 160 feet (Jules and Kauffman 1999), limitations to the study make it impossible to ascertain if the transmission was actually over this distance or resulted from several small tree infec-tions between the initial source of inoculum and the large tree that was studied. In any case, the probability of infection at distances greater than 50 feet is very low (2 to 4 percent).

Streams and Flow Paths

Stream densities vary by physiographic provinces. The Coast Range Province has total stream densities varying from 5.31 to 12.80 miles per mile square, Franciscan Formation has 6.27 to 9.04 miles per mile square, and Klamath has from 4.63 to 9.76 miles per mile square (FEMAT 1993). At a planning level, ephemeral and intermittent streams are in headwaters positions and can be classified as 1st and 2nd order (Strahler 1964). Perennial streams are normally 3rd order or greater where enough drainage area, soils, relief, and other landscape features interact to form a drainage that can support a year round flow. Ephemeral/intermit-tent streams vary from 65 to 80 percent of the stream network, and perennial 20 to 35 percent (FEMAT 1993).

Stream uppermost surface origin or pourpoints expand further up the drainage with the onset of maritime winter storms. As soils become saturated, further precipitation would runoff into ephemeral/intermittent stream channels, which are above the water table. Overland flow may also appear on compacted areas, including road surfaces, landings, quarries, or soils with high surface rock contents. Although infrequent, rapid melt of shallow snowpacks in the intermittent snow accumulation zone (above 2,000 to 2,500 feet) can lead to overland or concentrated flow in certain areas, increasing stream flow paths. Road-stream connections from roadside ditches, and gullies from ditch relief culverts entering a channel, can boost the drainage density substantially. In one study in the Cascades (Wemple et. al 1996) stream density increased from 21 to 57 percent, depending on dynamic expansion with increasing levels of stormflow.

Assessment of Salmonid Stocks

The assessment by Oregon Department of Fish and Wildlife and California Department of Fish and Game of the status of steelhead in southwest Oregon in 1997 found that the Winchuck River had healthy stocks, but others had depressed winter and/or summer runs (Illinois, Pistol, Chetco, and Rogue Rivers). Oregon Department of Fish and Wildlife determined that trends in the Rogue were positive and that the steelhead population was stable and not threatened. Winter steelhead spawners roam, and will migrate to other areas if conditions to spawn are not good in one stream. As a result, production can vary dramatically from stream to stream annually (RVCOG 1997). The National Marine Fisheries Service (NMFS) had ruled by 2001 that Klamath Mountain Province steelhead were not warranted for listing as threatened ([online]URL:http://www.nwr.noaa.gov/).

Steelhead habitat is contiguous with that of coho salmon, and 90 percent of the limiting factors for coho salmon are also limiting for steelhead. Similar habitat problems exist for the two species in the Rogue and South Coast Basins. One important distinction is that coho salmon require deeper pools and more side channel habitat than steelhead for optimal rearing (RVCOG 1997).

The NOAA-Fisheries listed wild southern Oregon/northern California coho salmon as a threatened species in May 1997, and Oregon Coast coho salmon were listed as threatened in August 1998. Southern Oregon Coast/ California Coast chinook salmon were ruled not warranted for listing as threatened by September 1999 ([online]URL:http://www.nwr.noaa.gov/).

Current BLM Manual 6840 provides policy and guidance for the conservation of special status species of plants and animals. Oregon/Washington BLM uses three categories for special status species: Bureau sensitive (BS); Bureau sssessment (BA); and, Bureau tracking (BT). Classification is dependent upon the different state of Oregon or Oregon Natural Heritage Program designations.

Fall chinook salmon (BS) and spring chinook salmon (BA) in the Southern Oregon and Northern California Coastal ESU are on the Oregon/Washington BLM special status species list. Bureau 6840 policy requires that any Bureau action not contribute to the need to list (under the Federal "Endangered Species Act") any species with BS designation (IB-OR-2000-092). The BLM Manual at 6840.01 directs the conservation of special status species by the use of all methods and procedures which are necessary to improve the condition of special status species and their habitats to a point where their special status recognition is no longer warranted.

Salmonid Limiting Factors

Salmonids are frequently used as indicators of watershed health and the impacts of human activities because they have complex life histories and specific environmental requirements. All salmonid species in the project area have similar freshwater requirements. For optimum production, all species require cool flowing waters; free passage through migratory routes; clean gravel substrate for reproduction; water with low turbidity during the growing season for sight feeding; high levels of dissolved oxygen content in streams and within gravel; sufficient instream hiding-cover; and invertebrate organisms for food (USDA-FS 1985).

Steelhead, in particular, serve as an indicator species for the fish and aquatic habitats affected by the proposed action because their freshwater requirements are similar to other salmonids, and their habitat extends further upstream than most. In the Rogue and South Coast basins, which correspond to the Oregon portion of the region and south to the Klamath River in California, there are approximately 6,913 total stream miles of steelhead spawning and rearing habitat. About 1,489 miles are designated as high value winter steelhead spawning areas, involving 61 streams. The proportion of Federal ownership on these 1,489 miles of high value streams is 50 percent, and 27 percent Federal ownership of a total of 245 miles of summer steelhead streams (RVCOG 1997).

The Southwest Oregon Salmon Restoration Initiative (RVCOG 1997) identified the representative priority limiting factors for steelhead streams in the Rogue and South Coast Basins, corresponding to most of the Oregon portions of the Region and south to the Klamath River in California. Low stream flows limit summer rearing habitat, increase water temperatures, and increase competition and the risk of predation. High water temperatures foster disease and diminish food supply. Inadequate riparian habitat was identified because stream canopy over side channels and alcoves provides shade which helps reduce stream temperatures, stabilizes streambanks, serves as holding areas for fry and smolts, and provides a food source for aquatic life. Inadequate levels of instream large woody debris were identified because large woody debris provides shelter for steelhead, creates pools, collects spawning gravel, helps reduce water velocity, and provides hiding habitat. Sediment and erosion were limiting factors, as they affect spawning areas, fishery health, and water quality. Fish passage at road crossings was identified as needing improvement

Aquatic Interactions

Habitat characteristics such as channel form, pool riffle sequence, water temperature, water chemistry, water flow depth, velocity, substrate, and cover are linked to the stream adjacent to riparian areas including large woody debris availability, shading, bank stability, litterfall, and nutrient cycling. Five classes of factors affect aquatic biota; food (energy source), water quality, habitat structure, flow regime, and biotic interactions (Spence et al. 1996).

Soils Limiting Forest Growth

POC in the Inland Siskiyou Region is often associated with dark-colored igneous ultramafic rocks. Ultramafic rocks and soils have higher iron and magnesium nutrient availability that limits tree growth of many species. However, POC thrives in these soils and often is the only species supported. The Gasquet Mountain Ultramafics Ecoregion roughly corresponds to this soils area (USDA-FS and USDI-BLM 2003b). There are approximately 33,000 acres of riparian plant associations with a prominence of POC on these soils (Table 3&4-12).

Ultramafic rocks were derived from sections of the seafloor which were produced at spreading centers and then lifted up onto the continental shelf, instead of being subducted. Less than 1 percent of the United States is underlain by ultramafic material ([online] URL: http://jersey.uoregon.edu/~mstrick/AskGeoMan/geoQuerry23.html). These rocks have a relatively low concentration of silica and oxygen, and are enriched in iron and magnesium. They are not stable at surface temperatures and metamorphose into other forms including serpentine ([online] 6URL:http://jersey.uoregon.edu/~mstrick/GeoTours/Josephine%20Ophiolite/JoOphiolite.html). Soils produced from ultramafic rocks can support rare plants.

Headwater Confined Stream Channels

Channel morphology. Headwater confined stream channels in the POC range would be classified as A, or Aa+ (more than 10 percent gradient on bedrock), channels (Rosgen 1996). Characteristics include: steep gradients (generally greater than 4 percent), vertically contained, width/depth ratios less than 12, relatively straight, and do not spread on floodplains with incremental increases in winter flow. These channels are generally 1st and 2nd order, and usually have steep stream-adjacent hillslopes. Substrates vary from bedrock, boulder, and gravels to fine sediments. These channels are above the water table and based on duration of flow are either ephemeral (stormflow only when soils are saturated) or intermittent (longer duration, but less than all year). Headwater channels collect from small catchments (normally less than 1 mile per mile square) that feed into drainages.

PL inoculum present in the water column may affect POC on streambanks, but not in upslope positions (Goheen D.J., *personal communication*).

Bank stability. Bank erosion is caused by stream power from flow and sediment in the channel that can erode channel margins. Bare banks are more susceptible to erosion (soil grain size and ease of detachability become important). Riparian vegetation acts as hydraulic resistance and binds soil particles. Herbaceous vegetation and trees with a matrix of fine and coarse roots that tend to interlock soils counter erosive forces. In headwater channels, banks can be undercut and cause trees to slide into the channel, but this is less frequent because many channels are laterally confined by bedrock. Some sections of channel are prone to downslope soil creep and delivery of whole trees, debris, and soils. Although tree mortality causes fine roots to decay in a few years, the larger roots last considerably longer (Burroughs and Thomas 1977).

Large woody debris. Large wood accumulates in confined channels and becomes reservoirs for sediment accumulation. Large woody debris creates a step-pool system and dissipates stream energies. Many low order streams accumulate large woody debris and sediment for long periods of time that is removed downstream by episodic transport as debris flows (May and Gresswell, *in press*).

Stream temperature. These channels do not contribute to stream heating, because they are dry during the summer months.

Mid-Drainage to Valley Moderately Confined to Unconfined Stream Channels

Channel morphology. Moderately confined to unconfined stream channels in the POC range would be classified as B, C, and D streams (Rosgen 1996). Stream characteristics include: gradients less than 4 percent and generally less than 2 percent, width/depth ratios greater than 12, and meandering on a variety of substrates moved and deposited by the river (alluvium). Higher winter flows cause spreading within the floodplain, at least on one side of the stream. The streams have active channel widths of 15 to 30 feet for B streamtypes and greater than 30 feet for C and D streamtypes. Floodprone areas can be narrow to hundreds of feet wide. The F channel type, common in the northern part of the POC range, is a larger stream on a flat gradient that does not have a floodplain. These streams to rivers are 3rd order and greater and are mostly perennial. Watershed drainage areas would generally be less than 15 miles per miles sqaure for the mid-drainage B channel types and greater than 15 miles per mile square for the C and D channel type valley streams corresponding to the 7th, 6th, and 5th field hydrologic unit boundaries ([online] URL:http://wwwga.usgs.gov/gis/iag.html).

Aspects of fish habitat that are influenced by channel morphology in these streams include pool frequency, residual pool depth, pool complexity, and the presence of side channels and alcoves.

Stream hydrology. Analysis of stream channel gauging data for southern Oregon shows an approximate 1.5 year bankfull flow would just fill the active channel and not spread laterally, while a 100 year recurrence interval flood would have a depth of 2.0 to 2.2 times the mean depth at bankfull (Fogg J., *personnel communication*). The actual flooding width during large storms would depend on the runoff and channel geometry, slope, and roughness.

Inoculum present in the water column may affect POC on streambanks, and laterally away from the active channel to the depth of runoff for a particular event. Major floods in southweswtern Oregon and northern California with extensive flooding occurred in 1955, 1964, 1971, and 1996.

Bank stability. Banks in low gradient mid-drainage to valley streams can be strengthened by dense root systems from shrubs and trees. However, the streambank can still be easily undercut, particularly on outside of channel bends and may reverse the binding effect of roots. Normally, tree roots are wide and spreading and are not more than a few feet deep. Within the ultramafic areas in these streamtypes much of the bank is armored with durable cobble and boulder material. Where POC trees line the banks, their roots are often undercut, providing instream cover for fish. Since dead POC is resistant to decay, there may be little difference in streambank stability compared to living POC when the overriding forces of streamflow are considered.

Large woody debris. Large wood is recruited from streambanks or transported downstream by debris flows or floatation during high flows. Typical studies in western Oregon (McDade et al. 1989) show that source distance for old-growth conifer has a median distance of 34 feet and 87 percent fall within 82 feet of the stream. Maximum source distance was 198 feet. Furthermore, 11 percent of all woody debris originated from 3 feet of the bank. Fluvial erosion and bank undercutting could be responsible for part of this observed supply. Researchers have shown that for mature and old-growth coniferous forests, that wind and tree mortality are the principal agents in initiating treefall (Lienkaemper and Swanson 1986).

POC large woody debris has tremendous longevity. For example, standing dead cedar in dendrochronology studies was routinely over 100 years old and one snag was dated to 264 years old (Jules et al. 2002). Dead wood that is subject to wetting and drying cycles and microbial decay in air breaks down faster than when buried in streams. In a study in western Washington, 80 percent of coniferous wood added to a channel was depleted within 50 years, although some wood was buried in the floodplain to be exposed centuries later by stream migration and dated at 1,400 years old (Hyatt and Naiman 2000). POC is expected to have long depletion times; much longer than reported for other coniferous species, whether spanning the channel or buried with sediments.

Large woody debris in moderate width B channels adds important structural elements that erode or protect banks, change flow direction and velocity, influence deposition zones, and scour pools. The debris adds cover and complex habitats for salmon and trout. The large woody debris is normally retained if its length is at least 1.5 times the channel width or includes a rootwad on the bank. In larger C and D channels, large woody debris is floatable and is moved downstream and can become embedded in jams. The debris is lodged near the high waterline on the outside of channel bends or on mid-channel bars and can initiate meander cutoffs. Secondary channel systems formed are primary areas for salmonid rearing because they provide off-channel refuge during high flows. The structural function of large woody debris, as described above, creates instream habitat complexity, which influences macro-invertebrate diversity and productivity. Small woody debris and fine organics are retained in a properly functioning stream and act as substrate and nutrient supply for fish prey species.

Stream temperature. Stream temperature is based on an array of physical and ecological processes. Summertime temperatures are of interest because thermal loading can elevate stream temperatures beyond optimum (14.5° C [58° F]) for salmonids and other aquatic life. The desired water temperature for salmonids during spawning is less than 13° C (55° F). Juvenile rearing salmonids can tolerate diurnal flucuations of 10° C without seeking cooler water if the daily minimum temperature is well within the optimum range (Meehan 1991).

Streams with limited canopy that are exposed during the winter months can have energy losses and a decrease in stream temperature. In most of the Oregon and northern California region, except for areas further inland and at high elevations, temperature losses are minor. This is due to nighttime cloud cover and normally moderate air temperatures (Beschta et al. 1987).

Average dry season precipitation (May–September) varies from 7 inches in the Northern Coastal Region, 9 to 18 inches in the Siskiyou Region, and 4 to 5 inches in the Inland Siskiyou Region (Oregon State University 1982). Mid-summer is even drier and streamflows recede in the POC region to about 0.22 cubic feet per second per mile square by July–August. The sun's vertical position (zenith angle) is higher in the summer and its horizontal position (azimuth) is more northerly. These interactions of solar physics result in greater incoming direct-beam solar radiation and this is the most important factor influencing summer stream temperature change (Brown 1969). Greater available solar radiation, peaking in June–August, coupled with low flows, can result in lesser stream buffering capacity to maintain temperature.

Depending on the sun's path and time of day in summer, trees and shrubs and topography cast shade on streams. When the sun is high, trees closest to the stream provide shade, and as the suns position lowers, vegetation farther from the stream intercepts radiation and casts shadows. Shade is often used as a surrogate for temperature because when shadows block the sun there is much less heat energy gain (Beschta et al. 1987). Depending on the riparian site (including, topography, stream orientation, tree height, tree overhang, canopy density, stream width, stand composition, and relative abundance of POC infected with PL) lesser shading may or may not result.

Angular canopy density, a measure of shade quality, can be used to track changes in shade from forest vegetation. Old-growth coniferous stands in western Oregon average 80–90 percent angular canopy density (85–90 percent shade) and undisturbed riparian coniferous forests in northern California average 75 percent angular canopy density (80 percent shade) (Beschta et al. 1987). Shade greater than about 80 percent, may have no further effect on stream temperature decrease (Boyd 1996).

Shade calculations are complex, but available computer programs for shade simulation (Boyd 1996; Park 1993) can ease laborious hand calculations. Chris Parks SHADOW Model vs. X-15 was used to simulate a general shade scenario for uninfected mid-drainage and valley streams on ultramafic parent material. The north-south, intermediate, and east-west orientations were modeled. Results showed that if POC was the dominant riparian cover present (as may be the case in many ultramafic riparian plant communities), then 86 percent, 88 percent, and 88 percent shade would exist along the mid-drainage streams using the three aforementioned stream orientations, and 70 percent, 69 percent, and 49 percent shade would exist along the valley streams. Furthermore, the model predicts a temperature rise of 1.4° C–1.6° C per mile for the mid-drainage streams and 1.8° C–3.0° C per mile for the valley streams with the predicted shade cover (see Appendix 9).

Modeled shade results should be used cautiously. Factors changing shade values or stream temperature effects may include: (1) site factors; each shade reach has its own specific attributes that should be modeled; (2) secondary shade trees of another species, set back from the water's edge, perhaps on stream terraces, can increase shade above the modeled predictions; (3) lateral adjustment of streams by bankcutting can increase or reduce shade; (4) effects of riparian shade on valley streams decrease with increasing distance from the stream bank when influenced by channel confinement and floodplain development– this may lead to a natural conditions equilibrium temperature in these stream types because vegetation has less control on temperature rise; (5) mixing of bank stored water in river alluvium with the stream can lower stream temperature; and (6) water withdrawals can increase stream temperatures.

303(d) Streams

There are many Oregon Department of Environmental Quality listed 303(d) stream segments for temperature in the region. The listings are in the approximate lower 5 river miles of most streams except for larger rivers. Because of many site variables (see Chapter 2), a site-specific analysis of each riparian plant association with an assemblage of POC would be required to determine if, and to what degree loss of canopy density may have on stream temperature.

Effects of the Alternatives

Hydrology/Fisheries Interactions

Inoculum would continue to be introduced into flowing water by spread vectors under all alternatives. The probability, timing, and spatial distribution of the new occurrences vary under the alternatives. Some alternatives apply more stringent control measures in an effort to limit the current infestation.

North Coast Risk Region (Coos Bay District, BLM, Powers RD, Siskiyou NF). POC is a scattered minor component of riparian associations. Since the infestation has been in the north area the longest (more than 50 years), nearly all streams (75 percent) have become infested (refer to Table 3&4-10 in the Pathology section). Approximately 20 percent of known POC distributions are in high-risk sites along streams, floodplains, bogs, fens or other low and depressional areas, or downslope from infected areas. It is estimated that an additional 10 percent of uninfected POC in these high-risk sites would become infested in the next 100 years under Alternatives 1 and 2, 5 percent under Alternative 3, and 20 percent under Alternatives 4 and 5 (refer to Pathology section).

The loss of POC under any of the proposed alternatives would not have a detectable effect on fish in this region. POC lost to PL in riparian zones would gradually be replaced by those of other conifer species (refer to Ecology section). Summer temperatures and large woody debris recruitment would be maintained within the natural range of variability in headwater streams and mid-drainage and valley streams (see discussion below).

The Siskiyou Risk Region (Siskiyou NF in Oregon and Six Rivers, Klamath, and Shasta-Trinity NF in California). This region has seen increasing spread of PL in POC along roads and down streams in recent years. Many POC in the valley bottoms are old and range 20 to 60 inches in diameter (refer to Background section). Estimates are that 40 percent of known POC distributions are in high-risk sites along streams, floodplains, bogs, fens, or other low and depressional areas, or downslope from infected sites (refer to Pathology section). It is estimated that 23 percent of the high-risk sites are infested. Modeling shows that an additional 29 percent of POC areas in these high-risk sites would become infested in the next century under Alternative 1, 27 percent under Alternative 2, 14 percent under Alternative 3, and 62 percent under Alternatives 4 and 5 (refer to Table 3&4-10).

The loss of POC on headwater streams in this region under any of the proposed alternatives will not have a detectable effect on fish because summer temperatures would not be elevated and the function of large woody debris transport would be maintained. Loss of POC on mid-drainage and valley streams within the non-ultramafic portions of this region would not have a detectable effect on fish for the same reasons stated above in the Northern/Coastal Region (i.e., other conifer species gradually replace POC, and summer temperatures and large woody debris function are maintained).

Mid-drainage and valley streams within ultramafic areas of this region would be affected by the loss of POC. Because POC mortality on these streams is not predicted to disrupt the recruitment of large woody debris (see following discussion), no effects to fish are anticipated related to its function (e.g., pool formation, instream complexity, gravel recruitment). However, the loss of POC stream shade and the associated elevation of summer temperatures on these streams would have an indirect short- and long-term effect on fish. For steelhead and most salmonids this effect would not be significant under any alternative because of the very limited habitat area it involves, the small contribution to the population the affected fish make, and the ability of steelhead and resident trout to move and vary their production (see Cumulative Effects discussion).

Coho also would be affected indirectly in the short and long term by elevated summer temperatures within ultramafic areas of this region. From Alternative 1 to 3, the area affected decreases as the 100-year high-risk riparian infestation prediction decreases to the lowest percentage (37 percent) in Alternative 3 (Table 3&4-10). Because PL kills almost all of the POC trees that become infected, under Alternative 1, 52 percent POC infestation would mean that half of the drainages could be affected by elevated temperatures due to shade loss (not that all drainages would lose half of the shade produced by POC). Under Alternative 2, this would be the case also, as 50 percent POC infestation is predicted. Under Alternative 3, the fewest drainages would be affected, as the POC mortality predicted is 37 percent. The indirect effect to coho from elevated temperatures would be about the same under Alternatives 1 and 2, and it would be the least under Alternative 3. Under Alternatives 4 and 5, the 100-year high-risk riparian infestation prediction of 85 percent would mean that most of the drainages in the area would be affected by elevated temperatures, and the effect on coho would be the same under both alternatives.

The elevation of summer temperatures would be likely to decrease production and survival in coho in the drainages affected by POC mortality. The fewest drainages would be negatively affected under Alternative 3, more would be negatively affected under Alternatives 1 and 2, which would have about the same effect, and the most drainages would be negatively affected under Alternatives 4 and 5, which would have the same effect (not including positive effects from any resistant stock planting). The Illinois River anadromous fisheries are a stronghold for wild anadromous fish repopulation in the Rogue Basin. The majority of wild coho in the entire Rogue Basin spawn in the Upper Illinois River. The ultramafic portions of the upper watershed are thought to be of less importance to coho production than the non-ultramafic portions. Ultramafic-influenced streams are not characterized as providing optimal salmonid habitat (USDA and USDI 1997; RVCOG 1996). The impact to coho cannot be quantified within the scope of this analysis. Although the relative importance of the ultramafic areas to coho production has been estimated, the significance of the predicted impacts to coho from the proposed alternatives cannot be determined in relation to the status of southern Oregon/ northern California coho.

The Disjunct California Region has POC in highly scattered drainages in different vegetation types and often confined to riparian areas. Infection incidence is less than 10 percent. Estimates are that 40 percent of known POC distributions are along streams, floodplains, bogs, fens, or other low and depressional areas, or downslope from infected sites (refer to Pathology section).

Inland Siskiyou Risk Region (Medford and Roseburg BLM Districts). POC is scattered on the Roseburg District in the coast range to the Umpqua Basin. POC on the Medford District is primarily associated with riparian areas, particularly on the Grants Pass BLM Resource Area (refer to Background section). Estimates are that 60 percent of known POC distributions are in high-risk sites along streams, floodplains, bogs, fens or other low and depressional areas, or downslope from infected sites (Goheen, D.J., personal communication). It is estimated that 15 percent of the high-risk sites are infected. Modeling shows that an that an additional 33 percent of POC areas in high-risk sites would become infested in the next century under Alternative 1, 30 percent under Alternative 2, 17 percent under Alternative 3, and 68 percent under Alternatives 4 and 5 (refer to Pathology section).

In the Roseburg portion of the region, the loss of POC under any of the proposed alternatives would not have a detectable effect on fish. POC lost to PL in riparian zones would gradually be replaced by those of other conifer species (refer to Ecology section). Summer temperatures and large woody debris recruitment would be maintained within the natural range of variability in headwater streams and mid-drainage and valley streams (see following discussion).

In the Medford portion of the region, the loss of POC on headwater streams under any of the proposed alternatives would not have a detectable effect on fish because summer temperatures would not be elevated and the function of large woody debris transport would be maintained. Loss of POC on mid-drainage and valley streams within the non-ultramafic portions of this region would not have a detectable effect on fish for the same reasons stated above for Roseburg.

The loss of POC stream shade and the associated elevation of summer temperatures in mid-drainage and valley streams within ultramafic areas of this region would have an indirect short- and long-term effect on fish. The effects are the same as described above for the mid-drainage and valley streams within the ultramafic areas of the Siskiyou Region.

Headwater Confined Stream Channels (1st and 2nd Order Streams)

Channels in these watershed and landform positions, on smooth to steeply dissected descending sideslopes, share several stream and riparian attributes common to all alternatives. These channels are most often intermittent or ephemeral. Since these channel types are laterally constrained by hillslopes and streamflow is vertically contained in the channel, only POC that is not already dead and in or near the water column would be affected. There may be some spatially distributed ongoing declines in root strength with infected POC, which could affect bank stability. However, this effect is localized and is not expected to significantly increase slumps or entry of colluvial material into the channel. Windthrow of dead POC would provide a beneficial effect by increasing the hydraulic roughness and creating a random-to-stepped stream profile. However, POC may persist as standing snags for many years before toppling. Stream large woody debris would have very long persistence and create sediment reservoirs with incorporated organic material. The streamside large woody debris recruitment rate would remain within the range of natural variability. POC overhanging the channels affected by PL would have small pocket areas of an estimated 10 to 15 percent canopy density provided by boles and branches. Winter and spring stream temperatures would remain unchanged. There would essentially be no effect on summer stream temperature relations. This is because these stream types are above the water table and go dry during the warm summer months when stream heating is at a maximum. A summary of riparian and stream attributes in differing morphologies and relationship to PL is shown in Table 3&4-18.

Variable implementation of selected management activities (current direction) under Alternative 1 may have a slight short and long term positive effect, on lessening the spread of the pathogen through water, when compared to Alternatives 4 and 5. The geographic position of

Table 3&4-18.—Riparian and stream attributes in differing morphologies and relationship to Phytophthera lateralis these headwater channels (in many cases in steep topography above roads or greater than 40 feet from roads) would “de facto” slow pathogen spread to animal or human carriers. Additionally, projects within the Riparian Reserves require Aquatic Conservation Strategy consistency. Current management direction regarding POC would be taken into consideration during these analyses.

Management Practices under Alternative 2 are applied in a more structured approach by application of the POC Risk Key. Although the standards and guidelines in Alternative 1 use the elements of the risk key, the effects of Alternative 2 may be slightly improved in the short and long term. Systematic planning, direction of limited resources, and operational consistency in avoiding, sanitizing, or eradicating POC may result in lower spread of the infection. Management Practice 1 (project scheduling during the dry season) would slow PL resting spore transfer to water because road ditches and 65 to 80 percent of the stream network would be dry. Management Practice 2 (using water from known uninfected sources or treating water) would limit spore dispersal into flowing streams. Management Practice 9 (road management measures with a system of road closures in the wet season and eradication along selected roads) could substantially decrease water entry points particularly into roadside ditches and stream crossings. This would effectively reduce up to 50 percent stream extensions by roads. Management Practice 13 (washing project equipment) when implemented with Management Practices 1 and 9 may be very effective in separating inoculum from watercourses.

Alternative 3 (applies mainly to the Inland Siskiyou Risk Region) is expected to aggressively protect specific headwaters uninfested POC core areas by minimal entry, no timber harvest, and eradication. Since many of the 32 6th field subwatershed core areas are above roads, this would assure that transport of the PL spores would be unlikely to spread by project activities. This alternative would have a slight beneficial effect on retaining the flow of litter and nutrient inputs, and tree overhang with canopy shading in the short and long term. This condition should maintain intermittent stream winter and spring water temperatures from being cooler than normal and buffer against higher day night temperature swings. Furthermore, natural large woody debris recruitment over temporal and spatial scales in the range of natural variability within the riparian zone has a better chance of occurring. This in turn would trap sediment and organic material and buffer downstream reaches from sediment pulse inputs from infrequent floods.

Alternatives 4 and 5 are similar to each other in that no specific management measures would be applied, other than a POC resistance breeding program in Alternative 4 and general discontinuance in Alternative 5. Effects on water and aquatic resources, above highest road crossings, would be similar to Alternatives 1 and 2 in the short and long term. Effects to POC mortality below roads would likely be greater in the short and long term because there is no containment strategy for PL spread. Even though seed is available for planting resistant stock in the North Coast Risk Region, many sites are inaccessible, small, and not likely to be replanted. Additionally, edaphic conditions suggest that other tree species can easily occupy the sites in this region. Seed would not be available for planting resistant stock in much of the Siskiyou Region until 2010 and is not planned under Alternative 5. Many sites are inaccessible and not likely to be replanted. Seed would not be available for planting resistant stock in the Inland Siskiyou Risk Region under Alternative 4 until 2010 and would not be planned under Alternative 5.

Several regional differences by stream type and watershed position that could influence hydrologic/aquatic effects from loss of POC are summarized in Table 3&4-19. In headwater channels of the Northern/Coastal Region, stream debris flows and torrents occur in the sedimentary formations on steep dissected slopes. Presence of dead POC may or may not increase the rate of debris flows over natural levels, because the tree is a minor species in relative abundance and is not likely to affect the matrix of tree roots that hold the banks together. Selection of an alternative should have no effect on the chronic loading with debris and sediments and episodic excavations as debris flows.

In the Siskiyou Risk Region, higher surface rock content may lead to some overland flow and higher drainage densities during storms. Some non-channel related POC might be vulnerable to infection, particularly in those areas below roads where drainage relief culverts could spread water on the way downslope to a channel. Furthermore, seasonal intermittent snow accumulation and rapid melt above 2,000 foot elevations could cause some overland flows in this region. Alternatives 3 and to a lesser extent Alternatives 2 and 1 would best protect uninfested POC stands in near channel upslope areas.

Mid-Drainage to Valley Moderately Confined and Unconfined Stream Channels (3rd Order+ Streams)

Several riparian zone and stream attributes are common to all alternatives in these landforms and channel types. The streams are mostly perennial and have year-round flow. There is a lower incidence of stream-road crossings, but these are larger streams with many parallel roads and road-ditch stream connections, indicating probable infection entry points. Furthermore, these channel types are subject to water spreading during flooding by overtopping the normal channel. The severity of flooding depends on stochastic precipitation events that would control the widths of the floodprone area where new infestations could occur. Declines in root strength from standing POC mortality may lead to windthrow or localized undercutting by stream currents, especially on the outside of channel bends. This is expected to have beneficial effects for aquatic habitat by providing increased pool depths, complex habitats and cover. However, if too wide of an area of dead POC is present the stream may move laterally across the floodplain, the channel may widen and may not be in equilibrium. POC trees that topple into the streams would create scour pools in the medium width channels and become parts of jam complexes or distributed on the floodplains in wider channels. A summary of riparian and stream attributes in differing morphologies and relationship to PL is shown in Table 3&4-18.

In the North Coast Risk Region POC is a minor species and widely scattered in the riparian area. Many larger streams do not have floodplain connectivity (F type channels), which would limit the waterborne spread of PL into riparian POC. Where floodplains are present, other species of conifers or hardwoods would quickly replace infected POC where there are dead crowns and localized holes in the canopy. Edaphic conditions are generally favorable and there is very high competition for light. Replacement species should phase in as infected POC diminish. Effects on stream temperature would likely be within the range of natural variability, regardless of alternative selected. Alternative 3 would have no effect in this region because there are no uninfected 6th field watersheds.

In the Siskiyou and Inland Siskiyou Risk Region infected POC with dead crowns may contribute to more expansive holes in the canopy in riparian areas along streams. Infections

Table 3&4-19.- Regional hydrologic/aquatic differences and effects from Port-Orford-Cedar-infection of POC with PL would result in lesser amounts of shade than a healthy stand. Cedar trees that undergo PL mortality still have branches and boles that remain standing for many years. Field studies show that canopy density for this condition on the Siskiyou NF to be in the range of 10 to 15 percent (Park, C., personal communication). On soils derived from ultra-mafic materials, shading may be reduced for long time periods. Other tree species have difficulty occupying the site due to waterlogged soils with unfavorable chemistry. Western white pine can occupy these sites but is susceptible to white pine blister rust (refer to Ecology section).

POC mortality causing shade loss would be greater where standing water or wider flood-plains are present, inoculum is present, and POC is more open grown with a high relative abundance. Mortality may elevate summer stream water temperatures. The amount of temperature increase would depend on stream and site factors, the extent of POC abundance, whether POC is along the stream (primary shade) or further back on the floodplain (second-ary shade) and the severity of the infestation. The north-south, intermediate, and east-west orientations were modeled for shade loss with POC mortality. Assumptions and results are shown in Table A9-2, Appendix 9. Shade modeling suggests that shade in mid-drainage streams may decrease by 9 to 14 percent, and 9 to 19 percent in valley streams. Further, stream temperatures in mid-drainage streams may increase 1.1 to 1.6° C per mile and 0.5 to 1.2° C per mile in the valley streams. The degree of change modeled would be greatest for Alternative 5; the other alternatives would have lesser change. Partial mortality or stands less than 100 percent POC cover would yield a greater shade estimate and lower temperature rise estimate. However, this condition is more difficult to model and data should be field col-lected. Modeled shade results should be used cautiously (refer to the affected environment for further explanation). For comparison, numerous watershed studies in the coast range of Oregon for clearcut harvesting show maximum temperature increases of 3° to 8° C (Bescha et al. 1987).

Alternative 1

Implementation of selected management activities (current direction) under Alternative 1 may have some effect on lessening the spread of the pathogen through water by limiting pathways for entry or eradicating infestation centers that could reinfect healthy cedars downstream. Most mid-drainage and valley streams have chronic infection present, being more pro-nounced in the north and less infested in the south and inland parts of the POC range. This alternative would most likely be more effective than Alternatives 4 and 5, but slightly less effective than Alternatives 3 and 2 in the short and long term.

There is some risk to fish from the use of Clorox. PL-contaminated waters used for washing and firefighting will be disinfected with a 50 parts per million concentration of sodium hypochlorite, the active ingredient in Clorox bleach. Rainbow trout (*Salmo gairdneri*) exposed to a 30 minute dose showed an LC50 (the concentration lethal to 50 percent of the test population) of .43 parts per million, while 5 minute exposures resulted in a LC50 of 1.65 parts per million (Brooks and Seegert 1977). Wash stations would be located to avoid direct flow of treated water into streams and other bodies of water, so there should be little or no effect to fish from that source. Direct input of chlorinated waters could result from fire suppression activities and would be small in scale and of short duration. Free chlorine ions rapidly combine with organic material and are rendered non-toxic. See Appendix 4 for additional information about Clorox.

Alternative 2

Management Practices under Alternative 2 are applied in a more structured approach by application of the POC Risk Key. Although the standards and guidelines in Alternative 1 use the elements of the risk key, the effects of Alternative 2 may be slightly improved in the short and long term. Systematic planning, direction of limited resources, and operational consistency in avoiding, sanitizing or eradicating POC may result in lower spread of the infection. Management Practice 1 (project scheduling during the dry season) would slow PL resting spore transfer to water because road ditches and 65 to 80 percent of the stream network will be dry. Management Practice 2 (using water from known uninfested sources or treating water) would limit spore dispersal into flowing streams. However, if Clorox is used to treat water and there is an unintentional spill into surface water there may be harmful effects on fish and aquatic life. Management Practice 9 (road management measures with a system of road closures in the wet season and eradication along selected roads) could substantially decrease water entry points particularly into roadside ditches and stream crossings. This would effectively reduce up to 50 percent stream extensions by roads. Management Practice 13 (washing project equipment) when implemented with Management Practices 1 and 9 may be very effective in separating inoculum from watercourses.

The Clorox risk discussed in Alternative 1 applies to Alternative 2 as well.

Alternative 3

Alternative 3 incorporates the features of Alternative 2 and adds additional measures to control the spread of PL within 32 currently uninfested subwatersheds. Most of these POC core areas are in headwaters positions and may have a limited effect downstream other than slow spore transport and reinfection to mid-drainage and valley stream segments. The buffer strategy of the cores encompassing the 6th field watersheds may yield a slightly higher protection over Alternatives 2 and 1 in the short and long term. POC stands in the valley bottoms on ultramafic soils tend to be large diameter trees (greater than 20 inches diameter) with greater abundance (refer to Background section). Uninfested stands would maintain water quality; particularly preventing summer stream temperatures from increasing and maintaining a continuous supply of large woody debris as well as providing bank stability.

The Clorox risk discussed in Alternative 1 applies to Alternative 3 as well.

Alternatives 4 and 5

Alternatives 4 and 5 are similar in that no specific management measures would be applied, other than a POC resistance breeding program in Alternative 4 and general discontinuance in Alternative 5. In the Northern/Coastal Region effects on water and aquatic resources would also be similar to Alternatives 1 and 2 in the short and long term. This is because POC is a minor riparian species in this region and 75 percent of the riparian areas are already infected in many of the lower drainages. Additionally edaphic conditions suggest that other tree species can easily occupy the sites in this area. Seed is available for this breeding zone and could be planted in select areas. The planted POC would be small and not provide effective shade or large woody debris recruitment for many decades. Alternative replacement species including hardwoods like red alder or conifers including western red cedar and western hemlock would most likely occupy the site.

In the Siskiyou and Inland Siskiyou Risk Regions, Alternatives 4 and 5 would be less favorable than Alternatives 1, 2 and 3 in the short and long term. Currently about 23 percent and 15 percent respectively of POC of high-risk riparian areas are infested. The Pathology section describes that an additional 62 percent and 68 percent of these regions will become infested in the next 100 years under Alternative 4 and 5, while 14 to 30 percent will become infested under Alternative 3 and 2 in the same period (refer to Pathology section). Seed would not be available for planting resistant stock under Alternative 4 until 2010 and is not planned for some areas under Alternative 5. If resistant stock succeeds, Alternative 4 may ultimately become more important in a longer time frame than Alternative 5. The effectiveness of a resistance-breeding program in growing large POC is unproven, because the effort has only been operating for about 10 years.

Summaries of several regional differences by stream type and watershed position that can influence hydrologic/aquatic effects from loss of POC are summarized in Table 3&4-19.

Effect of private intermingled lands

Reciprocal rights-of-way on the Coos Bay, Roseburg, and Medford BLM Districts limit access control with private landowners and effective control strategies. Some roads will remain open and management direction in Alternatives 1 and 2 cannot always be implemented. Management Practice 13 (vehicle washing of Federal equipment) may reduce, but not eliminate, spore transfer to water.

Cumulative Effects

POC predicted mortality along streams in the next 100 years ranges from 32 percent to 95 percent. In the North Coast Risk Region sedimentary rock derived soils, the loss of POC influencing shade or large woody debris recruitment on perennial streams is not anticipated to be measurable. Scattered distribution of POC and aggressive naturally occurring alternative species replacement are expected to continue these processes. A gradual transfer of shading from POC to other conifer and hardwood species would most likely occur as POC trees die. The effect on fish and aquatic resources from the loss of shade or change in large woody debris supply from POC mortality would also be undetectable at multiple watershed scales (5–7th field hydrologic unit codes).

In the ultramafic riparian areas of the Siskiyou and Inland Siskiyou Risk Regions, POC comprises on average 50 percent of the overstory cover in plant associations where it is prominent in the overstory (refer to Table 3&4-13). The predicted increase in summer temperatures from the loss of POC stream shade in any one stream may not produce immediate effects on salmonid production. However, the cumulative effects from several tributaries can result in loss of mainstem rearing habitat downstream (USDA 1985). Streams on public lands play an important role in the survival of salmonids as they provide cool water to fish habitat lower in the system and provide refugia during summer months when water temperatures are lethal (78.4 degrees for coho) in the valley segments. The degradation of cold water refugia would have a cumulative effect on salmonid production and survival in the ultramafic portions of these regions because of the current degraded condition of valley segments due to elevated water temperatures, water withdrawals, and natural lack of flow. The magnitude of this impact must be analyzed in the context that it will only take place where POC cannot be replaced by other species. This is on the ultramafics, or serpentine areas, which are characterized by a lack of many of the attributes of optimal salmonid habitat (USDA and USDI 1997). The trend for cumulative effects under all alternatives is the same as previously stated for the ultramafic areas of the Siskiyou Risk Region, that is, Alternative 3 has the least effect, Alternatives 1 and 2 have an increased effect (compared to Alternative 3) and are almost the same; and Alternatives 4 and 5 have the greatest effect and are equal. Coho would be affected indirectly in the short and long term by elevated summer temperatures within ultramafic areas of this region. The elevation of summer temperatures would be likely to decrease production and survival in coho in the drainages affected by POC mortality. This impact is difficult to quantify within the scope of this analysis. Coho are an upper tributary spawner and most spawn in the upper Illinois River watershed. Approximately 40 percent of the area of the upper Illinois River, and perhaps 25 to 30 percent of the stream miles, are on ultramafic soils (USDA and USDI 1997; USDA and USDI 2000). These soils are by far the least productive areas, however. For example, it is estimated only 10 percent of the Upper Illinois coho production comes from the ultramafic-dominated West Fork, and even that is mostly trackable to the non-ultramafic Elk Creek. The percentage of coho coming directly from ultramafic stream systems is probably less than 5 percent of the population. As noted above however, the effects of increased temperatures are not limited to the serpentine, but contribute to increased temperatures and effects on a larger scale. The precise significance of the predicted impacts to coho from the proposed alternatives cannot be determined from this analysis.

The impact to steelhead would be anticipated to be of the same magnitude as that of coho because only that portion of the region which is serpentine would be affected. As in the effects stated for the Siskiyou Risk Region, this would not be a significant impact because steelhead in the regions have a stable population and are less vulnerable due to their life history characteristics (scattered distribution, temperature tolerance, variable production, mobility and resiliency). The effects on steelhead are representative of resident trout as well. Chinook would not be impacted by indirect temperature effects on rearing habitat due to the timing of their use of the rearing habitat.

Wildlife

Affected Environment

As noted in the Background and other previous sections, POC is found in many different environments, from sea level to 6,400 feet, and in 64 plant associations. POC is commonly associated with moist areas; most commonly along riparian areas but also in wet areas in the uplands. POC typically occurs as single trees or small groups in the uplands; larger groups may be located in riparian areas and alluvial fans. POC can be prominent in stands occurring in administrative units in the central portion of the POC range. POC is capable of growing to a large diameter; in serpentine sites they may be the only source of large diameter trees, snags, and down wood. In plant associations found on ultramafic soils, POC may be a prominent overstory species, especially along riparian zones. In plant associations where POC is prominent, 54 percent of POC acres within the range of POC are on ultramafic soils, and 51 percent within Oregon (derived from Table 3&4-12). Ultramafic riparian plant associations with POC as a component (high-risk portion) constitute approximately 26 percent of the POC acres in the planning area where POC is prominent. POC occur on approximately 272,000 acres of forested habitat in Oregon and 307,000 acres range-wide. In the 130,000 acres where POC is prominent, POC may comprise 27 to 50 percent of the overstory cover, but is rarely the dominant species (see Table 3&4-13). Within many ultramafic associations that contain POC, approximately 58,300 acres in Oregon and 70,000 acres range-wide (Table 3&4-12), POC is a prominent overstory tree, and its loss could have a large impact upon the ecological functioning of those stands.

Chappel et al. (2001) identified two major wildlife habitat types within southwest Oregon: Westside Lowlands Conifer-Hardwood Forest and Southwest Oregon Mixed Hardwood-Conifer Forest. The Westside Lowlands Conifer-Hardwood Forest extends across western Oregon and isolating data specific to southwest Oregon out of the data matrixes would be impossible. Queries of BLM and FS biologists have failed to yield information that would indicate that any species is specifically tied to POC (Dillingham 2003; Miller 2003; Webb 2003a) or would be expected to be uniquely affected by the proposed alternatives. Therefore species occurrence and habitat association data will be derived based upon the Southwest Oregon Mixed Hardwood-Conifer Forest classification, the dominant type in the affected area. Johnson and O'Neil (2001) identified 226 terrestrial vertebrate species that occur within the Southwest Oregon Mixed Conifer-Hardwood Forest (Table 3&4-20). Wildlife impacts will be analyzed based upon species group and associated habitat elements. For many areas, POC has a keystone role in riparian areas (especially in ultramafic plant associations) and for providing down wood and snags (standing dead trees) (see the Ecology section for more information).

Effects of the Alternatives

Potential effects to species listed under the "Endangered Species Act" are (also) discussed in the draft biological evaluation in Appendix 7.

Alternative 1

Under the current strategy for managing POC and PL, very few activities have effects to wildlife habitat and the associated wildlife species. Habitat modifications and loss of POC in all stages during roadside sanitation efforts may occur. There are approximately 9 acres of potential treatment area per 1 mile of road, although this not all habitat. Much of the road-

Table 3&4-20.— Numbers of wildlife species associated with the Southwest Oregon-Mixed conifer habitat type [1] side sanitation area is within the original clearing limits of the road. The precise level of road treatments to occur is unknown, but it is expected to approximate that described in Appendix 2. Few snags are left adjacent to roads due to safety concerns. The removal of isolated or small groups of large diameter POC and their future as snags could affect up to 46 species of vertebrates that are associated with large-diameter snags.

The seasonal restriction/closure of certain roads would benefit wildlife by reducing disturbance to the adjacent habitat. Disturbance effects many species in a wide variety of ways causing them to move away from roads, increasing stress levels, predation, and nest abandonment, and reducing fecundity, depending upon the intensity, frequency, and duration of the disturbance. The closure of local and resource roads is expected to have minor landscape-scale wildlife benefits but may be important at a local scale. Note: (1) The rural local system primarily provides access to lands adjacent to the collector network and serves travel over relatively short distances (USDI 2002); and (2) the resource road system provides access for specific management actions and connects to local or collector road systems (USDI 2002).

PL-contaminated waters used for washing and firefighting will be disinfected by mixing 1 gallon of Clorox bleach to 1,000 gallons of water. This mixture results in a sodium hypochlorite concentration of 50 parts per million (milligrams per liter) (drinking water is about 2 parts per million). The toxicity level for sodium hypochlorite for freshwater aquatic species, as determined by EPA, is 0.011 parts per million 4-day average, or 0.019 parts per million for 1 hour (EPA 1984). Research into the control of zebra mussels (*Dreissena polymorpha*) showed it was an effective biocide at concentrations of 1 mg/L (1 parts per million) (Martin et al. 1993). Rainbow trout (*Salmo gairdneri*) exposed to a 30 minute dose showed an LC50 value of .43 mg/L at 20 C (0.43 parts per million) while triple exposures (or 5 minutes) resulted in a LC50 of 1.65 mg/L (Brooks and Seegert 1977). Wash stations would be located to avoid direct flow of water into streams and other bodies of water, so there would be little or no effects to aquatic amphibians from those sources. Direct input of chlorinated waters could result from fire suppression activities and would be small in scale and of short duration. Free chlorine ions rapidly combine with organic materials and are rendered nontoxic. See Appendix 5 for further discussion of Clorox.

Projections by pathologists indicate that 40 percent of the high-risk stands currently uninfested with PL will become infested under Alternative 1 by 2103, and that POC mortality in these infested stands would approximate 90 percent. Loss of individual large-diameter POC and small groups would be minor in the nonultramafic plant associations. In these stands, POC is not a dominant overstory species and canopy gaps created by the die-off would be quickly filled by other species. The increase in snags and down wood would benefit 46 and 57 species, respectively (Table 3&4-20). In 70,000 acres of ultramafic plant associations containing POC, POC is a prominent canopy species and may be a majority in some riparian plant associations. Infestation rates in 100 years in high-risk ultramafic riparian sites will be about 50 percent (Table 3&4-10), with mortality on these infested sites of about 90 percent. This mortality may cause measurable changes at a site-specific scale (such as changes in micro-climate), but should cause no effects at a landscape scale.

The development of PL-resistant stock would help to restore the POC losses. Available for deployment in 0 to 40 years depending upon seed zone (see Table 3&4-21 in the Genetics and Resistance section), large-diameter POC could be in the landscape again 80 to 100 years later.

Alternative 2

The effects of Alternative 2 are the same as Alternative 1 with the following exception.

Alternative 2 prescribes the use of a risk key for determining when mitigative measures are necessary to prevent/reduce the spread of PL. This risk key would standardize the implementation of mitigative measures and likely further reduce the infestation of drainages and the loss of POC.

Projections by pathologists indicate that 35 percent of the high-risk stands currently uninfested with PL will become infested under Alternative 2 by 2103. POC mortality in that 35 percent would approximate 90 percent. Potential effects to wildlife would be slightly less than in Alternative 1, but the overall conclusion remains the same. This mortality may cause measurable changes at a site-specific scale (such as changes in micro-climate) but should cause no effects at a landscape scale.

As in Alternative 1, the development of PL-resistant stock would help to restore the POC losses. Available for deployment in 0 to 40 years depending upon seed zone (see Table 3&4-21), large-diameter POC could be in the landscape again 80 to 100 years later.

Alternative 3

The effects of Alternative 3 are the same as Alternative 2 except as follows.

Provisions have been established to provide additional protection for 32 6th field watersheds that are currently identified as being uninfested with PL.

Timber harvests would be prohibited on 28,600 acres (Table 2-2) in the uninfested watersheds; this does not preclude salvage in the case of a stand-replacing event. Regularly scheduled timber harvests (those contributing to probable sale quantity), including regeneration harvests, would be prohibited on 2,300 acres of Matrix and Adaptive Management Area lands. Additionally, within POC cores all POC less than 10 inches dbh (diameter at breast height) would be removed along roads. These equates to about 9 acres per mile of road including previously cleared road clearing limits. The loss of these smaller diameter trees should have no effect on ability of the stands to function. There is the potential to restrict the recruitment of large diameter POC, but with the exception of ultramafic plant associations, POC is a minor component of the overstory. The restriction against timber harvest will restrict the ability of Agencies to do commercial thinning on approximately 6,000 acres of 40- to 80-year-old stands of Late-Successional Reserves in those uninfested watersheds in order to accelerate the development of late-successional forests or restore ecological processes. Such thinning is a major strength of the Northwest Forest Plan, but with nearly 2,000,000 acres of thinning needs in the Northwest Forest Plan area, this 6,000 acres is inconsequential to achieving Late-Successional Reserve objectives because of the small percent (0.3 percent) of this habitat compared with the Northwest Forest Plan area.

Projections by pathologists indicate 20 percent of the high-risk stands currently uninfested with PL would become infested under Alternative 3 by 2103, and POC mortality in these infested stands would approximate 90 percent. As with Alternative 2, loss of individual large-diameter POC and small groups would be minor in the nonultramafic plant associations.

In 70,000 acres of ultramafic plant associations containing POC, POC is a prominent canopy species and may be a majority in some riparian plant associations. Infestation rates in 100 years in high-risk ultramafic riparian sites will be about 35 percent (Table 3&4-10), with mortality on these infested sites of about 90 percent. This mortality may cause measurable changes at a site-specific scale (such as changes in micro-climate), but should cause no effects at a landscape scale.

The development of PL resistant stock would help to restore the POC losses. Available for deployment in 0 to 45 years depending upon breeding zone (see Table 3&4-21), large-diameter POC could be in the landscape again 80 to 100 years later.

Alternative 4 and 5

These alternatives remove all mitigation measures currently used by the BLM and FS to limit the spread of PL across the landscape. The alternatives differ only in the level of resistance breeding to continue. With Alternative 4, the current breeding and testing program for the development of resistant stock would be accelerated. Within 10 years resistant seed and planting stock will be available for all seed zones in Oregon. With Alternative 5, the further identification and testing of new resistant trees would cease, but use of resistant seed from the currently developed breeding zones would continue. These cover approximately 26 percent of the breeding zone.

Projections by pathologist indicate that 80 percent of the high-risk stands currently uninfested would become infested by the year 2103. Loss of individual large-diameter POC and small groups would be minor in the nonultramafic plant associations, with effects similar to those described for the other alternatives; they would be quickly replaced by other species. In 70,000 acres of ultramafic plant associations containing POC, POC is a prominent canopy species and may be a majority in some riparian plant associations. Infestation rates in 100 years in ultramafic riparian sites will be about 84 percent (Table 3&4-10), with mortality on infested sites of about 90 percent of the POC. This mortality would likely cause measurable changes at a site-specific scale (such as changes in micro-climate). However, in part because POC overstory contributes an average of 50 percent of the total canopy cover in ultramafic riparian sites where POC is prominent (Table 3&4-13), there should be no wildlife effects at a landscape scale.

The development of PL resistant stock of Alternative 4 and the continued use of PL-resistant stock would help to restore the POC losses— Alternative 4 more than Alternative 5. Large diameter POC could be in the landscape again 80 to 100 years following planting.

Ultramafic Soils

Affected Environment

The POC range includes just under 100,000 acres of ultramafic soils generated from serpentine and peridotite igneous rocks. These soils are characterized by a high iron and magnesium-to-low calcium ratio, severely restricting plant uptake of calcium and thus limiting the number of species that can survive and grow here. Many unique species grow here, either because they are adapted to the soils, or are not particularly dependent upon the soils (insectivorous), or have a competitive advantage because other species do not occur. POC does well in wet areas on these soils, in part because of its unique ability to extract calcium from these soils. POC does so well that it is often the largest, most dense plant present on these soils, and therefore, plays an important ecological role.

It has been suggested that POC's ability to retrieve calcium from ultramafic soils is an important soil-building characteristic that should be recognized and preserved. However, POC's ability to utilize soil calcium does not enrich soils, and although litter fall place calcium in a more usable form and location for other plants (Zobel et al. 1985), the effect is small (Powers, *personal communcation*). POC does not manufacture calcium the way some plants enrich soils by fixing nitrogen. The overall effect of POC on soil productivity is not materially different from having any other vegetation on these soils. Additional information about soils is included in the Water and Fisheries section.

Effects of the Alternatives

There would be no meaningful difference between the alternatives upon the status of the ultramafic soils or soil productivity. The indirect impacts due to POC mortality on ultramafic soils is discussed in the Water and Fisheries section.

Pacific Yew

Affected Environment

The Pacific yew tree and shrub is unique in western forests, growing inconspicuously either individually or in small groups in the understory of Douglas-fir and other conifer forests. Although important to American Indians and a small contingency of woodworkers, it was overlooked by modern society until taxol, a promising cancer fighting compound extracted from yew, was discovered. Demand soared, and in 1993 the FS and BLM prepared a joint EIS and record of decision describing the appropriate management of yew. Harvest accelerated for a few years, until a synthetic taxol virtually eliminated the need to harvest yew trees. Interest in natural taxol has recently resurfaced, and the future demand is uncertain.

As noted in the Pathology section, Pacific yew is infected by PL on infrequent occasions (Kliejunas 1994). It has been suggested this is cause for concern, and that this SEIS needs to address Pacific yew in detail, reevaluating the analysis made in the 1993 Pacific yew EIS. However, observations and laboratory trials show that Pacific yew is much less susceptible to PL than POC. Where it has been found infected, yew was growing in close association with many previously infected POC (Murray and Hansen 1997).

For the purposes of this analysis it is concluded there is no evidence that Pacific yew will carry PL on its own, or that PL poses a significant threat to yew.

Effects of the Alternatives

Pacific yew growing in close association with numerous POC will potentially be more susceptible to future PL infections. The potential for incidental Pacific yew growing on high-risk sites to become infected varies by alternative in proportion to the percent of POC predicted to become infected (Table 3&4-8). Within disease-infested areas, yew infections will follow the same infection patterns as those outlined in the Pathology section; that is, they will become infected on infrequent occasions. In all alternatives, overall yew infection rates are expected to be inconsequential.

Genetics and Resistance

Affected Environment

Genetic Variation

Genetic diversity among and within species is the basis for all biological diversity. Most plant species exhibit a large amount of genetic variation, which reflects adaptation to local environmental conditions (Linhart 1995). Paleobotanical evidence indicates that POC formerly occupied a vastly wider range and that restriction to its present distribution left considerable variation intact (Edwards 1985). Such diversity is an asset in allowing a species to survive and adapt to new, changing environments (such as when POC as affected by PL) (Kitzmiller et al. 2003). Knowledge of the patterns of this variability is crucial for successful genetic management, whether in designing elaborate resistance breeding programs, or in developing more passive, conservation strategies for natural ecosystems. Recent studies of this genetic variability can be grouped into two major categories: Allozyme Studies and Common Garden Studies.

Allozyme studies. Electrophoretic analysis of allozymes allows relatively quick, inexpensive quantitative measures of genetic structure, genetic diversity, and mating systems. They are often employed as a first step in describing and understanding the genetic architecture of a species.

In three studies conducted on POC, populations in California were moderately variable in allozymes (comparable to values for other California conifers with small- to moderate-sized distributions, but notably lower than most widespread conifers). Across all stands, 5 percent of total allozyme variation was attributed to differences among stands, and 95 percent to differences among trees within stands (Miller and Marshall 1991). Elevation was the strongest ecological factor associated with genetic differentiation, but at low elevations, soil contrasts (serpentine versus nonserpentine) was nearly as great (Miller et al. 1991). Overall, relationships between ecological habitat, allozyme diversity, and genetic differentiation over short geographic distances were markedly greater for POC than for more widespread Douglas-fir and white fir (Miller et al. 1991). Sampling on a much wider scale showed contrasts between populations from California and Oregon (Miller et al. 1992). For example, while the mean allozyme diversity was slightly greater for Oregon, the range of diversity was greater in California. In addition, the Oregon cline among populations in allozyme variation was strongest along latitudinal, weaker along longitudinal, and weakest along elevational gradients. In California, the cline was strongest along longitudinal strata, although elevation was also a relatively strong determinant of allozyme diversity (Miller et al. 1992).

Collectively, these studies show that a large number of common alleles associated with allozymes reside in any given population. Therefore, even if scattered stands over the species' range were completely lost in the future, common alleles would not be compromised.

Such genetic makeup bodes well for gene conservation, as well as for the genetic effects of alternatives. Note: The convention on International Trade in Endangered Species (March, 1994) quoted the consensus of scientist working on POC:

> . . . to the best of our knowledge, POC has not been eliminated from any area because of the root disease.

The conclusion is still applicable in 2003.

Unfortunately, since allozyme analyses cannot show definitive, adaptive responses to field environments over time, their practical utility is limited. Investigations of these responses are best accomplished by common garden studies.

Common garden studies. As the name implies, common garden tests are often designed to compare variation patterns of a few to relatively large numbers of genetic identities (those being provenances, open-pollinated, or controlled-pollinated families, clones, etc.), all grown in at least one, but frequently several, test sites, or "gardens." By careful selection of genetic entries, choice of uniform garden(s) representing environmental gradients or extremes, proper experimental design and statistical analyses, and appropriate management, these research sites can yield a wealth of practical information about genetic variation. If maintained judiciously over time they may also allow evaluation of genetic adaptation to infrequent events (such as severe frosts, droughts, and new disease epidemics) or more subtle future changes (such as global cooling or warming).

In 1995 the BLM and FS began to establish range-wide, common garden tests to further evaluate the genetic variability within POC. Seed was collected from 344 healthy parent trees on Federal land between 1991 and 1994. Stands were sampled throughout much of the species' range; their selection assisted by results of the earlier allozyme studies, noted above. Two different hierarchical models were employed to partition the genetic effects: (1) ecological or watershed model with watersheds, stands, and families; and (2) a breeding model with breeding zones, seed zones, and families (Kitzmiller et al. 2003).

Short term studies of height growth response (Kitzmiller and Sniezko 2000), height growth phenology (Zobel et al. 2002), and water relations of terminal shoots (Zobel et al. 2001) were conducted, utilizing seedlings from families transplanted in raised beds at two nursery sites (Dorena, near Cottage Grove, Oregon, and Humboldt Nursery, McKinleyville, California) in 1996. Seedlots from the extremes (high elevation, southern interior in California and low elevation, coastal stands near Coos Bay) of the species distribution exhibited striking contrasts in all traits. Of more practical adaptive relevance, height growth increased, while the proportion of early-season growth declined and proportion of late-season growth increased with change in source location from (1) high to low elevations, (2) from south to north, and (3) from east to west when populations spanning the range were included. Strong clinal patterns were noted for height potential with source elevation, latitude, and longitude (Kitzmiller and Sniezko 2000). Overall these data showed population structure and geographic patterns similar to, but much stronger than the allozyme work, noted above (Kitzmiller et al. 2003).

Short duration tests in low moisture and nutrient stress nursery environments are not well suited to assess cumulative responses to complex, site-specific environmental stresses in forest settings. Consequently, five individual common garden sites utilizing 266 of the families included in the nursery tests were planted in 1996 to 1998. Data collected on the Humboldt and Trinity Lake plantations for 3 years showed mean height was inversely related to survival at the inland site. Data collected for 5 years revealed a geographic cline in height growth associated with latitude, longitude, and elevation of seed origin. Northern, low elevation, coastal provenances grew taller than southern, high elevation, interior sources at both plantations. However, these faster growing sources also showed the greatest relative reduction in growth and survival when planted at the inland site (Kitzmiller 2000, unpublished).

Growth measurements would continue, and deleterious, episodic events assessed and genetic effects evaluated as warranted. Even very harsh sites with poor survival have value. For example, Sharpe (2002) assessed drought-prone interior sites (Althouse and Trinity Lake) sites, as well as greenhouse, in her study of drought resistance and root regeneration of POC genotypes. Her findings generally supported those of Zobel et al. (2001); mid-day field water potentials were correlated with survival of seedlings from different breeding blocks. Root growth and morphology also varied among seed sources, with probable adaptive consequences (Sharpe 2002). These data could be helpful in designing PL resistance mechanism studies.

Overall, these POC genetic variability studies fit with the classical, theoretical population genetics theory of changing responses to mutation and genetic drift, as confounded by various selection pressures (over time and space) and by migration patterns and rates (Namkoong 1979, p.312). Practically, the gradual clinal trends collectively infer adaptive changes in gene frequencies across the species' range. These data were all considered in developing geographic subdivisions for POC (see Breeding Block and Zone Designations as follows). They are also fundamental in breeding strategy planning (see Program to Develop Genetic Resistance to *Phytophthera lateralis*: Selection, Testing, and Breeding section), for deployment of resistant seed (see Utilization of Resistance section), and for general genetic and silvicultural management practices.

Breeding Block and Zone Designations

A breeding block designates the geographic area that envelops a number of breeding zones. Preliminary breeding blocks and zones have been delineated on the basis of a short-term genetic common garden study (Kitzmiller and Sniezko 2000) and general knowledge of southwestern Oregon and northern California species genecology (Figure 3&4-2).

Genetic common garden studies are short- and/or long-term tests that are commonly used to assess seed transfer or breeding zones (Westfall 1992). The common garden study noted genetic variation associated with latitude, longitude, and elevation of the seed sources. These macro-geographic variables, in part, imply natural selection to temperature and moisture, which affects growth initiation, growth cessation, and growing season length and climatic gradients over the range of the species. Additional studies (Miller and Marshall 1991; Zobel et al. 2001; Zobel et al. 2002) have also noted differences between the coastal and inland sources of POC in relation to allozyme, phenology, and physiological traits. In addition, a long-term common garden field study was established between 1996 and 1998 to assess genetic variation patterns over a long timeframe. Future analyses of this study would be used to verify and/or refine the genetic variation patterns inferred from the short-term test.

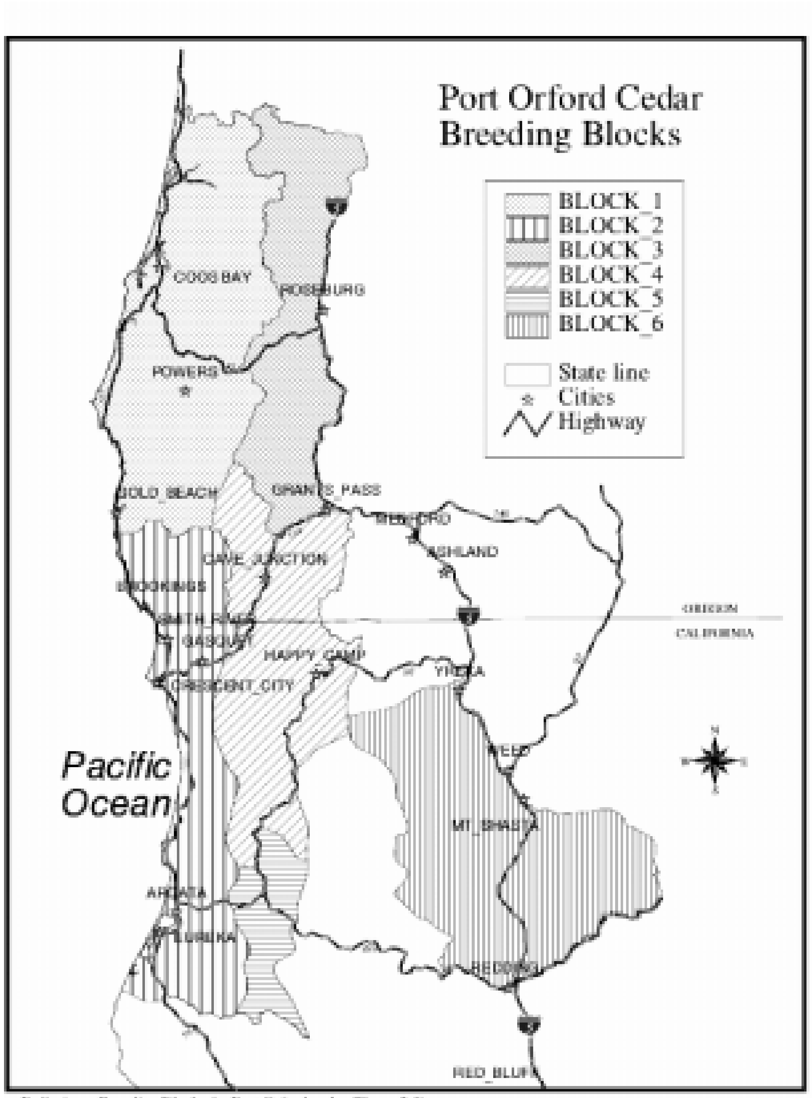

Figure 3&4-2.– Port-Orford-cedar breeding blocks

Breeding blocks and zones represent a geographic area where genetic reproductive materials (seed, seedlings, cuttings) are procured, and then subsequently deployed (seeded or planted). This insures that the seeded or planted stock are adapted to the deployed areas, and also helps conserve the natural genetic structure of the species over the landscape.

The preliminary breeding blocks and zones serve to guide seed transfer and associated breeding activities. Breeding zones are represented by elevation bands within the respective breeding blocks, and designate units of land in which seed transfer and improved populations (e.g., resistance breeding) are being developed. The elevation bands are listed in Table 3&4-21 (also see Figure 3&4-2). An elevation band within a breeding block constitutes a single breeding zone; all elevation bands are not represented in every breeding block.

Seedlots may also be delineated within any respective zone in the future on the basis of source soil type. POC occurs on both ultramafic (e.g., serpentine) and non-ultramafic soil types. A number of plant species have differentially adapted to these distinct soil types (Linhart 1995), but the degree to which POC has specifically adapted is not well known.

Conservation Genetic Considerations

Conservation genetics deals with the inherent genetic diversity of a species, and has been defined as the use of genetics to preserve species as dynamic entities that can evolve to cope with environmental change, and thus minimize their risk of extinction (Frankham et al. 2002, p. 19). Conservation genetics is especially relevant to the current POC ecosystem dynamics where populations are being fragmented to varying degrees as the disease spreads through portions of the landscape. The basic principles of genetics can be used to assess the effect on population structure. In addition, current or future conservation measures can be assessed as to their efficacy in conserving genetic diversity. This section will discuss aspects of the following: (1) effect on POC genetic structure where PL is spreading or has been in place; (2) general genetic effects of establishing resistant stock in restoration efforts; and (3) ex-situ and in-situ genetic conservation measures.

1) Effect on POC genetic structure where PL is spreading or has been in place: Population-level conservation is sufficient for both genetic and species conservation with a simple to very diverse structuring (Namkoong et al. 1988, p. 151). Population genetic structure refers to the amount and distribution of variation within and among populations. The genetic properties (and structure) are affected by population size, fertility, viability, migration (gene flow), mutation, selection, mating systems, and genetic drift in combination with environments (Falconer 1989, p. 6).

Many forest species adjust to repeated loss (such as through disease) and subsequent reinvasion (or recolonization) of its range (Stern and Roche 1974, p. 228). Change in genetic structure of populations can be summarized by the changes in allele frequencies, heterozygosity, and genetic variances. When populations are completely isolated from others (where there is no gene flow from pollen or seed), fragmentation would typically lead to greater inbreeding (reduced heterozygosity), loss of genetic diversity within fragments, loss of rare alleles, and greater risk of extinction of these populations (Frankham et al. 2002, p. 309). Fortunately, since extirpation has not occurred (see Note under previous Allozyme Studies section) nor is it predicted to in this analysis, the other genetic consequences may only be applicable in rare circumstances, mostly in very small disjunct inland locales with limited gene flow among stands.

A large segment of POC habitat can be described as a composite of numerous subpopulations (a deme or group of interbreeding individuals) where gene transfer (migration) occurs among subpopulations over time. The main factor relating to change in population structure is the rate of extinction of subpopulations and number and type of founder individuals that colonize the extinct subpopulations (Hedrick and Gilpin 1997). In addition, it is pointed out that the effective population size is increased when the rate of extinctions is reduced, and the number of subpopulations and rate of gene flow are increased. Selection pressures (as an evolutionary force) in any population will ultimately change allele frequencies to some extent. It is the combination of genetic processes that formulate both genetic structure and magnitude to which the structure changes over time.

Even after a severe PL invasion of prolonged duration, surviving natural POC persist and continue to exchange genes (both pollen and seed transfers) with neighboring subpopulations. A very analogous process would likely occur between resistant stock used to rehabilitate PL infestation sites and surviving POC from the same stand and others nearby, although gene flow may be limited and directional until planted trees reach reproductive capacity (see Genetic Resistance Program section) to balance natural trees.

When small, relatively isolated stands are considered (often referred to as the island or stepping-stone model) only small numbers of immigrants (~ 1; where 1 = [effective population size] x [percent of immigrants from other populations]) in any respective generation are required to prevent loss of alleles (prevent fixation by drift) and differentiation among populations (Falconer 1989, p.80; Namkoong 1979, p.308). When subpopulations are more continuously distributed over the landscape (neighborhood model typical of coastal conditions) and gene frequencies are more similar (among subpopulations), the effective population size must be on the order of 20 or less (circumstances not generally found in coastal subpopulations) for a large amount of local differentiation (Falconer 1989, p.80). Hence, in nature high genetic standards result for adaptability and species survival (fitness), but provides mechanisms or processes to promote genetic diversity/variation over time and spatial scales.

2) General genetic effects of establishing resistant stock in restoration efforts: Resistant stock can be deployed to various habitats throughout the natural range in order to help restore the habitats where the disease has occurred. Once disease resistance is obtained, it is useful, and it can be improved over time in an operational breeding program (Zobel and Talbert 1984, p.274). In addition to restoring the habitat, planting would help reestablish gene flow to a degree. This would enable pollen flow and migration (seed transfer) of selectively advantageous alleles/genes to be spread to adjacent subpopulations over time (Ledig 1986).

The genetic structure of the local or subpopulations would be dependent on the effective population numbers of the planted stock in addition to the various factors presented earlier (such as gene flow, number of subpopulations, etc.). The genetic structure over the species' range would probably not be changed much, since these plantings would not be on a scale sufficient to change effective population sizes over a large continuum of the range.

3) Ex-situ and in-situ genetic conservation measures: Gene conservation conserves and stores gene pools which in turn helps prevent the loss of genes, gene complexes, and genotypes (Zobel and Talbert 1984, p.461). In practice, application of gene conservation strategies, common genetic conservation measures that are undertaken to conserve genetic variation of a species, can be separated into two broad categories: (1) Ex-situ (saving genes offsite such as seed banks, clone banks, seed orchards), and (2) in-situ (management of populations onsite). Saving genes with efficiency, security, and completeness are the first objectives for conserving biological diversity, and ex-situ conserves genes more conveniently (Namkoong et al. 1988, p.152). In-situ continues the evolutionary process in the wild, but it may not be practical (Namkoong et al. 1988, p.152), or the natural stands may be vulnerable to damaging agents (such as disease) or catastrophic events (Ledig 1986). Thus, conservation measures are selected and put into place to meet specified conservation objectives.

a) In-Situ — Coastal Populations: Miller and Marshall (1991) suggested that in California, because of low allozyme distance among populations and high proportions of variability within stands, a few large (as opposed to many small) natural areas would conserve much of the genetic diversity in POC. The same conclusion should also apply to coastal Oregon populations. Indeed, even in stands that have been severely infested for 30 to 40 years, some seed bearing POC seem to survive, whether by favorable location on micro-habitat niches that escape infection, by random chance, or by some combination of heretofore undetected quantitative genetic resistance mechanisms. Furthermore, the precious and prolific seed production of POC (Zobel 1979), its relative shade tolerance and ability to establish itself on a variety of seedbeds (Zobel et al. 1985) seem to result in continued natural regeneration on these infested sites. On the Oregon coast, it appears that natural conservation areas are presently, functionally covered by Reserve and Withdrawn Land Use Allocations (Table 3&4-3).

b) In-Situ — Inland populations: Frequently disjunct, inland stands of POC have much smaller pre-infection effective population sizes, restricted gene flow with "neighboring" subpopulations, and a higher "average" predicted infection percentage (Table 3&4-10, Pathology section), as well as a likelihood of the occurrence of proportionally more rare alleles. Some notable stands and large acreages are also protected by Reserve or Withdrawn Land Use Allocation (Table 3&4-3). Examples include the Brewer Spruce Research Natural Area (RNA) southwest of Grants Pass; Beatty Creek RNA west of Riddle, Oregon; Caves National Monument; and Late-Successional Reserves. Riparian Reserves may be particularly unsuited for protection of POC, since they are often, by definition, high hazard sites.

c) Ex-Situ – Seed Collections: Several authors have noted that ex-situ collections can extend the range of genetic protection and reinforce in-situ programs (Miller and Marshall 1991). Ledig (1986) advised that ex-situ methods should be used when possible as added insurance against loss. Miller and Marshall (1991) recommended that seeds should be collected as soon as possible from main stands throughout the range, especially in infested areas and from dying trees.

They further noted that early evidence suggests that POC seeds may retain high viability for more than 50 years under proper cold storage conditions.

A substantial quantity of POC is available in operational reforestation seed lots. Over 120 pounds of seed, representing nine seed zones (with discrete elevation bands within them, ranging from 1,000 to over 4,000 feet), collected from over 250 wind-pollinated trees from natural stands are in storage at the five administrative units (Coos Bay, Medford, and Roseburg BLM; the Siskiyou NF; and the FS Dorena Genetic Resource Center). This broad-based store of locally well-adapted, but primarily nonresistant parents, all collected since 1989, is available for project work, rehabilitation following catastrophic events, and as operational baseline controls (for contrasts with bred, resistant stock). In some breeding zones, operational seed lots are rapidly being replaced by resistant seed from orchards, although the rate of conversion would vary by alternative (see Table 3&4-21 in Program to Develop Genetic Resistance section). Each production orchard at Dorena Genetic Resource Center also has a current goal of a conservation seed bank of 50,000 to 100,000 seeds, primarily for use in unscheduled restoration projects (following wildfires, for instance).

Open-pollinated cone collections from single trees of precisely known location formed the basis for many past genetics research projects, including the range-wide common garden study (see Genetic Variation discussion). Approximately 500 of these half-sibling families each retain at least 50 seed in storage. While their primary utility may be for additional research projects, they can also serve simultaneously as ex-situ genetic reserves. Dorena Genetic Resource Center also maintains an operating, expanding collection of full-sibling families, inbred lines, and a variety of other materials used in their work on breeding PL resistance.

d) *Ex-Situ – Vegetative Material:* There exist a number of ex-situ collections of clones/families which are preserved at various locales. Dorena Genetic Resource Center maintains a breeding arboretum of numerous clones, in containers. The BLM Tyrrell Seed Orchard, southwest of Eugene, Oregon, currently contains numerous clones, with 3 ramets per clone, in an "in-ground" clonebank. More room is available for expansion, as an offsite backup for Dorena's material, as well as a longer-term repository.

The numerous validation plots established in the field (see Genetics section) also serve as repositories of known identity and pedigree. The range-wide common garden plantations also preserve half-sibling, open-pollinated families, as well as bulked reforestation lots. Finally, although their natural origins are largely unknown, the 50 or more cultivars currently still available commercially (Zobel et al. 1985) could be of interest, especially since their adaptability to a wide range of climatic extremes may be appreciated by horticulturists.

These materials represent a sampling of the gene pool, and preserve both resistant and non-resistant materials from across the species' range. They would be utilized in the future breeding program to some extent, and help conserve the gene pool on a limited scale.

Program to Develop Genetic Resistance to *Phytophthora lateralis*: Selection, Testing, and Breeding

Nearly all seedlings and trees of POC are highly susceptible to PL. This is one reason for very high mortality levels (potentially 90 percent) on infested high-hazard sites in natural ecosystems. On these sites, very few, if any, seedlings would ever survive beyond the sapling stage. There appears to be genetic resistance within native POC populations, however, only a very small percentage of trees have complete resistance (probably less than 1 percent of trees) and only a low frequency of trees appear to demonstrate partial resistance or slower rate of mortality (further investigation is underway) (Sniezko, *unpublished data*). The rare, resistant trees are too scattered to expect natural interbreeding toward resistant stock without severely compromising genetic diversity in the high hazard areas. A resistance program coupled with restoration efforts can overcome this.

Based on initial indications of genetic resistance in the late 1980s (Hansen et al. 1989) and confirmation in cooperative work between the BLM, FS, and OSU in the early 1990's (Sniezko, *unpublished*) an operational program to develop resistance was begun in 1997. Over 9,000 prospective resistant trees were selected between 1997 and 2001 on Federal and non-Federal lands (Bower et al. 2000; Sniezko et al. 2003b) funded in part by a special technical development proposal. Until the start of this program, only a handful of trees had been identified with complete resistance. By 2002, more than 100 trees had been identified with complete resistance (Sniezko, unpublished data). Traditional resistance breeding such as employed in the program allows bringing together stock from those present, and allowing them to pollinate each other to generate populations of diverse, adapted, and resistant trees without having to utilize the recently devised but controversial techniques used in the development of genetically modified organisms.

The resistance program is based at the FS Dorena Genetic Resource Center and is a cooperative venture between the BLM and FS. OSU provides disease testing facilities and further technical pathology input. The primary resistance test is a greenhouse root dip test of seedlings or rooted cuttings (Sniezko et al. 2003a). In the greenhouse, rooted cuttings of some field selections consistently show high levels of survival (usually 100 percent), while rooted cuttings of susceptible parents often show 0 percent survival (Sniezko and Hansen, unpublished data). Seedling survival in greenhouses can vary from 0 to 100 percent 9 months after inoculation depending on the family tested (Sniezko et al. 2002; Sniezko and Hansen 2000; Sniezko et al. 2003a; Sniezko et al. 2003b).

Field validation plantings have been established at more that 20 sites (Federal, county, and private cooperators), but most tests were established since 2000. The oldest field test (planted in 1989) is at Oregon State University's Botany Farm. The resistant clones (using rooted cuttings of parent trees selected at field sites) and a seedling family have shown good survival and little new mortality in the last 7 years (Sniezko et al. 2000). Nearly all of the susceptible clones died within the first 2 years at this site (Sniezko et al. 2000). Three-year results from one of the 2000 test series involving 26 seedlings families showed that short-term greenhouse testing correlated well (r = 0.65 to 0.84) with a raised bed test and with tests at two field sites (Sniezko, unpublished data). All four of these tests had moderate to high mortality levels (41 to 69 percent). Analyses of additional tests of this nature are underway, but at this point current data suggest the utility of resistant trees on high hazard areas would be good.

There is difficulty finding good tests sites on BLM and FS land that are available for planting, but other interested landowners (county and private) have recently provided sites. These validation tests would be followed over time to determine whether resistance holds up under an array of environments, as well as whether the resistance is durable.

Two of the earliest field selections have survived in high hazard areas infested with PL since the late 1980s. Progeny and/or rooted cuttings of trees with complete resistance have been repeatedly tested in short-term tests and have consistently demonstrated higher survival (50 to 100 percent) than the most susceptible trees (less than 10 percent). Complete resistance in POC is likely a form of major gene resistance (Sniezko, unpublished data), but it is unknown at this point whether there is more than one resistance mechanism for complete resistance.

Future breeding efforts would focus primarily on improving the levels of partial resistance as these traits are confirmed. Several generations may be needed to increase the levels of partial resistance to levels sufficient for field use. Under natural stand conditions this process would proceed slowly, if at all, due to the rarity of resistant trees and the pollination by susceptible trees outside the immediate high hazard areas. Fortunately, breeding generations for POC are relatively short (3 to 6 years or more depending on funding). Parents with partial resistance could also be easily added to orchard populations as desired. Resistance from a putative major gene(s) and the affiliated complete resistance already yields moderate to high survival (50 to 75 percent) and this resistance would generally be incorporated directly into the seed orchard populations. The potential addition of partial resistance would increase the diversity of resistant mechanisms and should bolster the durability of resistance. As feasible, the genetic base for each breeding zone would incorporate selections from throughout the breeding zone. Breeding strategy would be adaptive to take advantage of new findings on inheritance of resistance and to try to keep the genetic base of orchard populations broad. Seed production levels from orchards could easily and inexpensively be increased as needed to meet any Federal or non-Federal needs for resistant seed. Once resistant populations are established in the field it is anticipated that resistance in future generations of natural regeneration would be sufficient to sustain populations in areas of high hazard.

The biology of POC (Elliott and Sniezko 2000; Sniezko et al. 2003b) and high levels of interagency cooperation have allowed very rapid development of resistant populations and orchards for a few breeding zones (Table 3&4-21). Current estimates based on greenhouse and limited field tests indicate that 50 to 75 percent of the seedlings from orchards should survive areas infested with PL versus less than 5 percent of highly susceptible parents. The first resistant seed from seed orchards was available in fall 2002 (Table 3&4-21). If funding is available, selection and testing of additional resistant candidates would help establish seed orchards for additional breeding zones.

Work on the inheritance of resistance and field validation continues, directed by staff at Dorena Genetic Resource Center. With funding and plant materials from the BLM, FS, and OSU has undertaken a project to examine the underlying nature of some types of genetic resistance. Results from these projects and trials would help lead to more efficient development of resistant populations of POC. As new information becomes available it would be incorporated. Containerized seed orchard technology developed at Dorena for POC allows orchards to be updated as frequently as needed to increase genetic diversity or the amount and types of resistance.

Co-evolution of POC and PL. The genetic variability and evolutionary potential of the pathogen can also be important in developing resistance that would be durable. Fortunately, PL appears to have relatively little genetic variability (McWilliams 1999; Goheen et al. 2003). The geographic origin of PL is unknown, but is thought to be outside the range of POC (Goheen et al. 2003), and thus POC and PL have not co-evolved. The low genetic variability suggests the likelihood of a single or limited number of introductions. PL may or may not exhibit greater genetic variability in its sites of native origin. The chance of accidental importation of new strains of PL is very low, but could cause concern if strains with virulence to resistance in POC were introduced. However, the spread of such a strain should be slow, especially if any management measures that slow the spread of PL are in place. The lack of genetic variability in PL in the Pacific Northwest increases the likelihood of developing durable resistance. Pathogens with lower migration rates and relatively low population sizes are hypothesized to have relatively lower evolutionary potential (McDonald and Linde 2002). Thus there appears to be good likelihood for durability of complete resistance in POC. Even if breakdown of resistance were to occur in one location, the redistribution of any new virulent strain would be slow, if it would occur at all. An array of management techniques and options are available (Goheen et al. 2000) and can be utilized to increase the potential

Table 3&4-21.— Projected resistant seed availability per breeding zone by alternative durability of resistance for POC. Confirmed resistant parent trees in the field can be monitored over time to assay whether a new virulent strain of PL may have arisen.

In summary, the majority of trees in high hazard areas infested with PL would die. Without the use of resistant seedlings there would be little chance of large tree structure developing for POC in these areas. Some of these areas would continue to have large POC on nearby adjacent sites that are low hazard (particularly where POC is not confined primarily to riparian areas). Private landowners are unlikely to plant nonresistant POC decreasing the species diversity on their lands.

Utilization of Resistance

The current anticipated level of resistance to PL (50 to 75 percent survival) is high enough to deploy in those breeding zones for which there is orchard seed. The level and the number of resistant mechanisms should increase in the future. Resistant seed can now be used to achieve large POC on high hazard sites when this is a goal. Resistant seed can be used on almost any high hazard site for PL, except in areas where there is a high probability that infection would spread to uninfected POC downstream, or in sanitation areas along roads (because 25 to 50 percent of the seedlings from the first-generation orchards would be susceptible and that even the resistant seedlings may be host to PL spores [at a reduced level]). Planting guidelines for resistant POC should take account of the current expected levels of resistance.

Vegetative propagation (rooted cuttings for POC) may increase the survival to 75 to 100 percent, while still planting a diverse array of genotypes. However, this may not be the most cost-efficient because of (1) the added cost of rooted cuttings (over seedlings), (2) the potential added selection pressure on the pathogen (if relatively few clones are planted), and (3) the potential of increasing the resistance level available in the near future from seed.

Large amounts (millions) of resistant seed can easily be produced for those breeding zones for which there are containerized seed orchards. Direct seeding may be a viable alternative to planting in some cases.

The ease of seed production for POC also opens an opportunity to supply non-Federal landowners with seed for reforestation or horticultural needs. Estimates from 2000 indicate that the need from these landowners in coastal Oregon would be more than 400,000 seed per year. Without resistant seed, most non-Federal landowners would not plant POC (or would plant at much lower levels) and the forest plantations would be less diverse.

Effects of Alternatives — General Discussion

Port-Orford-Cedar Genetic Structure: The most critical variable for determining change in genetic structure of POC over the landscape may pertain to the percent of an area that is of high risk to the disease, and the respective probabilities for infection and associated mortality over time. This percentage would vary over the next 100 year period of time, depending upon the selected management alternative, over portions of the POC range accordingly: Coos Bay BLM District/Siskiyou NF Powers Ranger District—16 percent to 19 percent; Siskiyou area—15 percent to 34 percent; and Inland Medford and Roseburg BLM—19 percent to 50 percent (Table 3&4-10). On the basis of the affected areas where mortality might progress/

occur and the fact that subpopulations would infrequently be (if ever) entirely extirpated in the POC range, the very localized genetic population structure(s) would be impacted to varying degrees, but the species' genetic structure, overall, should not be intrinsically altered. This is due to the large number of natural regeneration, proximity of neighboring subpopulations or stands, and migration events (gene flow) that occur over time. In addition, the degree to which resistant stock is reintroduced into the infected locales would also be a factor in the effects per alternative. The basic causal factors associated with changes in population structure apply to the planted stands as well. Gene exchange continues amongst the neighboring subpopulations, and the genetic structure evolves for the same reasons as stated previously.

Availability of Resistant Seed for Restoration: Although POC is not in danger of extinction, there are some high hazard areas (particularly riparian areas) where 90 percent or more of the POC trees are dead. In these PL infested areas it is not likely that POC would get older and bigger as long as the disease is present and there is no resistant stock planted. If large POC trees in these specific areas are desired, the use of restoration with resistant seedlings may be effective. Restoration, either following PL infestation and mortality, or preemptive (on sites anticipated to suffer high mortality in the next 50 or 100 years) would potentially allow for reestablishment of POC as it existed before PL. The use of standard silvicultural tools may be used to promote good growth of POC, thus decreasing the time to develop large POC trees.

Once resistant trees are established in heavily impacted areas they would serve as parents for future generations, thus allowing for natural regeneration. This would be particularly desirable if there are affected portions of Late-Successional Reserves where large POC is desirable for future generations. In most areas, the genetic base for future generations would be large and would include both surviving POC around the infested riparian area and the resistant POC. Thus, the genetic composition for the future would continue to be broad and help ensure adaptability of POC to changing future environments.

In fall 2002, large quantities of resistant seed became available for 3 of the 19 breeding zones that include Oregon (some of these zones also include parts of California). Seed from one of these breeding zones could probably be used for two others without much compromise in either resistance or adaptability. Thus, the option of restoration with resistant seed is now available to land managers, particularly in the coastal Oregon Breeding Block 1 (Table 3&4-21). Under current program levels, it is projected that resistant seed would be available in 2010 to 2045 for other breeding zones (Table 3&4-21)

Since POC readily produces abundant seed, resistant seed could be made available to non-Federal landowners, although some barriers to this seed transfer need to be overcome. Use of resistant POC by non-Federal landowners would provide these landowners with another species to use in their plantings, adding to the biodiversity on the landscape and potentially boosting local economies. This is also important in these areas because of the recent negative impacts of Swiss Needle Cast disease of Douglas-fir as well as the potential impacts of Sudden Oak Death to the diversity of the forests and plantations (POC is thought not to be susceptible to either of the causative pathogens). Management of the seed resource by the BLM and FS would help ensure genetically diverse seed would be used—this should help ensure durability of resistance by limiting the potential for plantations involving only one or a few clones. Guidelines could be developed to help all landowners play a role in maintaining the durability and utility of the resistant POC resource.

For breeding zones without enough tested selections to find resistant parents to utilize for seed production there are several options, including:

1) No mitigation of high hazard PL infested areas with POC mortality now or in the future. Leaving the process to strictly natural regeneration when only a few rare scattered resistant POC serve as the foundation for future regeneration may severely restrict genetic diversity. Large trees (if they do develop in each local area) would be very limited in their genetic variability (probably be the offspring of only a couple resistant trees even if pollen were to come from additional susceptible trees).

2) No mitigation of high hazard areas now due to lack of resistant seed, but proceed with the development of resistant orchards to allow restoration efforts at a future date (2010 to 2045 depending upon breeding zone). The restoration of large POC in the ecosystem would be delayed, but the genetic diversity would be broader when they are established. This would provide for a POC population more likely to persist over generations.

Breeding zones vary dramatically by the acreage of POC on Federal lands (see Table 3&4-21). However, the breeding zones where resistant seed would be most valuable for restoration may depend other factors, including the role POC plays in the specific ecosystem, the percentage of POC on high-risk sites, and the relative abundance of POC in a area. Prioritization of breeding zones by managers would potentially enable earlier resistant seed development in the zones given higher priority. New selections could generally have a resistance evaluation and be producing seed in as little as 5 years of selection in the field—timing of orchard seed availability depends upon level of funding available, and to a lesser extent, limits of facilities and personnel.

Effects of Alternatives — Discussion by Alternative

Alternative 1

Port-Orford-Cedar Genetics Structure: The relative projection of infection/mortality (Table 3&4-10) varies between 17 to 29 percent over the extent of the species' range in Oregon. The relative mortality predictions are similar for Alternatives 1, 2, and 3 within each of the respective macrogeographic areas; defined as Coos Bay BLM District/Siskiyou NF Powers Ranger District, Siskiyou, and Inland (Medford and Roseburg BLM). Fragmentation would likely be higher in the Inland riparian zones as opposed to the other two macrogeographic areas. However, there would still be survivors within the immediate infested area (about 10 percent), and neighboring uninfected POC (seed trees) reside within the confines of riparian vegetative habitat (outside of, or on microsites within, the highly infected zone). This allows both natural regeneration and pollen flow throughout the area. Thus, there is likely to be little effect on genetic diversity and structure over the landscape scale. Gene frequencies have been and would be modified to an extent, but this also occurs in the natural populations (uninfected) as well. The Coos Bay BLM District/Siskiyou NF Powers Ranger District area has larger continuous stands and subpopulations. This area would experience large amounts of natural regeneration from a larger gene pool base in addition to larger gene flow (pollen). This should create less population level divergence, and should also promote population structure stability over time.

Resistant stock would also be planted in varying amounts in infected areas, and this would help conserve the gene pool and structure to a commensurate degree. The planting of resistant stock in those breeding zones with orchard production should enhance genetic diversity in comparison to those breeding zones without. This is a result of the relative difference in gene frequencies (in this seed orchard population versus local stand population), which creates a more diverse genetic base in this locale after planting.

Availability of Resistant Seed for Restoration: Under Alternative 1, the interagency resistance program would proceed at current levels (assumes funding is stable). No resistant seed was available until fall 2002 (for some breeding zones), but restoration with resistant seedlings can now be considered in project analyses and used as a mitigation technique where relevant.

Seed orchards have been established for a few breeding zones, but for most breeding zones many more field selections (probably more than 1,250 per breeding zone) are needed to find the low frequency resistant trees.

The source and timing of funding for additional field selections would determine which other breeding zones resistant orchards are developed as well as the timeline to develop them. Table 3&4-21 projects by breeding zone when resistant seed might become available. In order to increase the diversity of resistance and level of resistance, breeding would need to continue after the initial first generation orchards were established.

For planting on low hazard sites, nonresistant or resistant seedlings could be utilized. Under this alternative, restoration on high hazard sites could begin now for only certain breeding zones; other breeding zones would not have resistant seed for another 7 to 42 years (Table 3&4-21). Without this restoration effort, large POC would likely not develop in many affected areas.

Alternative 2

Port-Orford-Cedar Genetics Structure: The relative projection of infection/mortality (Table 3&4-10, Pathology section) varies between 17 to 27 percent over the extent of the species' range in Oregon. This is virtually the same as Alternative 1 projections, and for the reasons described in Alternative 1, there is probably little effect on genetic diversity and structure over the landscape scale. One minor difference pertains to the slightly decreased infection rates, with obvious, commensurate declines in need for restoration plantings.

Availability of Resistant Seed for Restoration: Alternative 2 would be similar to Alternative 1 (see above) in potential effects of resistant seed. One of the objectives of this alternative is to attempt to reestablish POC in plant communities where it has been significantly reduced in numbers by root disease. Restoration with resistant seed would be the best opportunity to accomplish this. As in Alternative 1, the continued development of resistant stock for various breeding zones would continue at current levels (assuming current funding levels maintained). A deployment strategy for the planting of resistant POC stock would be included, and would give consideration to state, county, and private lands (see Appendix 6). Because a seed bank for each breeding zone that has an orchard for the production of resistant seed would be established, there would be seed available immediately after stand replacement events such as large-scale wildfires.

Alternative 3

Port-Orford-Cedar Genetics Structure: The relative projection of infection/mortality (Table 3&4-10) is 15 to 19 percent over the extent of the species' range in Oregon. In Alternative 3, the change in genetic structure and diversity outside of the POC core areas should be similar to effects stated in Alternatives 1 and 2. Protecting uninfested POC cores and buffers (6th field watersheds map for Alternative 3), if successful in preventing infection by PL over a longer period of time, would maintain the populations in a more natural state. The population structure would be affected less in these areas, where they evolve without the PL factor being present.

Availability of Resistant Seed for Restoration: The use of resistant seed and its effects (increasing the potential of large POC trees in high hazard areas infested with PL in the future) should be similar to Alternatives 1 and 2. Because of the additional protected areas, there should be fewer PL infested areas that may need restoration with resistant seedlings.

Alternative 4

Port-Orford-Cedar Genetics Structure: The greatest amount of infection and predicted mortality occurs in Alternatives 4 and 5 (Table 3&4-10): Coos Bay BLM District/Siskiyou NF Powers Ranger District—19 percent; Siskiyou—34 percent; and Inland—50 percent. The effect of this alternative in the Coos Bay BLM District/Siskiyou NF Powers Ranger District area would be similar to those stated in Alternatives 1 and 2. Population structure would not change to a great extent in this area, with or without the planting of resistant stock, in consideration of the large amount of natural regeneration, gradual environmental gradients, and more continuous interbreeding populations. The largest amount of fragmentation and effect on population structure would occur in the Siskiyou and Inland populations. The planting of resistant stock provided in this alternative would be helpful in conserving and/or improving upon the diversity of gene pools. The accelerated level of resistance breeding provided in this alternative, should enable resistant stock to be planted at a quicker rate across more breeding zones, if so desired. Large planting programs in the inland breeding zones would also modify the populations to a greater extent than that described for the Coos Bay/Powers area. Initially, effective population sizes would probably decrease (in numerical number) even more in the Inland zones because of high-risk sites (scattered riparian habitats) being spread (with resultant fragmentation) across the landscape. Selection pressures over the expanded area would change allele frequencies to some extent, and is expected whenever selection pressures are applied to populations. Planting resistant stock in these situations may have the greatest relative genetic benefit (see discussion on migration of genes in Effects on Genetic Structure section). However, the effective population sizes (within and among subpopulations) should still be within the orders of magnitude that are sufficient to prevent large scale population divergence and loss of common alleles across the landscape.

Availability of Resistant Seed for Restoration: Alternative 4 would expedite the availability of resistance seed for those priority breeding zones in which seed is not available (Table 3&4-21). More high hazard areas would be expected to experience mortality under Alternative 4 (78,000 acres compared to 43,000 acres under Alternative 3, and 52,000 acres under Alternative 2); more resistant seed would be needed to replace dead POC (however, seed availability is not anticipated to be a limiting factor, once an orchard is operational for a given breeding zone). There are still many areas in all parts of the range of POC that are low risk. In the future as resistant trees develop, this alternative should lead to an increase in large POC over the landscape in those high hazard areas that would be PL infested under other alternatives. The sooner the resistant seed is developed the sooner the restoration of large POC can develop. However, additional restoration would be needed in areas that would not be affected under Alternatives 1, 2, and 3.

Alternative 5

Port-Orford-Cedar Genetics Structure: The predicted levels of mortality are the same as in Alternative 4, but resistant stock would be limited primarily to the Coos Bay BLM District/ Siskiyou NF Powers Ranger District area (about 65 percent of the POC acreage). Population structure would not change to a great extent in this area for the reasons described in Alternative 4. The changes in population structure and probable changes in the gene pool would be slightly greater in this alternative versus Alternative 4. This is due to the inability to plant resistant stock into the Siskiyou and Inland areas. The effects of this alternative would be similar to Alternative 4, except that there would be minimal opportunities for restoring the impacted habitats. While natural evolution of resistance to PL is theoretically probable, the rate and degree of natural resistance would vary markedly over time and space. Selection pressures in this alternative would have similar effects as in Alternative 4, where allele frequency change over time reflects the high selection pressures within the infected areas. Failure to plant resistant POC in the Inland breeding zones of highest disease incidence can lead to lesser effective population numbers in localized areas (where disease is present). This could lead to greater population divergence and loss of rare alleles. However, the effect on the overall population structure across the landscape should still be similar in magnitude to Alternative 4, where there is sufficient variation across the landscape in effective population sizes to prevent large scale population divergence and loss of common alleles.

Availability of Resistant Seed for Restoration: Under Alternative 5, only some breeding zones would have resistant seed available (only those for which orchards are currently available) (see Table 3&4-21). For most breeding zones, 85 percent of high hazard areas for PL would seldom achieve large POC, resulting in a loss of large POC across the landscape (in high hazard areas which include many riparian areas). Further development of resistant program would cease, limiting the diversity of parents represented in current orchards as well as the potential for including other resistance mechanisms. Impacts could be reduction in potential durability of resistance to PL, as well as continued absence of large POC in some areas. Under this alternative there would the most acres affected (similar to Alternative 4) and the fewest acres with restoration using resistant seed (few breeding zones would have seed available), resulting in the fewest acres potentially achieving large POC.

Fire and Fuels

There are three aspects of Fire/Fuels potentially affected by POC root disease and the alternatives for its management: (1) the management requirements of the various alternatives can have a direct affect on the Agencies' ability to fight fire successfully; (2) the direction in the various alternatives can have a direct affect on the Agencies' ability to reduce forest fuels; and (3) the level of fuel loading created by disease-killed POC. Since POC killed by the root disease contribute directly to forest fuel loading, the success of the alternatives at reducing mortality affects forest fuel-loading levels. Mortality-related fuel-loading differences between the alternatives is much less than 1 percent of the total fuels in the area at any one time because of the distribution and stocking levels of POC in the landscape, the relatively slow spread of the disease, and the relatively limited difference in annual POC mortality between the alternatives. Hence, this third aspect will not be discussed further in this section.

Affected Environment

Wildland Fire Suppression

Wildfires are common within the range of POC. Southwestern Oregon has a long history of major fire occurrence (Payne 1983; Haefner 1975; Cooper 1939; Morris 1934). Recent large fires have included the 500,000-acre Biscuit Fire in 2002, the 6,998-acre Mendenhall Fire in 1994, the 2,201-acre Chrome Fire in 1990, and the 9,860-acre Longwood Fire and 96,310-acre Silver Fire in 1987.

Fire occurrence has averaged 35 fires per year on the Siskiyou NF (1970 to 2003), and 34 fires per year on BLM-administered lands (1970 to 2002). A majority of these wildfires (71 percent) are suppressed at less than 0.25 acres. A little over 1 percent of the wildfires exceeded 100 acres. Most of the wildfires are lightning caused (52 percent), as are nearly all of the large fires (greater than 1,000 acres) (79 percent). The next most common cause of all wildfires (22 percent) is from recreational users (such as campfires and smoking). Fire season is typically during the drier months with approximately 86 percent of all fires occurring from June 1 through September 30. Fires are generally less frequent from east to west and south to north in the range of POC. The Powers Ranger District, for example, has the greatest concentration of POC in the world, but averages less than three wildfires per year (1970 to 2003) with the largest fire at 94 acres.

The objectives of initial attack fire suppression is to safely and efficiently suppress fires in conformance with existing policy and procedures, consistent with approved fire management and land and resource management plans. The FS has initial attack responsibility for the Siskiyou NF and the BLM has contracted with the Oregon Department of Forestry for its initial attack fire suppression.

All wildland fire suppression Agencies in southwest Oregon have interagency agreements to share suppression resources within preplanned responsibility areas. These areas generally border adjacent Agency jurisdictions, and several Agencies could respond to a wildfire in these mutual aid areas. Resources dispatched to a wildland fire depend on the Agency jurisdiction, values threatened, preplanned dispatch plans, fire danger rating for the day, and resource availability.

All of the wildland fire Agencies rely on similar initial attack fire suppression resources, such as engines, hand crews, tractors, aircraft (including fixed-wing air tankers and helicopters), smoke jumpers and rappellers. The staffing and availability of these resources are determined by the time of year, available funding, seasonal severity, and minimum fire organization. Engines are typically the primary initial attack resource in areas with road access. The use of water can quickly facilitate containment, control, and mop-up of a wildfire. Hand crews, tractors, and aircraft (helicopters or air tankers) may also be part of the preplanned dispatch or ordered if necessary by the incident commander. Where road access is poor, crews may have to walk long distances to reach a fire. In these cases, aircraft are often used to mobilize hand crews, rappellers, or smoke jumpers. Firefighters in remote locations also utilize portable pumps to access water from sources close to a fire.

Fixed-wing air tankers may deliver fire retardant and helicopters may provide water bucket drops to knock down rapidly initiating fires regardless of ground access. The helicopter buckets are filled from streams, rivers, lakes, or ponds close to the fire that are large enough for the bucket and safe to access by the helicopter. The primary initial attack fire suppression helicopter is a shared-resource, rappel-capable, light helicopter (130 gallons of water per bucket) based in Merlin. The Oregon Department of Forestry also staffs medium helicopters (300 to 700 gallons per bucket) for 60 days at the peak of the fire season in Central Point and Roseburg. In severe fire seasons, a heavy helicopter (1,500 gallons per bucket) has occasionally been staged for initial attack.

A wildfire that escapes initial attack enters extended attack or the transition phase to a large fire operation. These fires become increasingly complex and large with many resources, logistics needs, and safety concerns. Only a small percentage of all fires enter this phase, but they require the most resources, and aircraft, and affect the largest number of acres.

Firefighter and public safety is the first priority in every fire management activity (USDI and USDA 1998). If there is risk to firefighter or public safety, the incident commander would safely and efficiently take appropriate suppression action with available resources without any POC considerations. Equipment could be ordered and used as soon as it was available on the fire, and water could be used from any source.

POC Management Practices become a concern to fire managers when there is POC near the fire and especially when it is known to be uninfected. Some POC management practices are not a concern during initial attack operations. Initial attack fire suppression resources, such as engines and crew vehicles, are normally clean and washed on a daily basis, and water in the fire engines is usually from uninfested sources. The fire season is also during the dry season and the warmer times of the year when the risk of spreading POC root disease is the lowest.

Management practices start to effect wildfire suppression when additional water is needed on a fire (such as refill engines, pumping from local sources, and helicopter bucket drops) and/or resources accessing the fire are going through both clean and infested areas. Management practices to reduce the risk of spread of PL decrease the efficiency of fire suppression resources and increase the costs of operation. The greatest effect would be on a fire with uninfected POC where the closest available water source is infested. Application of Clorox (see Appendix 4) in engines or water tenders would be relatively inexpensive and not lose much time. Planning for and installing a pumping station to treat water before pumping it to the fire would require time and additional personnel (if it was feasible). If a helicopter would have to travel 5 minutes longer to a clean source for bucket use it would reduce the number of bucket drops in a day. Helicopter water operations usually attempt to keep the turn time for a bucket load to less than 15 minutes. If the infested source was a 10-minute turn and the clean one was 15 minutes, the effect is a 33 percent reduction in the number of buckets the helicopter can deliver in an hour.

The recent Biscuit Fire (2002) is an example of how POC management practices can affect wildfire suppression. Five lightning fires that started in the Kalmiopsis Wilderness and adjacent roadless areas burned together over several months into the 500,000 acre fire

(USDA 2002). These remote fire starts were initially a low priority for suppression resources when many other fires in southwest Oregon and the region were threatening communities. The size of this fire resulted from concerns for firefighter safety, early resource unavailability, poor road access, fire weather conditions, protecting structures and communities at risk, and using available roads and topographic features for control lines. POC management practices probably did not affect the size of this fire, but did affect the cost.

The drainages around the initial fire starts were known to be uninfested and have populations of POC. Management practices in place early on included ensuring contract equipment were clean and inspected before going to the fireline, and locating clean water sources for the few aircraft available. As the fire grew increasingly larger and more complex, the POC mitigations also increased in scale and complexity. None of the mitigations affected firefighter or public safety or property. There were up to four incident management teams at one time on this fire, with thousands of firefighters, hundreds of pieces of equipment, multiple fire camps, incident command posts, and hundreds of miles of fireline and access roads. Management practices for protecting POC included: identification of travel access routes, multiple wash stations, identification and mapping of approved water sources for helicopter and ground resources, and installation of helicopter dip tanks to supply treated water closer to the fire. Wash stations were also installed at the fire camps, spike camps, and equipment staging areas. Many of these stations were staffed 24 hours a day for several months with a minimum of two persons, a water tender, and an engine. All vehicles were washed at least once a shift and sometimes several times depending on their assignment and travel route. If equipment was moved between Divisions on the fire, it was also washed if it was going from an infested area to a clean one. All of these management practices increased the number of personnel on the fire, increased the amount of equipment, increased the time personnel spent washing vehicles or following longer travel routes, reduced the efficiency of helicopter and ground resource water use, and required planning to implement. It is estimated these practices added between $1.5 million and $3 million to the suppression costs of $150 million, or about 1 to 2 percent to the total cost. On smaller fires, the percentage could be higher.

Each wildfire situation is different and it is impossible to estimate the cost of POC management practices over the entire southwest Oregon area. It should be assumed that implementation of POC management practices would not affect firefighter or public safety or private property, but could increase the acreage burned, damage to natural resources, and cost of suppression for wildfires that escape initial attack where POC is found. Severe wildfires can kill POC. Larger fires in the range of POC would result in the loss of more POC to wildfire mortality. Small fires on average have lower total fire suppression costs than large fires, but have far higher per acre costs. Siskiyou NF average costs per acre (1990 to 1999) for fires less than 1 acre is $4,740, and for fires 5,000 to 10,000 acres is $373. The cost of the Biscuit Fire (the most expensive wildfire to suppress in history) was approximately $300 per acre. Additional aircraft time on a small fire could easily double the suppression costs.

Fuels Management

The 1995 "Federal Wildland Fire Management Policy" (USDA and USDI 1995) directs Federal land management Agencies to achieve a balance between fire suppression and fuels management to sustain healthy ecosystems. While previous policies emphasized fire suppression, the current policies emphasize fuels management as a part of ecosystem management (USDA and USDI 1999, 2000, and 2001). This approach recognizes fire as part of the ecosystem, and focuses on hazardous fuels reduction, integrated vegetation management, and firefighting strategies (USDA and USDI 2001). The "Healthy Forests Initiative" (2002) also emphasizes more active forest and rangeland management to reduce the accumulation of fuels and to restore ecosystem health. Attainment of the goals of the 10-year Comprehensive Strategy requires an investment. Market-based approaches (selling by-products) to offset the cost of hazardous fuels reduction are encouraged wherever feasible and cost effective (USDA and USDI 2001).

Hazardous fuels treatments should be designed to:

- Reduce the risk of wildand fire to communities and the environment;
- provide safety to firefighters; and
- improve ecosystem health.

The focus is on actively managing acres in the wildland-urban interface, and acres outside of the wildland-urban interface that are in Condition Classes II or III (have missed two or more natural fire cycles) to reduce hazardous fuels and restore fire-adapted ecosystems (USDA and USDI 2003).

The wildland/urban interface is defined as the line, area, or zone where structures and other human development meet or intermingle with undeveloped wildland or vegetative fuel (USDA and USDI 2001). Communities at risk within the range of POC and near Federal lands include Agness, Cave Junction, Grants Pass, O'Brien, Powers, Selma, Williams, and Wolf Creek. These communities include surrounding developed areas outside of the defined city limits. The BLM has the largest percentage of Federal lands in the interface in southwest Oregon. The highest priority treatment areas are generally on the eastern and southern Oregon portions of the range of POC.

Condition class is the degree of departure from historical natural fire regime resulting in changes to key ecosystem components, such as stand structure, age, and degree of canopy closure. Due to fire exclusion policies, grazing, invasive plant species, and insects and disease (1995 "Southwestern Oregon Late-Successional Reserve Assessment") many areas in southwest Oregon are in Condition Class II or III. Fire frequencies have been altered and there is an increase in fire size, frequency, intensity, severity, or landscape pattern. The risk of losing key ecosystem components is also moderate to high. The recent Biscuit Fire is such an example (USDA 2003). Large areas of Late-Successional Reserves, Riparian Reserves, and uninfested POC were burned. Over $150 million was also spent to suppress this fire and protect adjacent communities.

Federal Agencies in southwest Oregon have actively managed hazardous fuels on Federal lands for many years. Treatments were historically linked to timber sale activities, but are becoming more associated with treatment of natural fuels in the wildland-urban interface. These are the priority areas for hazardous fuels treatment to reduce wildland fire risks to communities and allow wildfire to take a more natural role in the surrounding forest. The Medford BLM District and the Siskiyou NF currently treat the most acres of the administrative units in the planning area. Over the next 5 years, the Grants Pass BLM Resource Area could accomplish 70,000 acres, the Glendale BLM Resource Area 4,200 acres, and the Siskiyou NF 23,000 acres. Most of these treatments are not in stands with POC. The actual acreage treated is highly dependent on funding and is lower than the numbers indicate, because many of these treatments are accomplished on the same acre.

Hazardous fuels treatment objectives are to change fire behavior by reducing its rate of spread or intensity, or to maintain conditions that support desirable fire behavior characteristics. Combinations of treatments are used in southwest Oregon to restore vegetation and historic fire conditions. Most of these treatments are noncommercial, but integrated vegetation management with commercial timber harvesting or producing by-products also occurs. In the high hazard areas next to communities, pretreatment is often needed prior to any prescribed fire use. This is because most areas are well outside the natural fire regime and fire cannot be reintroduced without first modifying the fuels in some way (pretreatment). Dense understory vegetation from years of fire exclusion has resulted in ladder fuels that contribute to crown fire initiation and excess down woody fuels have accumulated. Pretreatments include: the cutting, hand piling, and hand pile burning of excess vegetation and fuels; mechanical treatments to masticate or crush fuels and vegetation; and small diameter tree removal for by-products. The usual plan is to underburn within a few years of the pretreatment to reduce vegetation regrowth and maintain desirable fire behavior characteristics.

Hazardous fuels reduction and integrated vegetation management is a potentially large and recurring program in the range of POC (tens of thousands of acres per year). The majority of acres needing treatment would not have POC in the stands, but about 17 percent of the planning area contains stands with POC as a component. Drainages could have POC populations, and access roads could traverse areas with POC. POC management practices could affect wet season (October 1 through May 31) operations, road access, water use, and available treatment options. This in turn would affect the timely implementation, cost, and accomplishment of fuel treatment activities.

Many of these fuel treatments are labor-intensive mechanical or manual treatments. Workers may walk over nearly the entire stand at several different times to cut vegetation with chain saws, lop and scatter slash, hand pile slash, and burn hand piles. Daily production rates are low and large crews and/or a long season is required to accomplish the amount of work. Walk-ins to the work site reduce crew production rates. Mechanical treatments that masticate or crush vegetation have higher production rates, but require access for the machinery and operators, and maintenance and refueling on a daily basis. Seasonal restrictions or road closures limit the amount of time a contractor can work or restrict access. Work in summer is often affected by seasonal industrial fire precaution level restrictions due to fire season severity. Even in the dry season contractors may not be allowed to run saws or motorized equipment.

Road access affects treatment options, access to work areas, travel time to work areas, and access to water sources. Treatments such as small diameter tree removal and commercial timber harvest require a well-developed road network to be feasible or economically viable. Crews also need some road access to accomplish hand treatments and prescribed burning. Long walk-ins increase costs and risks with prescribed burning, and reduce the feasibility of treatments.

Prescribed fire uses, such as hand pile burning or underburning, are normally accomplished during the wet season to meet burning prescription objectives and reduce fire escape risk. Hand crews and engines usually accomplish the burning. Equipment is washed and cleaned on a daily basis, and water in the engines is from uninfested sources. Unlike wildland fire suppression, prescribed fires are preplanned and have a project-specific burn plan. Where POC is a concern, the burn plan specifies mitigation measures that could include: priority of operations, travel routes, water sources that require treatment with Clorox, or additional washing.

The costs of hazardous fuels treatments and the number of acres accomplished are interrelated. High per acre treatment costs result in fewer acres being treated due to funding limitations.

Effects of the Alternatives

Alternative 1

Wildland Fire Suppression: POC management practices have the greatest potential effects on fires where there is no immediate threat to firefighter safety, public safety, or private property, and the fire is either not controlled during initial attack by ground-based resources or requires local water use by crews (portable pumps) or helicopter water drops. Larger fires require equipment inspections, travel access management, wash stations, identification of clean water sources, setting up helicopter dip tanks to treat water closer to the fire, and greater use of water tenders. When additional water is needed by engines and water tenders, Clorox is available to treat unknown or infested water sources in the field. To the extent these actions delay suppression action or decrease the efficiency or fire suppression resources, the potential size, cost per acre, and total cost of a fire could be increased.

Approximately 20 percent of all fires on NF lands and 30 percent of all fires on BLM lands receive helicopter water bucket drops. Assuming safety and property are not threatened, delays can occur if POC status and clean water sources are not already known and identified. For example, if there were uninfested POC in the fire area, helicopter water drops would be from the closest clean water source. It could require additional time to find and verify a clean water source. If the clean water source is farther away than an infested source, then the potential efficiency of the helicopter has also been reduced and there could be both a larger fire size and an increased cost per acre. The increased cost is the flight time to deliver the water needed on the fire. One solution when resources are available is to add extra or larger aircraft ($600 to $900 per hour for a light and $1,200 to $1,800 per hour for a medium) to make up for the difference in lost efficiency if multiple water drops are needed. Another is to utilize an air tanker with retardant (approximately $5,000 per load) to hold the fire until other resources can get to the fire. If resources are unavailable or additional time is necessary to acquire them, then the fire could get larger. The use of these additional resources could easily double the cost of a relatively small fire. All of these activities increase the complexity, number of resources, and cost of an incident.

If management results in larger fires, it increases the areas at risk to PL spread from suppression actions, and can result in the loss of more cedar to fire mortality.

Fuels Management: POC management policies would affect wet season operations. If uninfected POC is within the work area or accessed by roads with seasonal restrictions, activities could be restricted to the dry season. This would contribute to scheduling difficulties to accomplish the work, require hiring more seasonal workers, and provide a less stable local work base. It could also make the purchase and use of specialized small-diameter tree removal or masticating equipment uneconomic by local contractors if it cannot be used for a large part of the year. This would increase the cost and time to accomplish the work, and limit the available treatment options. Mitigations such as daily washing of vehicles and tools, scraping mud off of boots, and priority of operations also have a minor affect on the cost. Prescribed fire burn plans would also include restrictions or mitigation measures that reduce the burning window or increase costs through required mitigation measures.

In general, the larger the potential hazardous fuel treatment program in areas with POC concerns the greater the effect would be on accomplishing the work and the potential for increased costs. Although cost increases may only be in the order of 5 percent to 10 percent for planning, implementation, and monitoring, some areas would probably not be treated due to the difficulty of scheduling treatments around seasonal restrictions or road closures (primarily for prescribed burning). Higher per acre costs would also reduce the total number of acres treated.

Alternative 2

Wildland Fire Suppression: This alternative is similar to Alternative 1, but would be simpler to implement the management practices due to more consistent policy over multiple-agency jurisdictions. Some preplanning would be in place, and the risk key would facilitate quicker decisions by incident commanders and resource advisors in the field. This would reduce potential delays in planning and implementing fire suppression tactics and operations, and slightly reduce the potential acreage and costs of a wildfire compared to Alternative 1.

Fuels Management: This alternative is similar to Alternative 1, but it would be simpler to implement the management practices due to consistent policy, and the risk key would facilitate easier identification of POC areas that do not require management practices. Unlike wildfire suppression, fuels management activities are preplanned and POC management practices are integrated into those plans. This would be expected to slightly reduce the cost per acre of fuel treatments and increase the acreage treated compared to Alternative 1.

Alternative 3

Wildland Fire Suppression: This alternative could have the greatest potential effect on fire suppression. Reducing road density in POC buffers and cores would limit access for resources such as engines and hand crews. This could increase the time it takes to respond to a wildfire and lead to larger fires. It could also require the use of more resources and water than if better access allowed prompt and successful initial attack. Many of these POC buffers and cores are adjacent to private property and communities. Additional restrictions on water use within the POC cores and buffers could also reduce helicopter efficiency and could increase fire suppression costs in extended attack or large fire operations. POC management practices may have to be foregone in these areas if fire threatens nearby property.

This alternative could contribute to larger fire size and higher suppression costs than the other alternatives. It would slightly increase the risk of POC fire mortality in the POC cores and buffers due to less efficient initial attack and larger fire size.

Fuels Management: This alternative would have the greatest potential effect on fuels management in the wildland-urban interface. Many of the proposed POC cores and buffer areas are adjacent to or include high priority for treatment wildland-urban interface areas. Approximately 2,300 core and 60,000 buffer acres are within the wildland-urban interface. Reducing road density or increasing seasonal road closures in POC buffers and cores would limit access for fuel treatment projects and prescribed burning crews and resources. Treatment options may not be feasible or costs would be increased. The result would be the least amount of acres treated because of higher costs, or result in not treating the POC buffers and cores and treating less expensive acres elsewhere. The latter could result in larger and more severe wildfires in POC cores and buffers as well as threaten communities.

Alternative 4 and 5

Wildland Fire Suppression: These alternatives would have the same effect on wildfire suppression. Resources could be used without any considerations for POC root disease. No restrictions on water use or requirements for Clorox would maintain the effectiveness of helicopter bucket drops and other water use operations. Fire suppression costs and, potentially, final fire size would be the least of all of the alternatives. This would primarily benefit those few wildfires that escape initial attack, are in extended attack or large fire operations, and are in areas with uninfested POC.

Fuels Management: These two alternatives would have the least effect on fuels management. Hazardous fuels treatment projects could be implemented without any considerations for POC root disease. No restrictions on water use or requirements for Clorox would maintain the effectiveness of water use operations during prescribed burning operations. Road access would be available to cheaply implement projects and utilize the full mix of fuel treatment options to accomplish the most acres of treatment.

Air Quality

Affected Environment

The Federal “Clean Air Act,” as amended in 1990, is designed to reduce air pollution, protect human health, and preserve the Nation’s air resources. To protect air quality, the Act requires Federal agencies to comply with all Federal, state, and local air pollution requirements (Section 118).

Effects of the Alternatives

The effects of the alternatives on air quality is unquantifiable and inconsequential. The degree to which Alternatives 1, 2, or 3 might increase wildfire size because of increased POC mitigation measures is offset by the reduction in overall mortality which would slightly decrease fuel loading and soil erosion that could lead to wind-borne soil.

Recreation, Visual, Wilderness, and Wild and Scenic Rivers

Affected Environment

Recreation within the analysis area ranges broadly, from relatively unstructured and dispersed recreation use, to structured, activity-based recreation within managed areas, sites, roads, or trails. Total recreation use on public lands within the analysis area is approximately 2.5 million visitor use days.

The analysis area has a number of developed campgrounds, lakes, rivers, and trails (such as horse, foot, and motorized) on public lands where recreation use (47 percent) is managed (USDI-BLM 1995b, p. 3-84). Managed sites in the area operate near capacity during the high use months of June through September.

Segments of the Rogue, Illinois, Chetco, and Umpqua Rivers are congressionally designated components of the National Wild and Scenic Rivers System; other streams are in various stages of study and evaluation for inclusion within the system. These river reaches provide over 1 million visitors per year with whitewater rafting opportunities.

There are numerous wilderness areas (such as the Kalmiopsis and Wild Rogue Wilderness Areas) throughout the region, and a few wilderness study areas. These areas provide unconfined primitive recreation opportunities for hikers and horseback riders. Both wilderness and wilderness study areas share the same management objective of allowing natural processes to predominate, and mechanized activity is not allowed. These areas do allow horseback riding, pack stock, and some livestock grazing.

Dispersed recreation consists of back-country camping, hiking, horseback riding, picnicking, general sightseeing, driving for pleasure, hunting, fishing, whitewater rafting, winter sports, and off-highway vehicle use. These uses account for about 20 percent of total use throughout the analysis area, and are typically by those desiring an uncontrolled environment, unaffected by other users (as occurs in managed sites).

Dispersed recreation activities, which are affected by level of access, are most likely to be affected by general land use management standards and guidelines, due to the unstructured nature of the activities and their prevalence on all public lands.

There are no existing demand analyses for dispersed recreation opportunities within the analysis area. Off-highway vehicle industry leaders predict, however, that off-highway vehicle use has, and continues to, rise dramatically within the State.

Off-highway vehicle management guidelines vary slightly between the different land management agencies; however, they all basically contain the same tenets of protection of natural resources, providing for visitor safety, and minimizing conflicts among various users (USDI-BLM 1995).

Depending on the resource conditions and characteristics within different drainages or areas, lands are generally classified as open, closed, or limited, to off-highway vehicle use. Open is defined as an area where all types of vehicle use is permitted at all times, anywhere in the area subject to applicable operating regulations and vehicle standards. Closed is simply defined as an area where any off-highway vehicle use is prohibited. Limited means an area is restricted at certain times, in certain areas, and/or to certain vehicular use (43 CFR, 8340.0-5, 2002).

These off-highway vehicle use classifications are periodically reviewed as part of each Agencies' land management planning process and are adjusted/changed as needed to respond to changing resource conditions, use patterns, and public input expressing a demand for recreation opportunities.

The Agencies also include off-highway vehicle use, horseback riding, hiking, mountain biking, and any other mode of transport in the construct of specific transportation management plans. Such plans are usually part of or adjunct to the broader land management plan governing that particular administrative unit, and address broad issues concerning access to public lands.

The visual resource within the analysis area has been inventoried and has received scenery quality ratings based upon an analysis of a particular viewshed's uniqueness within the region, its relative importance as a component of the characteristic landscape when viewed from popular observation points (Interstate highways, viewpoints, points along rivers and trails) and other factors. Generally, the scenery quality within the area is considered high by most visitors based upon the prevalence of extensive conifer stands, interesting physiographic features, and opportunities for viewing. Although POC seldom occurs in pure stands, its dense, green foliage makes a significant scenic and esthetic contribution to the forests. Its affinity for water particularly brings it into contact with many forest users, such as at campgrounds and other high-use areas. Recreation activities that may be linked with the occurrence of POC include camping in sites dominated by a POC overstory and photography.

The overall character and perceived quality of the visual resource varies by location, viewer, and type of use. Qualitative statements regarding scenic quality are dependent on a variety of factors. It can be assumed, however, that the color contrasts presented by browning POC crown(s) amidst a stand of healthy trees would create a color contrast at that site. Higher mortality generally translates into increased contrasts, thus degrading the visual scene for some visitors.

Effects of the Alternatives

There are two distinct ways the alternatives affect recreation-related use. The first is the degree to which alternatives limit access. Access and availability of public lands for recreation use is a key variable used for analysis of each alternative. Existing levels of availability of public lands for recreation use is deemed adequate at this time. The second is the degree to which the alternatives contribute to esthetic resources by maintaining POC over the long term.

It is assumed that increasing human populations within the area would increase recreation use of public lands. Demand would increase relative to growth. Cumulative effects would be relative to levels of increased demand and reduced availability.

Off-highway vehicle use, horseback riding, and all vehicular use are recognized as probable PL export agents, and thus are most affected (targeted) by any use restrictions. Saddle and pack stock require reasonable watering opportunities, increasing the probable exposure to POC and PL areas.

Although the standards and guidelines of the various alternatives generally do not affect wilderness or wilderness study areas directly, each of the alternatives could allow for varying levels of introduction of PL into the wilderness units via foot and horse traffic. There would be a resultant reduction in visual quality and related recreation experience.

Alternative 1

Access to and availability of public lands for recreation use appears to be adequate for present demand. Any effects associated with this alternative would increase or decrease based on the level of access provided to the public. Current direction allows for gating or barricading roads to protect POC when consistent with other resource objectives. A desire to maintain public access is always a major concern whenever a road closure is considered. Public input and feedback thus far has generally not indicated a perception of overly-restricted access. Various other road closures have occurred for other resource-related reasons, and have generally not elicited noticeable public resistance (except in isolated circumstances). As future use increases—depending upon the level of road or seasonal restrictions imposed—demand could be displaced to other lands, resulting in a reduction in the quality of user experience.

This alternative would result in infestation of 48 to 52 percent of high-risk areas (those most associated with water) throughout all portions of the range except at Coos Bay BLM District/ Siskiyou NF Powers Ranger District. There would be a corresponding reduction in the aesthetic environment to individual recreationists. The visual quality of the characteristic landscape could suffer degradation until stands recover with replacement conifer species.

Alternative 2

Effects of Alternative 2 are similar to Alternative 1. Management Practices 8 (Routing Recreation Use) and 9 (Road Management Measures) are probable effect-producing actions depending on the degree of the closure or restrictive action. Application would be variable depending upon POC and PL locations and the nature of the use or activity—there is no reliable indicator of the totality of any effect. These types of actions have already occurred over the past decade for various management reasons throughout the area. Individual occurrences of such management actions would require specific analysis based on their scale and scope and the interest level and nature of stakeholders affected. Depending on the relative importance of certain roads or road systems to particular user groups, controversial or recreation-impacting closures could occur. As future use increases—depending upon the level of road or seasonal restrictions—demand could be displaced to other lands, resulting in a reduction in the quality of user experience.

Given the flexibility of management options within this alternative, and the unlikelihood of substantial decreases in access or availability of recreation opportunities when compared with the current direction, access effects associated with this alternative are considered negligible.

This alternative would result in infestation of 45 to 50 percent of high-risk areas (those most associated with water) throughout all portions of the range except at Coos Bay BLM District/

Siskiyou NF Powers Ranger District. As in Alternative 1, there would be a corresponding reduction in the aesthetic environment to individual recreationists. The visual quality of the characteristic landscape could suffer degradation until stands recover with replacement conifer species.

Alternative 3

In addition to the effects described for Alternative 2, Management Practices applying to POC cores, Management Practices 1 (Minimize Entry), 3 (No Vehicles), and 6 (Trails) are probable effect-producing actions. Depending on the level of closure involved, the effect would range from "low" to a level where existing demand for access and availability is not being met, and recreationists (especially off-highway vehicle users) would be displaced to other lands, decreasing the quality of the recreation experience for the user.

POC buffer protection Management Practice 1 (Transportation Analysis) is a probable effect-producing action. The level of availability of roads for public use, and the resulting effects, are the same as those described for the Management Practice 3 (No Vehicles) above.

This alternative would result in infestation of 32 to 37 percent of high-risk areas (those most associated with water) throughout all portions of the range except at Coos Bay BLM District/ Siskiyou NF Powers Ranger District. Although less than Alternative 1 and 2, there would be a some reduction in the aesthetic environment to individual recreationists. The visual quality of the characteristic landscape could suffer degradation until stands recover with replacement conifer species.

Alternative 4

Removing existing POC disease-prevention practices would have little effect on the availability of recreation opportunities on public lands. The lack of closures or access restrictions would, however, lessen the likelihood of impacting an individual user group concerned about losing access to a favorite area. This alternative would also decrease the likelihood of displacement-related congestion in other areas in the future.

This alternative would result in infestation of 83 to 85 percent of high-risk areas (those most associated with water) throughout all portions of the range except at Coos Bay BLM District/ Siskiyou NF Powers Ranger District. Recreation activities that may be linked with the occurrence of POC (camping in sites dominated by a POC overstory, certain photographic activities) would be affected. The effect would simply be the loss of the aesthetic environment that served as a draw to individual recreationists and a backdrop for their chosen activity.

Visual resources would be affected by the eventual loss of POC—effects would vary depending on the amount of POC in a viewshed. The visual quality of the characteristic landscape could suffer degradation until stands recover with replacement conifer species.

Alternative 5

Similar to Alternative 4, removing existing POC disease-prevention practices would have little effect on the availability of most dispersed recreation opportunities on public lands.

The lack of closures or access restrictions would, however, lessen the likelihood of impacting an individual user group concerned over lack of access. This alternative would also decrease the likelihood of displacement-related congestion in other areas in the future.

This alternative would result in infestation of 83 to 85 percent of high-risk areas (those most associated with water) throughout all portions of the range except at Coos Bay BLM District/ Siskiyou NF Powers Ranger District. Recreation activities that may be linked with the occurrence of POC (camping in sites dominated by a POC overstory, certain photographic activities) would have an affect on the enjoyment of these activities. The effect would simply be the loss of the aesthetic environment that served as a draw to individual recreationists and a backdrop for their chosen activity.

Visual resources would be affected by the eventual loss of POC—effects would vary depending on the amount of POC in a viewshed. The visual quality of the characteristic landscape could suffer degradation until stands recover with replacement conifer species.

Areas of Critical Environmental Concern and Research Natural Areas

Affected Environment

As a part of the preplanning process for the SEIS, the staff considered and evaluated all lands within the Oregon range of POC that are designated areas of critical environmental concern (ACECs) and/or research natural areas (RNAs). "The Federal Land Policy and Management Act" and BLM policy require the BLM to give priority to designation and protection of ACECs during the land use planning process (USDI-BLM 1988). ACECs are areas within BLM-administered lands where special management is required to protect and prevent irreparable damage to important historic, cultural, or scenic values, fish and wildlife resources, or natural systems or processes, or to protect life and safety from natural hazards. Appendix 8 contains a complete description of the ACEC criteria.

ACECs may be nominated by members of the public, other agencies, and BLM staff at any time. BLM policy requires that RNAs be managed as ACECs; therefore, areas nominated as RNAs must meet the ACEC criteria. RNA management goals and plans are usually more restrictive than ACEC management alone, as RNAs are created for scientific research and should maintain values for the representative cells and values.

Existing Areas of Critical Environmental Concern

At present there are 28 existing ACECs or RNAs in the range of POC in Oregon (there is no POC on BLM lands in California). See Appendix 8 for a listing of these ACECs and their size, primary objectives, and other management information. Appendix 8 also includes the process and requirements for designation of ACECs.

Management activities in or near ACECs must be implemented in such a manner so as to be compatible with specific management objectives identified in site-specific activity management plans. In general, direction requires the BLM to: (1) manage ACECs for the maintenance, protection, or restoration of relevant and important resource values; (2) manage RNAs for the purpose of scientific study, research, and education, and to provide a baseline against which human impacts on natural systems can be measured; and (3) manage outstanding natural areas for recreation in a way which will not damage the natural features that make the area outstanding.

Management plans for each area will address such actions as land acquisition, use of prescribed fire, interpretation, introduced species, fire suppression, domestic grazing, insects and disease, public use, minerals, and hydrology. Direction requires pursuit of mineral withdrawals for all RNAs; the inventory and designation of new RNAs as appropriate "cells" are identified, a limitation of off-highway vehicle use in all special areas to existing roads (unless closed), and development of monitoring plans that address ecological status, defensibility, and compliance monitoring issues.

Effects of the Alternatives

Nine of the ACECs are not known to have POC; hence, there is no effect under any of the alternatives. Fourteen ACECs or RNAs have POC and no known root disease. Thirteen of these ACECs or RNAs were selected at least partially for the presence of POC plant communities. Five ACECs or RNAs currently have root disease. Four of the infested ACECs or RNAs were selected at least partially for the presence of POC plant communities.

The risk to any specific ACECs or RNAs is generally the same as percentages described in the Pathology section for each alternative. Under Alternatives 1, 2, and 3, management plans for the ACECs or RNAs would be developed where they do not exist and these areas would be managed to reduce the spread of (or possibly eliminate) PL, according to the standards and guidelines of the selected alternative. Under Alternatives 4 and 5, existing areas of PL would remain untreated, placing those ACECs or RNAs selected for the presence of POC plant communities at higher risk of losing those values for which they were selected. These alternatives would raise the probability of infestation occurring, particularly on sites favorable for the pathogen, compared to Alternatives 1, 2, and 3.

Culturally Significant Products for American Indian Tribes

Affected Environment

The current range of POC falls within the traditional territories of numerous American Indian Tribes along the west coast of North America. Included is the 5,400-acre forest of the Coquille Indian Tribe in west-central Oregon that must be managed according to the standards and guidelines of adjacent Federal land. Other Tribes in Oregon and California also manage lands containing POC, but these are not directly affected by the management requirements of the various alternatives. POC continues to play a significant role in the cultural and religious life of many Tribes living within the POC range from west-central Oregon south through northwest California. Native cultures toward the northern end of the POC range suffered more severe disruption during U.S. settlement of the region in the mid-19th century than those toward the southern end of POC range. As a result, POC use was largely disrupted and information is limited. Specific information concerning where, how, what time of year, and by whom POC is harvested and used is restricted from distribution.

Cedars of all type are considered the most used wood by native cultures of the Pacific Northwest. Despite declining availability, the cultural importance of POC remains high given its physical and structural characteristics, distinctive appearance, and aroma. The smells of POC also enhance the meaning of cultural rituals. Known for its durability, POC has straight grain properties allowing it to be split evenly. In contrast, spruce, which is also valued, does not split as evenly and has more pitch. Therefore POC is sought as a source of planks for building traditional structures and for arrows or lances that support bone or stone projectile points. However, shortages and diminishing accessibility to mature trees sometimes relegates POC to parts of a plank house or sweat lodge, such as benches or sidewalls. This is also true for construction of canoes.

POC has other traditional uses. Boughs are used as brooms, and the bark and roots are peeled and at times finely shredded for use in making traditional clothing, basketry, nets, twine, mats, and other items. Limbs may be twisted into rope.

Unlike western red cedar and incense cedar, POC has limited medicinal value due to its highly toxic character as a diuretic. Similarly, POC is less effective than incense cedar for preserving and storing perishable materials such as feathers, hides, and other materials. POC typically does not have the cedar-closet aroma of other cedars.

The declining availability of healthy mature POC trees through the 20th century however has increased the importance of remaining POC stands to Tribes. Although the region has experienced an economic and cultural rejuvenation by the Tribes, a declining availability of POC due to several factors including past timber cutting, disease, endangered species protection, fish protection, and land use allocations hinders Tribal initiatives to restore and revive cultural traditions.

Agencies issue permits for collection of special forest products including non-POC boughs, beargrass, and cones, but seldom issue permits for POC product collections. Therefore, quantitative data concerning modern-day cultural uses of POC is highly variable among the Tribes and generally not readily available outside Tribal communities. In general, however, use of POC is at modest levels. No information is available regarding the association of other culturally important species associated with the occurrence of POC.

Maintenance of POC stands on Federal lands as a culturally-important species is important to Tribes and fulfills Federal policies and goals for accommodating traditional Tribal uses. These uses are also consistent with the "American Indian Religious Act," and other statutes that highlight the importance of traditional cultural uses of plants on Federal lands. There are no effects to the exercise of those rights, because there are no off-reservation treaty reserved rights within POC range.

Effects of the Alternatives

There are two distinct ways the alternatives affect Tribal uses of POC products: (1) the degree to which alternatives limit access to products, and (2) the degree to which the alternatives maintain collectable quantities of POC over the long term.

Access to Products: Access is least restricted in Alternatives 4 and 5, and more restricted with Alternatives 1, 2, and 3. For example, Alternatives 1, 2, and 3 include a variety of

Management Practices including sanitation measures (removal of roadside POC in disease infested areas), road construction restrictions, restrictions on harvesting boughs, and washing vehicles accessing diseased areas. Alternative 3 would result in further access restrictions in some watersheds. However, because of the modest demand and the availability of at least some products from private lands, the actual difference between the alternatives is extremely small, perhaps affecting less than one collection request per year in the most restrictive case of Alternative 3. Further, the adverse effect on access is more than compensated for, in the view of the Tribes, by what they view as the long-term benefits of reduced access. The Tribes contacted for this SEIS felt strongly that slowing the spread of the root disease was important to protect their cultural uses. Many responses advocated limiting access to areas to achieve that goal by restricting the introduction of disease-infested soil.

Maintain Collectable Quantities: Even though access and collection restrictions of some alternatives may remain in place indefinitely, the effect on Tribes depends primarily on the amount of healthy POC that would be provided by each alternative over the long term.

An analysis of the five SEIS alternatives on the spread and impacts of PL on POC stands reveals useful trends in determining the implications for availability of POC on Federal lands for cultural use. The pathology effects section indicates the five alternatives pose insignificant differences for POC stands in low-risk areas. The occurrence of low-risk areas varies greatly in the POC range, from 80 percent of the area in the northern coastal areas of western Oregon, to 60 percent in the southern coastal range of California, and 40 percent in inland areas of POC. The analysis does indicate significant differences posed by the alternatives on high-risk areas within the region. Therefore, only 20 percent of the northern coastal range shows significant variation in results of the alternatives over a 100-year period. This increases to 60 percent in the further inland areas. The analysis further determines for uninfested high-risk sites that the alternatives would lead to the following infestation rates over the next 100 years (from Table 3&4-8 in the Pathology section):

Alternative 1 — 40 percent;
Alternative 2 — 35 percent;
Alternative 3 —20 percent;
Alternative 4 — 80 percent; and
Alternative 5 — 80 percent.

Those stands newly infested are expected to experience a 90 percent mortality rate within 20 years or less of becoming infested.

The primary difference in alternatives is in the application of management actions to prevent/reduce the spread of disease in uninfested areas of Alternatives 1, 2, and 3, and the lack of such provisions in Alternatives 4 and 5. However Alternative 4 includes a strong emphasis on disease resistance breeding in POC planting stock, which would increase the availability of POC products as they grow older.

Given the following factors that: (1) the alternatives only vary significantly for high-risk sites in regard to rate of disease spread; (2) Tribal reliance on POC stands for culturally important products is at modest levels; and (3) under all alternatives some level of healthy accessible POC stands would be sustained over the 100-year analysis period, the difference in effects on Tribal use of POC among Alternatives 1 through 5 is immeasurable. It should be noted however that Alternative 5 poses a potentially greater effect over a longer time span because it combines lack of disease prevention measures with a non-aggressive genetics program, and thus could impact Tribal product availability more than for the other alternatives. However, the difference will be insignificant through the 100-year period addressed by the SEIS.

Note: Persons contacted in soliciting information for this section included Don Ivy and George Wasson of the Coquille Indian Tribe, the Hoopa Tribe Forestry Department, Jason Younker of the University of Oregon, Forest Service Region 6 Tribal Affairs Specialist Les McConnell, land management agency Cultural Resource Specialists Dr. Steve Samuels, Isaac Barner, Dr. Mike Southard, and Reg Pullen.

Special Forest Products

Affected Environment

POC shares the same decay resistant properties as other cedars, such as western red cedar and incense cedar, and is used for posts, rails, and shakes. Western red cedar and incense cedar are more sought after because they have a wider range and are more easily accessible.

POC is in greatest demand for boughs during Christmas and to a lesser degree, for year-long floral arrangements. Boughs have a graceful, flat, beaded-lace appearance that makes them ideal for tying continuous strands to a wire backing for garlands or for layering into Christmas wreaths. The foliage also combines beauty with durability and needle retention that allows it to be preserved with glycerin mixtures for long-lasting floral displays. These attributes make POC a desirable commodity for personal use and commercial harvest. Commercial buying sheds in southwest Oregon purchased more than 400,000 pounds of POC boughs during 2002, yet less than 4 percent came from Federal land. The existing market for POC boughs could accommodate an increase in Federal bough supply either through expansion of demand or substituting POC boughs for western red cedar boughs. The price paid by the sheds ranged from $0.25 to $0.35 per pound, making POC economically desirable to harvest during a time of year when other agricultural work is diminishing.

The nature of commercial POC harvest involves an individual or crew making numerous trips from a vehicle into a grove of POC to clip and carry bundled boughs back to the road. Typically, a road will bisect several draws in a drainage growing POC, and harvesters will drive a road visiting and collecting from each draw. Greatest demand is prior to Christmas, typically a wet time of year, which increases these chances of moving infected soil by mud on shoes or vehicle tires. The intensity and focus of the foot traffic during commercial harvest in POC groves makes this a higher risk activity for PL spread than incidental foot traffic from hiking, hunting, or gathering of other special forest products such as mushrooms.

In addition to spring and fall mushroom gathering, other products potentially sharing range with POC or in demand during the wet season include firewood and Christmas trees. Each of these activities requires a permit, so there are opportunities to close areas and direct collectors to areas with low risk. Within the range of POC, the Agencies issue approximately 800 personal use firewood permits, 1,200 mushroom permits, and 2,900 permits for individual Christmas trees each year. Closures of road systems that pass through POC range could affect access to Christmas tree cutting areas or limit availability of firewood permits. Mushroom gatherers using road systems for access or walking through the woods between infected and uninfected areas may be affected either by road closures, spread control techniques, or denial of permits.

Effects of Alternatives

The effects of the alternatives are based entirely on management constraints to the program. POC products are such a small percentage of the live POC on Federal lands that mortality differences between the alternatives are deemed to have little potential to affect supply in the foreseeable future.

Alternative 1

This alternative continues the current direction in the land and resource management plans of the BLM Districts and the Siskyou NF. Limitations on the harvest of POC boughs, stemming in part from incompatibility with the objectives of various land use allocations, and in part because of concerns about the role of bough collection in the spread of POC root disease, would continue. The level of harvest activity from Federal lands is expected to continue to provide only a small percentage (less than 4 percent) of total harvested boughs in southwest Oregon. Other special forest product opportunities within the range of POC are expected to continue at their present levels.

Alternative 2

Alternative 2 is similar to Alternative 1, except that practices currently implemented or recently developed are better described, and a risk key is included for clarification of the environmental conditions that would trigger additional control or mitigation measures. Implementation of disease-control practices is expected to be somewhat more consistent than under Alternative 1. Bough harvest is expressly prohibited, except under specified permit conditions. There will be instances where site-specific analysis of a project would require the undertaking of some proactive POC roadside sanitation. These projects could provide several tons of boughs with the utilization of the severed trees. This translates into the level of bough harvest activity from Federal lands remaining approximately the same, or slightly higher, than current levels. Additionally, there may be road management practices that would result in a slight decrease (less than 5 percent) in other special forest products permits for firewood and Christmas trees due to restricting access to lands during the wet season or closing roads. Areas for firewood or Christmas tree cutting outside these closure areas are generally available to accommodate these requests.

Alternative 3

Alternative 3 incorporates all of the direction from Alternative 2, and adds protections for uninfected watersheds by creating POC core areas totaling 34,000 acres (or over 10 percent of the land base occupied by POC). The key management directives for these POC core areas relevant to this analysis is (1) closing of some road systems, and (2) suspension of all special forest products permitting in these areas. However, as in Alternative 2, there would be POC sanitation projects (including in POC buffer areas) that could provide several tons of boughs for utilization. As with Alternatives 1 and 2, the availability of boughs is tied primarily to sanitation and other management activities, which would remain similar to current levels or increase slightly. Hence bough availability under this alternative would be approximately the same as current levels.

With restricted road access and special forest products permits in the POC core areas, and additional road closures or seasonal limitations put on activities in POC buffers (approximately 33 percent of the Federal land within the POC range in Oregon), there is an expectation of a slight decrease in mushroom, firewood, and Christmas tree special forest products permits. Because much of the core and buffer areas are in wilderness or roadless areas, any reductions in available collection areas would be small enough to be essentially negated through permitting in other areas.

Alternatives 4 and 5

Alternatives 4 and 5 remove the current management techniques used to control the spread of PL and are differentiated only by the increase of the disease-resistant seed program in Alternative 4 and discontinuing the resistance breeding program in Alternative 5. The effects for both alternatives with regard to special forest products would be similar. In the long term, a program of growing and planting seedlings may offer more opportunity for bough harvest than natural regeneration alone may offer, but plantings of disease resistant trees are not expected to be subject to bough cutting within the near future. Depending on Agency funding for the preparation and administration of bough sales increases, there would be a enough market and product availability to support 100 to 200 tons of bough collection per year. Additionally, there may be a slight increase in other special forest products permits due to increased access to lands, including during the wet season.

Timber Harvest

Affected Environment

Timber harvest occurs for a variety of reasons on the BLM and FS units within the range of POC. An understanding of timber harvest activity and the lands involved is important to calculating the effects of the alternatives on future timber harvest. It is also illustrative about the amount and nature of harvest activity on public lands, acknowledged to be a factor in POC root disease spread.

Probable Sale Quantity (PSQ)

Long-term sustained-volume production is a goal on about 11 percent of the Federal forestlands within the range of POC, all within the Matrix and Adaptive Management Area land allocations. These lands are managed for regularly-scheduled timber harvest while meeting a nondeclining yield policy objective (Table 3&4-22).

The annual volume expected to come from these lands is called probable sale quantity, or PSQ. The decisions regarding how exactly to harvest in the Matrix and Adaptive Management Areas, and what schedule to use, are made after considering a variety of nontimber resource values at the administrative unit, watershed, and site-specific scales. PSQ levels are established in the land and resource management plan for each administrative unit, and

Table 3&4-22.– Acres by Northwest Forest Plan land allocation and administrative unit within the range of Port-Orford-cedar in Oregon

currently reflect the plan amendments of the Northwest Forest Plan (USDA and USDI 1994b) (Table 3&4-23). No previous PSQ adjustment was made for the current POC standards and guidelines. For the purposes of this analysis, it is assumed that PSQ is directly proportional to the forested lands dedicated to its production. That means for each acre removed from the Matrix or Adaptive Management Areas, there is a proportional and nearly straight-line reduction in PSQ. As noted in the Assumptions section earlier in this chapter, the following discussion assumes full implementation of the Northwest Forest Plan volume, and other Northwest Forest Plan objectives.

On most Oregon management units, POC is more concentrated toward the riparian areas and therefore, contributes little to PSQ. Across all land use allocations and topographic positions in Oregon, there are an average of five POC trees per acre in the 1 to 7 inch dbh (diameter at breast height) class, three in the 7 to 20 inch class, and one over 20 inches dbh, per acre. On Coos Bay BLM lands and on the Powers Ranger District of the Siskiyou NF POC is more well-distributed across the landscape. As a result, around 5 percent of the volume in any given harvest unit might be POC. Disease-related mortality does not necessarily affect PSQ at all. The dead trees in the Matrix are salvable, and the growing space, if not readily captured by existing competitors, can be restocked with resistant POC or other tree species. On other units where POC is more concentrated toward the riparian areas, little of it contributes to PSQ.

Table 3&4-23.– Annual probable sale quantity (PSQ) in millions of board feet annually by administrative unit and within the range of Port-Orford-cedar[1]

Other Harvests

A strength of the Northwest Forest Plan is the expectation that commercial thinning will be done in Late-Successional Reserves and some Riparian Reserves to help these lands meet their primary objective of becoming habitat for late-successional forest-related species or contributing to achievement of water quality objectives. Harvest is typically limited to thinning in stands less than 80 years old, but may take place in older stands if necessary to reduce the risk of a major fire. The resultant volume does not contribute to PSQ and there is no programmed level of harvest. Nevertheless, recent Late-Successional Reserve harvest activity has taken place at an estimated rate of 3 million board feet per year and 300 acres per year on all the Oregon management units combined within the range of POC. There is a considerably higher capacity for these treatments. About 20 to 30 percent of all Late-Successional Reserve acreage within Northwest Forest Plan area are between 30 and 80 years of age and would benefit from such thinning. Within the Oregon portion of the POC range, the potential for these treatments is estimated to be about 85,000 acres.

Salvage activities may also take place in most land allocations (an exception is Congressionally Reserved), depending upon the magnitude of the disturbance event. Late-Successional Reserves permit salvage if an event such as a fire has reduced canopy cover below 40 percent on an area larger than 10 acres. Salvage is proposed, for example, within the 2002 Biscuit Fire area. Annual levels of salvage volume are highly variable.

Harvest Activity Implications

Harvest volumes per acre are variable depending upon the land allocation and whether a complete (regeneration), partial (thinning), or salvage harvested, but it would be reasonable to estimate about 20,000 board feet per acre is average. Further, the average logging truck carries about 5,000 board feet. Finally, the ratio of tractor or cable partial-suspension to full suspension (ground-based to nonground based) logging is about 80:20. With these numbers, general levels of ground-disturbing activities related to logging can be calculated.

Annual volume harvested on Federal lands in the Oregon portion of the POC range is about 51 million board feet (PSQ plus reserve thinning volume). This would represent harvest on approximately 2,500 acres per year, with 80 percent tractor or partial-suspension harvest methods generally moving some dirt. With 20 percent of the range actually having POC, and 9 to 15 percent of that being infected with PL, 45 to 125 acres of harvest are likely to run through PL-infested soils in any given year, and have the potential to move them around.

Further, transporting the annual volume from the forests in Oregon requires about 10,000 truck trips, traveling to various mills sometimes not even in the same state. For California, the 24.5 million board feet being harvested within the range of POC translates to another 4,900 truck trips. Timber management personnel from the northern California Forests estimate the amount of wood traveling into Oregon from their timber sales is less than 2.5 million board feet per year, about 500 truckloads, or about 5 percent of the truckloads generated within Oregon. These trucks are coming from potentially infected areas. Until recently, much of this timber was trucked directly into the Rough and Ready Mill at Cave Junction, Oregon. Recently, the Rough and Ready Mill closed and the amount of wood being hauled into Oregon would be much reduced, probably far less than 300 truckloads per year. A potential for exchange of spores at mill yards and the use of logs and logging trucks as infection vectors is probably very slight, given sale mitigations measures and poor spore survival under high temperatures (Goheen, D.J., *personal communication*).

On Federal lands, all harvests are done by the highest qualified bidder or their agents, using their own logging equipment. There is the possibility of infestation being spread throughout the range or from state to state with this equipment. Equipment used on private lands within the range of POC is not subject to the mitigations and seasonal restraints applied to Federal timberlands. This may be a particular concern with equipment from the Port Orford to Coos Bay area where the level of infestation on private lands is higher than on any of the Federal lands in this analysis. For these reasons, a key element of the current POC management practices is cleaning equipment before permitting a purchaser to work in or near uninfested POC stands on Federal lands.

Effects of the Alternatives

There are three possible ways the alternatives could affect the level of timber harvest. First, to the extent PL kills trees important to PSQ, the alternatives with the highest mortality would be the ones to most affect timber harvest. As noted in the Affected Environment section, this element has virtually no effect on PSQ either because POC are not well represented in the Matrix/Adaptive Management Area land allocations, or because they could be salvaged anyway and their growing space in most stands would be readily utilized by resistant stock or other species.

Second, if the standards and guidelines actually prohibit harvest on certain acres, there is a direct and proportional reduction in harvest levels. This is the case in Alternative 3 with the establishment of POC cores. Thirdly, if the standards and guidelines result in increased cost, some areas (when considering all of the other costs that go into timber sale economics) may become too expensive to harvest. This effect is real, but very difficult to quantify at the programatic scale.

Alternatives 1 and 2

These alternatives are essentially the same in their effects to PSQ. Neither prohibits harvest on any lands, but both increase costs. Estimates listed in the cost section for washing ($28,000 and $22,000 for Alternatives 1 and 2, respectively) and a portion (33 percent) of the $37,000 sanitation costs ($51,000 and $41,000 for Alternatives 1 and 2, respectively), are probably directly attributable to timber sales and borne by purchasers. This is about $0.80 per thousand board feet. Seasonal restrictions can also reduce the availability of prospective bidders, thereby reducing bid rates and Federal receipts.

Additionally, the standard and guideline in Alternative 2 that encourages nonground based equipment would increase harvest cost an undetermined amount compared to Alternative 1.

Alternative 3

In addition to the effects listed for Alternatives 1 and 2, Alternative 3 prohibits timber harvest within 2,281 acres of Matrix and Adaptive Management Areas in the 32 currently uninfested watersheds. To the extent these POC cores overlap with Matrix and Adaptive Management Area acres, there is a direct effect on PSQ. Map 1 shows the extent of this overlap. The acres for POC cores in Matrix/Adaptive Management Area/Riparian Reserve are shown on Table 3&4-3. Riparian Reserve acres are lumped with Matrix and Adaptive Management Area in Agency databases because there is no good way to completely account for Riparian Reserves with GIS mapping. Instead, a reduction factor is applied that reflects each administrative unit's experience with Riparian Reserves and nonforest acres, to calculate affected Matrix/Adaptive Management Area PSQ acres, and from here the potential PSQ reduction (Table 3&4-24).

Total PSQ reduction is about 0.7 million board feet in the Oregon portion of the POC range, or about 1.7 percent. There would be a proportional reduction in jobs, and in harvest acres and logging trucks. As noted in footnote 2 of Table 3&4-24, this may not all be attributable to Alternative 3— a significant portion of the uninfested watersheds on the Siskiyou are in roadless areas.

There is no prohibition of harvest in POC buffers designated under Alternative 3, so they have no effect on PSQ.

This analysis is not intended to be precise enough to redeclare PSQ, but provides a general quantification of the effects of this alternative. Precise PSQ calculations would require identification of the actual affected stands in unit databases and then rerunning each unit's harvest scheduling model without those stands.

The restriction against timber harvest in the POC cores will also restrict the ability of the Agencies to do commercial thinning on approximately 6,000 acres of 40- to 80-year-old stands in Late-Successional Reserves (approximately one-third of the Late-Successional Reserve acres in these watersheds). This thinning is done to accelerate the development of late-successional forests or restore ecological processes. Such thinning is a major strength of the Northwest Forest Plan, but with nearly 2,000,000 acres of thinning needs in the Northwest Forest Plan area, this 6,000 acres may not be significant unless it conflicts with specific identified habitat or fuel reduction thinning plans. This could occur, however, because a portion of these acres appear to be in the unburned wildland/urban interface along the west-

Table 3&4-24.— Alternative 3 Port-Orford-cedar core acres and resultant PSQ reduction for Oregon ern edge of the Illinois Valley.

Alternatives 4 and 5

These alternatives would not affect PSQ because they do not make any acres unavailable for timber harvest. The $0.80 per thousand board feet cost, the seasonal restrictions, and the extra cost for nonground-based logging equipment of Alternatives 1 and 2 would be gone.

Costs

Affected Environment

Introduction

Presently, Federal Agencies use a number of program activities to lessen the spread of PL. These efforts cost money that is ultimately borne by the Agencies, either directly or indirectly. Direct program costs are paid via Agency appropriated funds for such things as labor, vehicles, equipment, and facilities. Almost all of the POC program costs, in fact, are funded in this manner. The direct program activities include such costs as the design, sale, and administration of POC special forest products; the design, conduct, and administration of POC timber sale and service contract stipulations; program monitoring; resistance breeding; planting POC; and overall program management.

Direct costs related to mitigating adverse effects of spreading the pathogen, but within the context of larger, unplanned activities, such as wildfire suppression costs of washing fire vehicles or treating water with Clorox, are not captured in this analysis. On the Biscuit Fire of 2002, approximately $1.5 million was spent for vehicle washing, dust abatement, and treatment of firefighting water with Clorox (see Chapter 3&4, Fire and Fuels, Wildland Fire Suppression subsection).

Indirect program costs more integrally interwoven into general Federal land management practices have not been captured or analyzed. For example, best management practices to benefit POC management objectives, such as appropriate road drainage design, are components of specific projects that are not distinguishable as POC program costs. Since these indirect program costs are not easily quantifiable, they are not included here. They are a relatively small, but not necessarily insignificant, part of the total cost for these activities. Also not included are general overhead and support costs. The following discussion covers only identifiable direct POC program costs.

Existing Costs by Program Activity

POC program work-units and unit costs are grouped into the following eight basic program categories. In this analysis, reported Federal administrative unit costs were used to calculate Alternative 1 costs. The total direct program costs are estimated at $860,000 per year. This is the Alternative 1 cost displayed in Table 3&4-25 in the following Effects of the Alternatives section.

Program Costs: Under the current conditions of Alternative 1, labor costs for two full-time

Agency program managers and District support personnel, for the BLM and USFS respectively, are the principle costs. Included in their expenses are vehicles, supplies, and travel costs. In addition, there are other employees designing and administering elements of the program with similar program costs. The costs of the FS disease pathologists providing regional consultation for POC are included in this element. The total program costs for Fiscal Year 2002 are estimated at $348,000.

Eradication: In the last 7 years, only one eradication project has been completed, at a cost of $23,000. A follow-up treatment is estimated to cost $5,000. With the $28,000 spread over a 7-year period, the average annual cost is $4,000.

Roadside Sanitation: In a recent survey of all BLM and FS Oregon administrative units, sanitation costs were estimated to be $2,500 per mile for removal of unmerchantable POC on about 20 miles of roads per year. The total annual cost for roadside sanitation is approximately $51,000.

Roads/Trails: Current treatments include renovation or relocating existing roads, road closures, and moving trails. These costs are estimated at $37,000 per year.

Washing: Current costs of washing applied to timber sale contracts average approximately $2,700 per sale. Analysis for Alternative 1 assumed 1.5 timber sales per year for each of the four administrative units. Under service and construction contracts, there is an average of six contracts per year per administration unit, with an average estimated washing cost of $500 per contract. The existing washing cost is estimated at $28,000 per year.

Port-Orford-Cedar Special Forest Products: Under current management direction, only one administrative unit sells POC boughs. It costs that unit approximately $5,000 per year to manage these sales.

Resistance Breeding: BLM and the FS spent $333,000 in Fiscal Year 2001 on the resistance breeding program. As described in an interagency agreement between the BLM and FS (USDA-FS and USDI-BLM 2002), the costs for Fiscal Year 2003 are $369,000 for the resistance breeding program.

Monitoring: Present POC monitoring includes field measurement and evaluation of common garden study sites, operational project monitoring, semiannual technical review of POC research, and annual program reviews by each administrative unit. These costs are estimated at $6,000 per year. It should be noted that some of the above POC program treatments are often undertaken for other reasons. Roadside sanitation, for example, is partially accomplished as a by-product of routine roadside brushing.

Effects of the Alternatives

Alternatives 2, 3, 4, and 5 costs are predicted using Alternative 1 as a baseline and then adjusting each expected alternative costs based on the differences in the standards and guidelines for each alternative. A summary of this data is shown in Table 3&4-25.

Program Costs: There would be no change in costs with the implementation of Alternatives 2 or 3. These costs cease under Alternatives 4 and 5.

Table 3&4-25— .Summary of average annual Port-Orford-cedar program costs ($) by category and alternative

Eradication: It is assumed that under Alternative 2 eradication treatments would be tried more regularly than under current practices. With a 50 percent increase under this alternative, the cost would be $6,000 per year. Eradication treatments are predicted to triple under Alternative 3, to three eradication projects needed every 7 years under this alternative, because of aggressive action to eliminate new infestations in the POC core areas within the 32 uninfested watersheds. The average annual costs under Alternative 3 would be $12,000. Alternatives 4 and 5 would not use eradication.

Roadside Sanitation: Use of the site-specific POC Risk Key under Alternatives 2 and 3 permits better identification of areas not needing treatment in the North Coast Risk Region. There will probably be less roadside sanitation on the “checkerboard” lands of the BLM districts under Alternative 2, and about the same level as under Alternative 1 on the remainder of the range. It is projected that this would result in a 20 percent decrease in the road miles treated, and a projected cost of $41,000 per year. With Alternative 3 there would still be a probable decrease in roadside sanitation on the “checkerboard” lands of the BLM Districts; however, this would be offset by the increase in roadside sanitation in the POC buffers of the uninfested 6th field watersheds. It is estimated that this cost would be the same as Alternative 1, $51,000 per year. Alternatives 4 and 5 assume that no roadside sanitation would be done, so there are no costs.

Roads/Trails: The POC Risk Key described as part of Alternatives 2 and 3 would dictate appropriate road and trail management actions. Cost-effectiveness criteria, as defined by the Purpose statement of this SEIS, may further direct proposed actions to not necessarily treat roads and trails themselves, but to mitigate their effects on POC. An example of this rationale could be to sanitize a given road system rather than surfacing it. Most of the road renovations, relocation of existing roads, road closures, and moving of trails has previously occurred on the Siskiyou NF and would continue at the level identified for Alternative 1. Alternative 3 requires additional road treatments to protect POC core areas. However, many of the POC core areas are in withdrawn land uses or administratively designated roadless areas. There is a projected 30 percent increase in road relocation and closure cost under Alternative 3, for at total cost of $48,000 per year. Under Alternatives 4 and 5 road projects to specifically address POC considerations would not be done.

Washing: Similar to the discussion for roadside sanitation, the use of the site-specific POC Risk Key under Alternatives 2 and 3 provides greater predictability about the level of vehicle washing that will take place. There will probably be less vehicle washing within the “checkerboard” lands of the BLM districts under Alternative 2, and about the same level as under Alternative 1 on the remainder of the range. It is projected that this would result in a 20 percent decrease in the amount of vehicle washing and a projected cost of $22,000 per year. With Alternative 3 there would still be a probable decrease in vehicle washing within the “checkerboard” lands of the BLM districts, but this would be offset by the increase in washing in the POC buffers of the uninfested 6th field watersheds. It is estimated that this cost would be the same as Alternative 1, $28,000 per year. Washing for lessening the probability of long-range PL spread would continue for Alternatives 1, 2, and 3. Alternatives 4 and 5 would terminate present washing expenditures.

Port-Orford-Cedar Special Forest Products: Alternatives 2 and 3 would not change this expenditure, while Alternatives 4 and 5 would terminate special permit administration related to PL control, and related cost.

Resistance Breeding: Actual costs for Fiscal Years 2001 through 2002, and projected costs for Fiscal Years 2003 through 2006, as described in a BLM and FS interagency agreement is used as a basis to estimate the resistance breeding program costs (USDA-FS and USDI-BLM 2002). For the last 4 years of the 10-year analysis period, breeding costs are assumed to remain level at $350,000 per year. Included in these costs are breeding monitoring costs. Also, increases or decreases of these costs for Alternative 4 or 5, respectively, were estimated by the FS Dorena Genetic Resource Center personnel. Associated field work, such as new field selections, would remain the same for Alternatives 1, 2, and 3, accelerate under Alternative 4, and not occur under Alternative 5.

Monitoring: Alternative 2 would leave these costs unchanged. Alternative 3 would require one-third more administrative monitoring to maintain disease-free POC cores and buffers. The cost for Alternative 3 monitoring would be $8,000 per year. Alternatives 4 and 5 eliminate many of the monitoring elements contained in Appendix 5, Monitoring. Alternative 4 would keep about one-third of the Alternative 1 monitoring costs to track genetic results and root disease spread, for a cost of $2,000 per year. Alternative 5 would retain about 15 percent of the Alternative 1 costs for tracking root disease spread, or about $1,000 per year.

Additional Costs for Port-Orford-Cedar Mitigation Measures During Fire Suppression. While the increase in Biscuit Fire suppression costs attributable to POC mitigation practices (estimated $1.5 million) is indicative of a direct program cost applicable to Alternatives 1, 2, and 3, it is very difficult to estimate this type of unplanned event on an annual cost basis. The Biscuit Fire burned 29 percent of the POC range in a single year. The Fire and Fuels section of the “Draft SEIS To Remove or Modify the Survey and Manage Mitigation Measure Standards and Guidelines” (USDA and USDI 2003) predicted 113,000 acres of wildfire within the range of the northern spotted owl. Although the POC range includes some of the most fire-prone portions of the owl range, the proportion of the 113,000 acres attributable to the POC range cannot exceed 15 to 20 percent. Such a relationship would suggest fire-related root disease mitigation costs might be in the neighborhood of $30,000 to $40,000 per year. Basing such numbers on the Biscuit Fire, however, is not representative. As noted in the fire section, fires that are extinguished during initial attack have few costs attributable to POC mitigation. On the other hand, the Biscuit Fire was so large as to generate economies of scale; mid-size fires would experience a higher percentage of suppression costs going to POC mitigation. A reasonable prediction is tens of thousands of dollars per year applicable to Alternatives 1, 2, and 3.

Costs May Vary by Year. While annual costs are projected over a 10-year horizon, individual category expenditures may vary over the period. Some category costs will be higher at the beginning of implementation, while becoming lower at the end of the 10-year period. Under Alternative 4, resistance breeding is a category where annual program costs would began at $515,000 in 2004, declining to $474,000 in 2008, and then settling to $413,000 in 2013. And, because under this alternative its overall costs are accelerated but not actually increased, Alternative 4 resistance breeding costs in the second decade will drop dramatically as compared to the other alternatives.

Other cost categories shown in Table 3&4-25 may vary from year-to-year also, but are anticipated to remain on a relatively even-flow over 10 years. While cost estimations were for a 10-year timeframe, it is not implied that POC program costs for any of the alternatives would stop at the end of the decade.

Environmental Justice

Affected Environment

Executive Order 12898 (Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, February 11, 1994) requires that all Federal agencies

> . . . make achieving Environmental Justice part of [their] mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations.

Potential effects on minority groups, low income, and subsistence populations are to be addressed. Potential effects on American Indians are covered in Chapter 3&4, Culturally Significant Products for American Indian Tribes section. Race, class, occupational classifications, and immigration policies influence people's environmental perceptions, encounters, and experiences (Taylor 2002).

Racial Background

Illustrating this point, many nontimber forest workers involved in the collection of POC forest products as well as other special forest products originally came from other countries, such as Canada, Mexico, Guatemala, Honduras, and El Salvador in the Americas; and Laos and Cambodia in Southeast Asia (Brown and Marin-Hernandez 2000). While personally interested at many levels to natural resource management issues, many of these groups of people may also have linguistic, institutional, cultural, economic, or historic barriers to actively participating in public planning processes (Frewing-Runyon 1999).

Ten counties within the states of Oregon and California encompass the natural range of POC. Racial composition of the people that live within these counties is shown on Table 3&4-26.

Wages and Employment

While over 76 million new jobs were created in the last 30 years in the United States, the manufacturing sector of the economy that includes forest products has declined from nearly 22 percent of all jobs to less than 12 percent. Within the range of POC, county employment levels have reflected this trend—manufacturing sector jobs in Del Norte County, in northern California, for example, decreased from 25.1 percent in 1970, to 4.3 percent in 2000. While higher-paying manufacturing jobs became replaced by generally lower-paying services-related jobs, average annual earnings in these counties have declined (see Table 3&4-27). Compounding the effects of the lower personal incomes has been flat-to-rising unemployment rates. On a relative basis, every county unemployment rate is higher than both the State and national averages.

Effects of the Alternatives

This SEIS supplements EISs for the land and resource management plans of the three BLM districts and the Siskiyou NF, and the Environmental Justice discussion and consequences therein. These previous documents analyzed the effects of related management actions including human health, economic, and social effects.

The potential of the alternatives to affect American Indians was identified as an issue in this SEIS, and is addressed in the Tribal effects section earlier in this chapter. Tribal input was specifically sought during scoping and during analysis of effects of the alternatives.

There is high participation by minority and low-income populations in collecting special

Table 3&4-26.– Demographic statistics within the Oregon portion of the range of Port-Orford-cedar (2000 Census)

Table 3&4-27.– Average earnings and unemployment rate for the Oregon counties within the range of POC

forest products. Permits for collecting boughs will be severely restricted in Alternatives 1, 2, and 3 (similar to current direction). Permits, both commercial and personal use, for wild plants, mosses, bark, roots, mushrooms, firewood, and others could be reduced from current levels under Alternatives 2 and 3 (as described in the Special Forest Products effects section in this chapter), depending upon the results of analysis under the POC Risk Key. Such permits would also be reduced under Alternative 3 by restrictions in the POC core and buffers for the 32 uninfested watershed featured in this alternative. Under this alternative, it is expected that special forest products permits would be reduced by less than 5%, and therefore, would not have much affect. Conversely, Alternatives 4 and 5 will markedly increase special forest products harvest levels. These potential impacts to Environmental Justice are less than current under Alternatives 4 and 5, and slightly more than current under Alternatives 2 and 3.

Alternative 3 would result in a PSQ reduction of 0.7 million board feet per year, or about eight full-time jobs directly in the logging and milling industry. As part of Alternative 4, direct employment will increase by the equivalent of approximately eight full-time jobs resulting from an expanded special forest products program. No other Environmental Justice effects are identified.

Civil Rights Impact Assessment

Introduction

The Civil Rights Impact Assessment examines whether the alternatives identified in the draft SEIS may result in an adverse or disparate effect to additional groups of people beyond those considered by the Environmental Justice section. In accordance with USDA Departmental Regulation Number 4300-4, these additional groups or classes include:

Race, Color, National Origin	Age
Disability	Gender
Marital, Familial, Parental Status	Religion
Sexual Orientation	Genetics
Political Beliefs	Income from Public Assistance

It is assumed that these populations of people will continue to use or enjoy Federal forest lands for diverse purposes (such as recreation, hunting, and employment) and may be interested in, or potentially affected by, the proposed alternative.

Because this proposed alternative will result in a notice to be published in the *Federal Register*, this Civil Rights Impact Analysis has been prepared in accordance with Interim Use Departmental Directive (DR) 4300-4, Section 9.a.(1).

Demographic Information

Consistent with Council on Environmental Quality guidelines for determining affected environment for Environmental Justice (Council on Environmental Quality, Environmental Justice Guidance under the National Environmental Policy Act, December 10, 1997, section III.C.3), three maps were examined (see file copy of draft assessment) that describe specific racial groups (African American, Asian Pacific Islander, and Hispanic) living within the area of both the natural range of POC and the ten counties covered by the range of POC, five in Oregon and five in California. A fourth map was also examined, identifying population levels of people with disabilities (mobility disability for ages 16 to 64). Information on the other groups is either not available or too generalized to be useful for evaluation.

Analysis of the maps shows that the identified ethnic and disabled populations are present or in areas adjacent to the natural range of POC, but do not live evenly throughout this area. People with disabilities, for example, are generally congregated along the Interstate 5 highway corridor. The analysis area covers both metropolitan areas with diverse populations and economies, and rural areas with lower population densities in general, and lower population levels of minorities and disabled persons specifically.

Alternatives Considered

Alternative 1

This alternative would maintain the existing language in the Coos Bay, Roseburg, and Medford BLM District RMP/EISs and the Siskiyou NF EIS that described the range of social impacts of the existing POC program. No additional civil rights impacts are expected to accrue from maintaining the existing direction.

Alternatives 2 and 3

Hispanic and some Asian populations tend to be disproportionately involved with the collection of special forest products from Federal lands within the natural range of POC. No reduction in collection of POC boughs is anticipated under this alternative, but a slight decrease of less than 5 percent of other special forest products is predicted, and therefore, a slight adverse economic impact on these groups of people is anticipated. No mitigations for this effect have been identified.

Alternative 4 and 5

The analysis shows no additional adverse effects beyond Alternative 1, in terms of adverse civil rights impacts, are expected from implementing any of these three alternatives. Beneficial effects can be expected for groups involved with bough collecting, as levels of special forest products permitting dramatically increase.

Conclusion and Findings

This document has identified the demographic composition of the affected area; the types of potential impacts, if any, resulting from the alternatives; current information from scoping; and potential adverse or disparate impacts as they relate to groups of people identified in civil rights legislation.

Other than some slight potentially adverse economic effects to Hispanic and Asian populations as described above, no other adverse or disparate effects to the additional groups or classes of people are expected. The proposed action detailed in the draft SEIS is anticipated to comply fully with all applicable civil rights statutes, including Title VI of the "Civil Rights Act" of 1964.

Critical Elements of the Human Environment

Table 3&4-28 addresses the critical elements of the human environment.

Other Environmental Consequences

When considering the overall environmental impacts of this proposal, it is important to remember that this SEIS supplements the Siskiyou land and resource management plan SEIS that has been amended by the Northwest Forest Plan SEIS (USDA and USDI 1994a) and the Survey and Manage SEIS (USDA and USDI 2000). This SEIS also supplements the SEIS for the land management plans for the Coos Bay, Medford, and Roseburg BLM Districts which themselves incorporated the Northwest Forest Plan SEIS (USDA and USDI 1994a) and were subsequently amended by the Survey and Manage SEIS (USDA and USDI 2000). The Northwest Forest Plan final SEIS addressed issues and environmental impacts dealing with the full range of multiple-uses on Federal lands and led to sweeping decisions regarding timber management and resource conservation. The Survey and Manage Final SEIS was narrowly focused on issues concerning implementation of the Survey and Manage Standards and Guidelines. This SEIS is narrowly focused on the management practices and mitigation measures for the management of POC and its root disease. This SEIS only addresses management of POC and does not change the fundamental decisions or substantially change environmental impacts disclosed in the previous impact statements.

Table 3&4-28.– Critical elements of the human environment

The Council on Environmental Quality regulations require that the discussion of environmental consequences include

> . . . any adverse environmental effects which cannot be avoided should the proposal be implemented, the relationship between short-term uses of man's environment and the maintenance and enhancement of long-term productivity, and any irreversible or irretrievable commitments of resources which would be involved in the proposal should it be implemented (40 CFR 1502.16).

Adverse Environmental Effects Which Cannot Be Avoided

An agency does not have to avoid adverse effects, but must identify and disclose any adverse environmental, social, and economic effects in the impact statement. This SEIS attempts to describe all identifiable adverse effects caused by the alternatives herein. Adverse effects which cannot be avoided include the continued spread of POC root disease at some level. Because the introduced disease is virulent and is spread by vectors such as elk and water, no mitigation could be proposed that could completely stop the POC mortality. At least some of the alternatives seek to mitigate that mortality through an active resistance breeding program.

Relationship Between Short-term Uses of the Human Environment and Maintenance of Long-term Productivity

The Agencies' land and resource management plans, as amended by the Northwest Forest Plan, committed NF System- and BLM-administered lands to multiple-use, including commercial timber commodity production. The environmental analyses supporting those plans determined that the loss in long-term productivity of forest soils and other components necessary for a healthy forest environment would be minimal. The alternatives explored in this SEIS are projected to have little relative additional effect on soil productivity. Slight effects are discussed in the Ultramafic Soils and the Water and Fisheries sections

Irreversible or Irretrievable Impacts

Irreversible refers to a loss of nonrenewable resources, such as mineral extraction, heritage (cultural) resources, or to those factors which are renewable over long time-spans, such as soil productivity. Irretrievable commitment applies to losses that are temporary, such as loss of forage production in an area being used as a ski run or use of renewable natural resources.

Since POC will clearly not be extirpated from any significant portion of its range, nor is it likely to lose any significant genetic variability, there will be no irreversible or irretrievable impacts.

Conflicts with Other Plans

The CEQ regulations (40 CFR 1502.16) require a discussion of

> . . . possible conflicts between the proposed action and the objectives of Federal, regional, State, and local (and in the case of a reservation, Indian Tribe) land use plans, policies and controls for the area concerned.

This SEIS incorporates by reference the discussions in the underlying land and resource management plans as amended, and nothing in this SEIS would alter the conclusions in those plans regarding the possible conflicts with other plans.

The management direction in this SEIS applies only to federally-managed lands where state and local land use plans, policies, and controls have little application. Similarly, the alternatives in this SEIS do not apply to Tribal and Indian-owned lands, with one exception. The Coquille Indian Tribe currently manages approximately 5,400 acres of forest lands (Coquille Forest) under the same standards and guidelines as the adjacent Federal land management agency (Coos Bay BLM District).

Western states have raised concerns about the occurrence of catastrophic wildfires in recent years, which led to formation of the National Fire Plan, a national multi-agency policy designed to prevent catastrophic wildfires through broad-scale fuel treatment and improved suppression efforts. The National Fire Plan proposes aggressive hazardous fuels abatement activities around communities and at-risk landscapes. The 2002 fire season was particularly problematic within the range of POC. Some of the harvest prohibitions in Alternative 3 could directly affect the Agencies' ability to meet their hazardous fuels treatment commitments around communities in the wildland/urban interface. The other alternatives do not have such restrictions.