Ecologically Appropriate Restoration Thinning in the Northwest Forest Plan Area

A Policy and Technical Analysis

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A plantation in a moist forest type on the Siuslaw National Forest that could benefit from variable density thinning to accelerate the onset of mature and old-growth forest characteristics. *Oregon Wild/Elizabeth Feryl (Environmental Images)*

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Conservation Northwest connects and protects old growth and other wild areas from the Washington Coast to the BC Rockies, to benefit people and wildlife. Since 1989, CNW has protected hundreds of thousands of acres of wildlife habitat from the old-growth forests south of Mount Rainier to lands critical to Canada lynx in the Loomis State Forest east of North Cascades National Park. Today we are ensuring the region is wild enough for wolves, grizzly bears, and mountain caribou; working with local communities on forest restoration, sustainable timber jobs, and wilderness protection; and creating safe passage for wildlife across Interstate 90, to name a few. Conservation Northwest is a 501(c)(3) nonprofit organization with four offices and twenty-one staff around the state. We are supported by 5,000 member households and hundreds of supporters and volunteers who together provide 70 percent of our funding.

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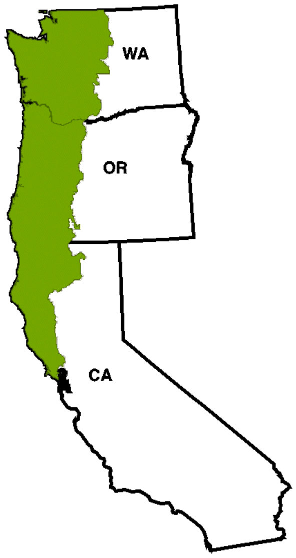
Klamath-Siskiyou Wildlands Center **www.kswild.org**

The Klamath-Siskiyou Wildlands Center is an advocate for the forests, wildlife and waters of the Klamath and Rogue River Basins of southwest Oregon and northwest California. We use environmental law, science, collaboration, education and grassroots organizing to defend healthy ecosystems and help build sustainable communities. Formed in 1997, KS Wild fights for protection and restoration of the incomparable ecological riches of southwest Oregon and northwest California. We monitor public lands in the Rogue River/Siskiyou, Klamath, Six Rivers and Shasta-Trinity National Forests, and the Medford and Coos Bay Districts of the Bureau of Land Management.

Oregon Wild **www.oregonwild.org**

Founded in 1974, Oregon Wild works to protect and restore Oregon's wildlands, wildlife and waters as an enduring legacy for all Oregonians. Oregon Wild (formerly the Oregon Natural Resources Council or ONRC) has been instrumental in securing permanent legislative protection for some of Oregon's most precious landscapes, including nearly 1.7 million acres of Wilderness, 95,000 acres of forests in Bull Run/Little Sandy watersheds (to safeguard the quality of Portland's water supply) and almost 1,800 miles of Wild and Scenic Rivers. As a leader of the national grassroots charge for conservation of roadless areas in our national forests, Oregon Wild helped secure administrative protections for more than 58 million acres of spectacular roadless areas across the country. Our wilderness, old-growth forest and clean rivers/watersheds programs protect pristine drinking water, unparalleled recreation opportunities and fish and wildlife habitat across Oregon.

Executive Summary



The Northwest Forest Plan covers all federal public forestlands within the range of the northern spotted owl.

Abstract

This report recommends a 20-year program of ecological restoration thinning (ERT) in degraded forests managed under the Northwest Forest Plan (NWFP); which is also the range of the northern spotted owl. ERT is one part of comprehensive restoration to restore forest and watershed health. The commercial timber volume that could result as a byproduct of ERT could be 44% more each year than has been produced on average under the NWFP between 1995-2010. In contrast to much of the timber volume produced to date under the NWFP—that came from mature and old-growth forests—commercial logs from ecological restoration can be produced with little or no controversy. Under the science-based principles and recommendations in this report, intact mature and old-growth forests can be conserved, degraded forests can be restored to late-successional character, and timber volume can increase from federal public forestlands.

Before you unabashedly embrace or reject the recommendations enumerated in this 10-page Executive Summary, please consider reading at least the body of the report to understand the thinking that went into making them and the reservations, clarifications, qualifications, sideboards, constraints, and caveats that are part and parcel of them. What follows are 45 titled, categorized, bulleted and brief summaries of the methodologies, findings and recommendations in the following categories:

A. The Numbers
B. Take Home Messages
C. Necessary Elements for Success
D. Comprehensive Ecological Restoration Needed
E. Clarifications and Amplifications
F. Differences Between Moist and Dry Forest Ecological Restoration Thinning
G. Timber Industry Considerations
H. After Two Decades
I. Technical Methodologies

A. The Numbers

1. **The Bottom-Line.** A 20-year program of ecological restoration thinning (ERT) is proposed for federal forestlands covered by the Northwest Forest Plan (NWFP); which is also the range of the northern spotted owl that could produce 774 million board feet (MMBF) annually. Please see the table on page 4.

Results for Acres Treated and Volumes by Federal Administrative Units								
Federal Administrative Unit	**Ave-rage Treated Area Per Year (acres)**	**Total Volume Available for Sale (mbf)**	**Average Volume Per Acre Available for Sale (mbf)**	**Average Volume Re-moved Per Year (mbf)**	**Average Volume Per Acre Re-moved (mbf)**	**Ave-rage Annual Sold Timber Volume 1995-2010**	**Projected Change in Average Annual Sale Quantity**	
							(MBF)	**(%)**
Gifford Pinchot NF	6,027	1,088,588	104,672	54,429	9.0	19,100	35,329	185%
Mt. Baker-Snoqualmie NF	3,003	558,198	53,673	27,910	9.3	7,800	20,110	258%
Okanogan-Wenatchee NF	9,261	1,160,930	111,628	58,047	6.3	29,200	28,847	99%
Olympic NF	2,957	684,938	65,859	34,247	11.6	17,400	16,847	97%
Washington Total	***21,248***	***3,492,653***	***335,832***	***174,633***	**--**	***73,500***	**101,133**	**138%**
Coos Bay BLM	1,860	407,909	39,222	20,395	11.0	30,500	-10,105	-33%
Eugene BLM	2,237	465,309	44,741	23,265	10.4	29,600	-6,335	-21%
Lakeview BLM	521	90,360	8,688	4,518	8.7	5,600	-1,082	-19%
Medford BLM	3,536	636,848	61,235	31,842	9.0	33,300	-1,458	-4%
Roseburg BLM	2,637	498,123	47,896	24,906	9.4	27,300	-2,394	-9%
Salem BLM	2,437	536,585	51,595	26,829	11.0	34,700	-7,871	-23%
Oregon BLM Total	*13,230*	*2,635,135*	*253,378*	*131,757*	--	*161,000*	-29,243	-18%
Deschutes NF	4,926	650,528	62,551	32,526	6.6	27,600	4,926	18%
Fremont-Winema NF	2,234	353,275	33,969	17,664	7.9	6,300	11,364	180%
Mt. Hood NF	5,565	1,036,913	99,703	51,846	9.3	32,000	19,846	62%
Rogue-Siskiyou NF	5,733	1,011,989	97,307	50,599	8.8	39,100	11,499	29%
Siuslaw NF	2,290	546,223	52,521	27,311	11.9	26,200	1,111	4%
Umpqua NF	5,332	979,428	94,176	48,971	9.2	30,000	18,971	63%
Willamette NF	7,544	1,474,809	141,809	73,740	9.8	59,300	14,440	24%
Oregon USFS Total	*33,623*	*6,053,166*	*582,035*	*302,658*	--	*220,500*	*82,158*	*37%*
Oregon Total	***46,853***	***8,688,300***	***835,413***	***434,415***	**--**	***381,500***	**52,915**	**14%**
N. California BLM	692	128,477	12,354	6,424	9.3	0	6,424	--
Klamath NF	5,126	891,617	85,732	44,581	8.7	25,000	19,581	78%
Lassen NF	238	48,913	4,703	2,446	10.3	3,100	-654	-21%
Mendocino NF	2,281	427,192	41,076	21,360	9.4	6,800	14,560	214%
Modoc NF	348	54,773	5,267	2,739	7.9	2,400	339	14%
Shasta-Trinity NF	7,429	1,326,924	127,589	66,346	8.9	37,400	28,946	77%
Six Rivers NF	2,361	420,540	40,437	21,027	8.9	7,600	13,427	177%
California Total	***18,476***	***3,298,435***	***317,157***	***164,922***	**--**	***82,300***	**82,622**	**100%**
GRAND TOTAL	***86,577***	***15,479,389***	***1,488,403***	***773,969***	**--**	***537,300***	***236,669***	***44%***
All volumes are from commercial treatments and include sawlog and pulpwood/chip material.								

2. **Comparison to Northwest Forest Plan Timber Outputs.** An average of 537 MMBF/year has been produced under the NWFP between 1995 and 2010. Implementing the ERT recommended in this report could increase timber outputs by 44% annually for the next two decades. The amount of timber sold under the NWFP varied by Administration, or an average of 546, 510 and 620 MMBF/year for Clinton, Bush and Obama respectively.

3. **Comparison to the Probable Sale Quantity (PSQ) in the Northwest Forest Plan.** Initially the PSQ was calculated to be 958 million (commonly represented as "one billion") board feet/year. Today, after adjustment for revised agency management plans, survey and management requirements, higher stream densities than originally believed, transfer of federal forestlands out of federal ownership, and other factors, federal forest agencies now officially estimate the PSQ at 760 MMBF/year. The agencies have estimated that—if they fully implemented the original "survey and management requirement" of the NWFP—the PSQ should be 510 MMBF/year.

4. **Results By State.** Timber production can be increased significantly above recent history from National Forests groups in each state: Washington (138%), California (100%) and Oregon (37%). The potential increase on Oregon national forests is partially offset by a decrease that is projected for western Oregon BLM lands (-18%), still allowing the Oregon's recent historic federal forest timber output to significantly increase (14%). In addition, federal logs often cross state lines.

5. **Western Oregon BLM Fall Off.** If it is socially important to maintain cutting levels of BLM lands in the near-term, and if an accelerated rate of implementation does not cause unacceptable impacts for northern spotted owls, marbled murrelets, fish populations, other wildlife, water quality and/or water quantity, the recommended ERT could be done on an accelerated schedule—congressional funding permitting.

6. **Amount of Northwest Forest Plan Forested Area Affected by Ecological Restoration Thinning.** The amount of land covered in the NWFP is approximately 24.5 million acres, of which 22.1 million acres are forested. In sum, it is proposed that ERT would be carried out—over a 20-year period—on 1.7 million acres, or 8% of the total forested area.

7. **Jobs in the Woods and the Mills.** Using the generally accepted multiplier of 11.4 direct, indirect and induced jobs per million board feet of timber produced in western Oregon, the additional increment of timber volume recommended in this report (~237 MMBF/year) would equate to 2,702 timber (logging, hauling, milling and related) jobs.

B. Take Home Messages

1. **No Longer Zero-Sum Game.** Historically, the battle over public lands logging in the Pacific Northwest was a zero-sum game where if one side won the other side lost. This is a win-win-win-win for the conservation community, timber industry, rural communities, and for the agencies and policymakers who have struggled to balance competing interests.

2. **High-Probability of Success.** The recommendations—because they are limited to ERT where commercial timber is a byproduct—have a much higher probability of being achieved than controversial logging practices and projects. The limiting factors to attaining these timber outputs from ERT recommendations in this report would be congressional funding and agency implementation, not administrative appeals and judicial litigation.

3. **The Reasons for This Report.** Conservationists sought this information to educate ourselves, government policymakers and the timber industry as to the common ground the conservation community and timber industry can share—if policymakers end the logging of mature and old-growth federal forests (and also natural early-successional forest ecosystems) and provide for the restoration of uncharacteristically dense, previously logged public forests into functional old-growth forests over time.

4. **Social License.** The timber industry has lost its social license to log older trees and roadless areas on public lands. The best and only hope for any significant volume of timber to come from federal forestlands is to produce timber as a byproduct of scientifically sound ERT. The public increasingly looks to their forests for other values such as clean water, recreation, wild salmon and wildlife habitat, and carbon storage and sequestration.

5. **Conservation Community Commitment.** When mature and old-growth forests are fully protected by Congress, the President and/or the Secretaries of Interior and Agriculture, conservationists will be even more able to advocate for responsible ERT. We can then dedicate more resources to seeing that such restoration gets done without having to expend resources to prevent timber volume coming at the expense of mature & old-growth stands or trees.

6. **Board Feet are Not All Alike.** A portion of the timber volume that has been sold under the NWFP has been highly controversial in that it came from mature and old-growth forest, either as "green" or "salvage" sales. Timber produced as a byproduct of ERT will be commercially valuable, but it won't come from the largest trees, which are treasured by a majority of Americans as an important natural legacy and a critical component of functioning, resilient, ecosystems and watersheds.

C. Necessary Elements for Success

1. **Congressional Funding.** To achieve the environmental, social and economic benefits that can come from ecological restoration projects, including commercial timber for local mills, Congress must appropriate funds adequate to implement the effort.

2. **Bureaucratic Willingness.** For the most part, all National Forests have moved or are moving to ERT where timber is a byproduct, as is the national leadership of the Forest Service (USFS) and the Department of Agriculture (USDA). For the Bureau of Land Management, only some BLM Districts have made or are making the transition. Congressional funding for ecological restoration can help move the agencies to where they need to be.

3. **Bureaucratic Reform**. Contracting and project layout requirements should be streamlined to reduce costs, while also protecting the environment.

4. **Collaboration.** Talking, especially on site in the forest, about where and how to log to achieve ecological restoration (and the resulting commercial timber) can be more productive to one's goal—be it either ecological restoration or timber production—than arguing in the media and the courts.

5. **Stewardship Contracts, Not Timber Sales.** Traditionally, counties have received between one-quarter and one-half of receipts from the sale of federal timber (Most western Oregon BLM lands are on track to receive three-quarters). The expected continuation of low timber prices would not provide much revenue for the counties, but can provide a very significant amount of money for the managing agencies to conduct additional ERT and implement non-commercial restoration activities.

D. Comprehensive Ecological Restoration Needed

1. **Congressional Commitment.** Congress needs to pay down the ecological debt to forests and the hydrological debt to watersheds managed under the Northwest Forest Plan by adequately funding non-commercial restoration activities. It will take stable and increased appropriations to fully implement the ERT recommended in this report, as well as the complimentary and necessary non-commercial ecological restoration activities.

2. **Ecological Restoration Thinning is Only One Part of Ecological Restoration.** This report addresses only one element of terrestrial restoration and focuses solely on the commercial timber volume that can come as a byproduct of ERT. ERT itself does not constitute full forest and watershed (including aquatic) restoration, and therefore cannot achieve all desired objectives, including restoring water quality and wild fish populations.

3. **The Road System Needs to be Re-Scaled.** Overbuilt and under-maintained roads are ticking time bombs threatening salmon and streams and water quality. Unnecessary roads need to be decommissioned. Necessary roads need to be storm-proofed to minimize harm to watersheds.

4. **Other Ecological and Hydrological Stressors.** Other ongoing human-caused stressors to forest health and watershed health must also be addressed. Specifically, damage from livestock grazing, invasive species, off-highway vehicles, and illegal dumpsites needs to be contained, controlled, remediated and/or eliminated.

5. **Ecological Restoration Thinning Not An Ecological Panacea.** In plantations, ERT results in large trees, multiple canopy layers, and diversity understory vegetation. However, such thinning can also slow development of other late successional forest attributes, such as dead wood accumulation and cool moist microclimate. Good planning is required to find the right mixes of treated and untreated areas across the landscape and degree of treatment within each treated area.

6. **Ecological Restoration in Dry Forests, Not Just Fuels Reduction.** Ecological restoration in dry forest types is more than just fuels reduction. Fuels reduction projects in dry forest types are not necessarily good ecological restoration projects. Treatments that focus exclusively on fuels reduction will likely fail to restore ecosystem functions and reduce habitat values for many organisms. In dry forest types, good ERT projects include fuels reduction benefits. Those who want to log most everything and anything (or make their living "fighting" fire) often exaggerate the risk of stand-replacing fire. ERT addresses stand density and its impact on the remaining old or future old trees in the stand, while also retaining and recruiting optimal

levels of snags and dead wood, including large pulses of dead wood that typically follow disturbances like fire.

7. **Fire!** In dry forest types, prescribed fire needs to be carefully reintroduced. Be it of low-, moderate- or even high-severity, fires and other natural disturbances play important ecological roles and must also be allowed to occur when human and key natural resources are not threatened.

E. Clarifications and Amplifications

1. **Focus on Stand Conditions More Than Land Allocations.** Large amounts of the forest in Late Successional Reserves (LSRs) and Riparian Reserves (RR) is not late-successional (mature or old-growth) forest and much of the forest in the Matrix (those lands in the NWFP threatened by industrial logging of mature and old-growth forest) is late successional. Adaptive Management Areas (AMAs) include a comparable mix of previously logged younger and older forest. Because these NWFP allocations contain a mix of forest types (e.g. species mixes) and conditions (e.g. age), this analysis disregarded the LSR, AMA, RR and Matrix land allocations as indicators of appropriateness for ERT.

2. **Ecological Restoration Thinning in Riparian Reserves.** Limited ERT in those portions of RRs that are not riparian, but are in fact plantation, in character is not ruled out. Given the necessity of site-specific analysis and the balancing of various hydrological and ecological resources in the Riparian Reserves (for example, an additional purpose of RRs is to serve as migration corridors between LSRs), we are even more conservative in our recommendations.

3. **Best Available Science.** A growing body of scientific research shows that the restoration treatments proposed in this report improves habitat value for most species, increase biodiversity, and make degraded forests more resilient. It is expected that the agencies will conduct monitoring and learn more about how to effectively restore degraded forests during the proposed 20-year implementation period. This learning should be used to adjust and improve ecological and hydrological restoration plans.

4. **Climate Change.** Ecological restoration treatments can also better prepare forests for climate change, while still allowing forests to store more carbon over time and across the landscape. The carbon consequences of restoration treatments should strive to harmonize climate resilience and carbon storage.

5. **Imperiled Species.** Of special concern are habitats for Endangered Species Act-listed species such as the northern spotted owl, the marbled murrelet and various stocks of Pacific salmon. The recommendations of this report are consistent with the recommendations of the final recovery plan for the northern spotted owl. Much of the owl's best habitat (moist old-growth forest) has been destroyed on federal, state and private lands. That fact that the owl occupies much habitat in dry forest types that likely wasn't owl habitat 100 years ago does not negate the need to protect its habitat wherever it is now or how it came to be. The recommendations would also leave room for adequate large buffers around marbled murrelet nests to avoid nest predation and blowdown.

6. **Needed Research.** Remarkably, for all the years that thinning in northern spotted owl habitat has been debated, very little peer-reviewed scientific experiments have been conducted on the effects of thinning on the species, especially in dry forests. This needs to be a research priority. Based on what little literature exists, the recommendations in this report are conservative, and restoration plans can be designed to buffer nesting/roosting and forage (NRF) habitat and account for cumulative effects.

7. **No New Roads.** The vast majority of the ERT proposed in this report can and should be done from existing roads. In a few cases, the benefits of a temporary road that is promptly and fully decommissioned afterwards, may outweigh the environmental and fiscal costs. These circumstances should be carefully considered and documented.

F. Differences Between Moist and Dry Forest Ecological Restoration Thinning

1. **Moist Forest Ecological Restoration Thinning.** ERT in moist forest types is generally variable density thinning (VDT) designed to accelerate the onset of late-successional (mature and old-growth) forest characteristics in plantations (stands that were clearcut, generally burned and then planted, generally with one species of the same age, size and spacing). The objective for moist forest restoration is creation of complex *stands*.

2. **Dry Forest Ecological Restoration Thinning.** ERT in dry forest types is generally conducted by thinning-from-below (TFB) and seeks to recreate more natural stand conditions of an open forest of large old trees. The objective for dry forest restoration is retention of old *trees* and re-creation of natural stand conditions.

3. **Intermediate (Mixed-Severity Fire Regime) Forests.** In this report, intermediate forest types (neither clearly moist, nor clearly dry) were lumped with the moist forests. The result is that no commercial timber volume from ERT is projected to come from older stands of intermediate forests. The conservation community will continue to evaluate peer-reviewed science as it emerges. For now, thinning in intermediate forests (except for plantations) is controversial (unsettled science) and therefore has a low probability of being achieved.

4. **Generally Keep the Large and Old Trees Anywhere.** The logging of the largest and/or oldest trees on any forest site is not generally recommended. Large and old trees are in short supply regionally and contribute to a wide variety of ecological, hydrological, social, and climate benefits. However, there are cases where removal of younger, but larger trees to favor older, but smaller trees can be justified.

G. Timber Industry Considerations

1. **Milling Capabilities.** Most of the mills in the region have moved beyond dependence on large trees. The future of the timber industry in the Pacific Northwest is in building flexibility to respond to changing markets and to handle a variety of supply streams—mostly from non-federal lands.

2. **Ecological Restoration Thinning Won't Work for All Mills.** While the sizes of timber recommended are indeed commercial in value, those sizes will not work for all mills. The few mills with business models that require cutting large—especially old growth—trees will not benefit from these recommendations. No timber output from the logging of old trees is projected because it is generally illegal, socially unacceptable and ecologically harmful.

3. **Logging Capabilities.** Current logging industry infrastructure is not well aligned for ecological restoration. To fully and profitably acquire timber volume from ERT projects on federal public forestlands, the logging industry needs to retool to more efficiently remove smaller logs from the woods. It also needs to retool equipment to minimize damage to soils and other natural resources, by investing in state-of-the-art, low-ground-impact, and fuel-efficient logging, yarding, and hauling equipment. Federal tax credits should be offered to leverage private investment in this area.

H. After Two Decades

1. **20-Year Horizon.** Management recommendations after the 20-year analysis period are not made in this report. Nearly two decades ago, the timber cut on these federal public forestlands was 10 times as high and essentially all volume came from clearcutting old growth forests. Forecasting beyond 20 years is futile.

2. **After 20 Years.** Upon completion of a two-decade ecological restoration period, society will have options. It can continue to leave the federal public forestlands on a trajectory to conserve or restore old-growth forests and embrace natural disturbance processes that sustain and renew natural forests and by doing so continue to protect and conserve ecosystem services like water quality, in-system water storage, biodiversity, carbon storage and sequestration, and recreation. Alternatively, society may decide that some level of commercial logging remains an appropriate use of the federal public forestlands. Ecologically thinned stands will have adequate densities of trees for either pathway. Restoration treatments will also likely better prepare forests for climate change and long-term carbon storage.

3. **Additional Ecological Restoration Thinning.** Opportunities for additional ERT will exist after the 20-year projection of this analysis. Second entries may be desirable in many previously thinned stands, and additional stands that were too young for thinning during the 20-year restoration period will become suitable for ERT.

I. Technical Methodology

1. **Estimating Potential Timber Volume from Ecological Restoration Thinning.** To estimate the potential volume outputs from the policy recommendations of the groups producing this report, the technical authors used the following methodology:

• Acres in land management allocations where treatments are not legally allowed (e.g. Wilderness) or are inconsistent with the policy recommendations were removed from consideration for ERT.

• The forest vegetation communities from NatureServe found in the NWFP area were grouped into forest types. Forest types with a strong ecological rationale for active management were selected as candidates for treatment. Forest types where treatments are typically not ecologically beneficial or require intensive site-specific analysis were removed from consideration.

• In each candidate forest type, size/vegetation classes not consistent with the policy recommendations were removed from consideration. Size/vegetation criteria were based on average overstory diameter, canopy cover, and conifer versus hardwood composition.

• The percentage of the total number of candidate acres in each size/vegetation class of each forest type to treat was then determined. As not all candidate acres should or could be treated—because of steep slopes, unstable soils, past treatments, distance from road or for maintaining a particular kind of wildlife habitat, etc.—a large portion of the candidate acres were dropped from further consideration. Depending on the forest type and size class, 10 to 60% of candidate acres were selected for treatment.

• Based on experience from past restoration treatments on USFS and BLM lands, the percent of the total volume to remove during treatments was determined.

• The number of treatment acres in each candidate forest type and size/vegetation class was then run through a growth and harvest-scheduling model commissioned for this study to determine volume output and number of acres treated per year over a 20-year period.

2. **The Model Shows How Much and What Kind, but not Where.** The spatial location of stands deemed appropriate for ERT is not shown in this report due to the huge area involved and methodological limitations of this report.

3. **Categorizing Forest Types.** Bifurcation of all forest types into either "moist" or "dry" is simplistic. Forest types exist, and are best managed, along a continuum of moisture, temperature, and disturbance regimes. Treatment percentages were individually set for each of the 15 distinct candidate forest types along this continuum.

4. **Conservative Results.** Conservative assumptions regarding treatment percentages were made to ensure a high probability of achieving the recommended timber volume levels, and also to recognize the inherent uncertainty.

Report Contributors

Andy Kerr* is the overall author of this report. He prepared the Executive Summary, the body of the report and Appendix F. Kerr has been professionally involved in Pacific Northwest forest policy matters since 1976.

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Two technical authors contributed greatly to this report.

Consulting forester Derek Churchill** was commissioned to conduct the technical analysis and modeling for this report based on the policy proposals of the organizations producing this report. Churchill wrote Appendices A, D and E of this report. Churchill is a PhD candidate at the University of Washington focusing on landscape level restoration of dry forests. He received his Masters degree in silviculture and conservation biology at the University of Washington where he focused on uneven-aged management and variable density thinning in Douglas-fir forests.

Appendices B and C were prepared by Dr. Peter Bettinger, Associate Professor of Forestry and Natural Resources at the University of Georgia. One of the nation's premier timber schedulers, Dr. Bettinger was commissioned to prepare a volume growth and harvest-scheduling model for this project. He received his PhD from Oregon State University. His graduate committee included both Professors Norm Johnson and John Sessions, who generally have diametrically opposing views of how forests should be managed.

Dr. Bettinger's role was limited to development of the model. He played no role in the technical choices (what kinds and how many stands to apply ERT, etc.) or policy recommendations. Churchill's role was similarly limited defining the technical choices and framing some policy choices. The final choices are those of Geos Institute, Klamath-Siskiyou Wildlands Center and Oregon Wild. Bettinger and Churchill do not necessarily agree with the policy recommendations of this report.

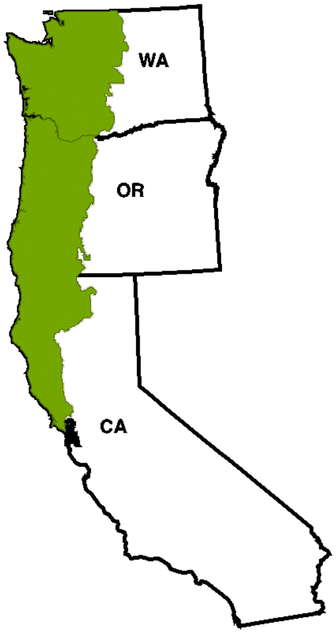
** Derek@stewardshipforestry.com; Stewardship Forestry Consulting. Correspondent for technical matters.

Table of Contents

List of Abbreviations

AMA	Adaptive Management Area
BLM	Bureau of Land Management
ERT	Ecological Restoration Thinning
DBH	Diameter at Breast Height
FIA	Forest Inventory and Analysis
FAU	Federal Administrative Unit
GAP	Gap Analysis Program
GNN	Gradient Nearest Neighbor
LSR	Late-Successional Reserve
LUA	Land Use Area
MBF	Thousand Board Feet
MMBF	Million Board Beet
NRF	Nesting, Roosting and Forage (habitat for the Northern Spotted Owl)
NWFP	Northwest Forest Plan
PSQ	Probable Sale Quantity
RR	Riparian Reserve
TFB	Thinning-From-Below
USDA	US Department of Agriculture
USDI	US Department of the Interior
USFS	US Forest Service
VDT	Variable Density Thinning

Introduction



The Northwest Forest Plan covers all federal public forestlands within the range of the northern spotted owl.

Geos Institute, Klamath-Siskiyou Wildlands Center and Oregon Wild commissioned this analysis to determine how much commercial timber volume could be produced as a byproduct of a scientifically credible ecological restoration program for federal public forestlands under the Northwest Forest Plan (NWFP).

Conservationists sought this information to educate ourselves, government policymakers and the timber industry as to the common ground the conservation community and timber industry can share—if policymakers end the logging of mature and old-growth federal forests (and also natural early-successional and natural young forest ecosystems) and provide for the conservation and restoration of uncharacteristically dense, previously logged public forests into functional old-growth forests over time.

Most of the conservation community is comfortable with supporting commercial logging on federal public lands in the Pacific Northwest—if such logging is driven and defined by the need for comprehensive (aquatic and terrestrial) ecological restoration of degraded forest types.

The ecological restoration thinning (ERT) recommended in this report is only for degraded forests—in particular:

- even-aged plantations in both moist and dry forest types; and
- fire-excluded dry forests that have been degraded by logging, fire exclusion, livestock grazing, and road building.

The disturbance regimes and stand development trajectories of these forest stands have been altered to the point where their ecological function is compromised. ERT—as part of a comprehensive restoration program that includes other passive and active measures to restore natural ecological and hydrological functions—reestablishes a more representative diversity of development pathways in forest stands and spreads the risk created by past and currently contemplated management.

For plantations,[1] this means introducing more heterogeneity into the stands, which are generally a monoculture of all the same species, age and spacing of trees. It means variable density thinning (VDT) in much of the stand to reduce density to allow the remaining trees to grow larger faster. It also means creating small structure-rich openings (gaps) in the stand, as well as not thinning every part of the stand (skips) to mimic what would have occurred under more

[1] A "plantation" is a stand of trees, generally all of the same age, size, spacing, and species that have been planted, usually after clearcut logging or a stand-replacing fire. A selectively logged forest stand or a clearcut that regenerates naturally is not a "plantation."

natural conditions. Without such ERT, these homogenized and degraded forests are less likely to develop diverse ecologically beneficial old-growth forest conditions.

In fire-suppressed dry forest types, it means the thinning-from-below (TFB) of small young trees that are encroaching on older and generally more fire-resistant trees due to past and current management activities. Without such ERT, the residual large trees are much more susceptible to premature death due to from insects and disease.

The organizations that commissioned and endorsed this report have reviewed the best available science and are comfortable with the conservative recommendations for ERT contained herein. The best available science (see footnotes in "To Thin or Not to Thin (and Where, How and How Much)? Those are the Questions!" section below) argues for careful thinning in appropriate amounts of particular forest types with specified characteristics in defined locations under enumerated conditions. It is equally the case that a portion of the young managed stands should remain unthinned in order to provide certain values associated with dense forests and natural recruitment of snags and dead wood.

The recommendations in this report are those of the author and Geos Institute, Klamath-Siskiyou Wildlands Center and Oregon Wild. In addition, other expert conservationists were intensely consulted in the preparation of this report. Some also provided useful and relevant reports they have produced.[2]

Proponents of ERT readily acknowledge that even well-intentioned logging has some unavoidable adverse impacts. However, the available evidence is clear and convincing that there are net benefits from ecological restoration thinning in a significant portions of previously managed dense young moist forest stands and fire-excluded dry forest stands. An important aspect of any credible landscape restoration effort is to determine the most ecologically desirable mix of thinned and unthinned areas. No new roads should be constructed unless certain extraordinary conditions apply and these roads should be removed promptly after the project is completed.

The restoration-based approaches encompassed by the ERT recommended in this report are almost all the actions that scientists are recommending to prepare forested landscapes for climate change.[3] As projections of the local effects of climate change become more certain and the science of climate adaptation further develops, management approaches can be adjusted.

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[2] For examples: Heiken, Doug. 2010. Log it to save it? The search for an ecological rationale for fuel reduction logging in Spotted Owl habitat. Oregon Wild. V 1.0. May 2010. (http://dl.dropbox.com/u/47741/Heiken_Log_it_to_Save_it_v.1.0.pdf) and Heiken, Doug. 2009. The Case for Protecting Both Old Growth and Mature Forests. Version 1.8 April 2009. http://dl.dropbox.com/u/47741/Mature%20Forests%2C%20Heiken%2C%20v%201.8.pdf]

[3] Dunwiddie P.W., Hall S.A., Ingraham M.W., Bakker J.D., Nelson C.S., Fuller R., Gray E. 2009. Rethinking Conservation Practice in Light of Climate Change. Ecological Restoration 27: 320-329; Harris J.A., Hobbs R.J., Higgs E., Aronson J. 2006. Ecological restoration and global climate change. Restoration Ecology 14: 170-176; Joyce L.A., Blate G.M., McNulty S.G., Millar C.I., Moser S R., Peterson D.L. 2009. Managing for Multiple Resources Under Climate Change: National Forests. Environmental Management 44: 1022–1032; Keane R.E., Hessburg P.F., Landers P.B., Swanson F.J. 2009. The use of historical range and variability (HRV) in landscape management. Forest Ecology and Management 258: 1025-1037; Millar CI, Stephenson NL, Stephens SL. 2007.

The assumptions and sources of data in this report have been clearly documented. Access to all the data used is available for anyone who wishes to review the analysis or conduct their own analysis.

Some conservation colleagues are opposed to ERT because they fear that the federal forest management agencies will go beyond the science and do more harm than good. While this concern is valid, this report advocates for scientifically sound ERT because the evidence is clear and convincing that it is ecologically necessary and desirable. Conservationists will continue to use the best combination of science, collaboration, public participation, court action, and policy advocacy to ensure that the federal forest agencies do what's right for the forests, wildlife and watersheds.

Classifying Forests in This Report

Forests can be arranged along a continuum of generally "moist" to "dry." The dominant variable is precipitation, but temperature is also a factor. (Some high-elevation forests are a third type: "cold" forests. Cold forests are not considered in this report, as they cannot yield significant amounts of commercial timber.) Bifurcation (a forest type is either moist or dry) was a necessary compromise in preparing this report.

It would have been better to at least trifurcate by categorizing forest types in between those that are clearly moist or clearly dry. For the purposes of this report, we lumped these "intermediate" forest types as "moist" as—since we had to choose—the restoration recommendations for moist forests were more applicable.

Fire severity is related to, but not a perfect analog for, precipitation—especially in forests that are neither clearly moist, nor dry. Moist forests have high-severity (but low frequency) fire disturbance regimes. Dry forests have low-severity (but high frequency) fire disturbance regimes. Intermediate forests have mixed-severity (and intermediate frequency with a very wide range) fire regimes.

This report addresses only one element of terrestrial restoration and focuses solely on the commercial timber volume that can come as a byproduct of ERT. It is important to stress that ERT itself does not constitute full forest and watershed restoration. In moist and dry forests, other human-caused stresses to forest health and watershed health must be addressed. Over-built and under-maintained roads are ticking time bombs threatening salmon and streams and water quality. Unnecessary roads need to be decommissioned and necessary roads need to be storm-proofed to minimize harm to watersheds. In dry forest types, prescribed fire needs to be carefully reintroduced. Be it of low-, moderate- or even high- severity, wildfire must be embraced. Fires

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Climate change and forests of the future: Managing in the face of uncertainty. Ecological Applications 17: 2145-2151; Noss R.F. 2001. Beyond Kyoto: Forest management in a time of rapid climate change. Conservation Biology 15: 578-590.; Spies T.A., Giesen T.W., Swanson F.J., Franklin J.F., Lach D., Johnson K.N. 2010. Climate change adaptation strategies for federal forests of the Pacific Northwest, USA: ecological, policy, and socio-economic perspectives. Landscape Ecology In Press.

and other natural disturbances play important ecological roles and must also be allowed to occur when human and key natural resources are not threatened. Damage from livestock grazing also needs to be addressed as well as eradicating the spread of invasive plant species. Off-highway vehicle damage needs to be contained and controlled. Illegal dumpsites need to be cleaned up.

A New Way

Historically, the battle over public lands logging in the Pacific Northwest was a zero-sum game where if one side won the other side lost. The dominant practice on public lands was liquidation of old growth or other natural forests. Today, while old forest logging has diminished dramatically, it still occurs—especially in westside forests.

In the isn't-life-ironic department, the conservation community finds that the best available science concludes that an appropriately scaled and equipped timber industry is necessary to conduct the needed ERT in degraded forest types.

After mature and old-growth forests are fully protected by Congress, the President and/or the Secretaries of Interior and Agriculture, conservationists will still advocate for responsible ERT—and in fact can dedicate more resources to seeing that such restoration gets done.

Conserving the remaining mature and old-growth forests is ecologically necessary, socially desirable, economically efficient and fiscally prudent. However, conserving what is left is insufficient. Degraded forests must be restored to mature and old-growth conditions historically appropriate across the landscape.

To Thin or Not to Thin (and Where, How and How Much)? Those are the Questions!

The best available science in support of ERT primarily centers on two degraded forest types: moist forest plantations and fire-excluded dry forests. In this report, they are considered separately. Generally, ecological restoration thinning (either variable density thinning [VDT] or thinning-from-below [TFB])—as opposed to industrial thinning—can:

(1) accelerate growth of large trees;
(2) help create multiple canopy layers;
(3) increase understory plant diversity; and
(4) maintain deep crowns.

Compared to natural disturbance processes however, thinning doesn't leave behind enough dead wood for wildlife habitat. That is why this report advocates leaving generous amounts of unthinned stands and "skips" left within thinned areas. It is the combined effect of both thinned and unthinned patches that provides the optimal mix of ecological benefits that is ecological restoration.

Moist Forest Plantations

Moist forests in this analysis consist of low- to upper-elevation westside forests (e.g., Sitka Spruce, Western Hemlock-Douglas-fir, Pacific Silver Fir forest types) as well as mid-to upper-elevation moist forests in the Eastern Cascades and Klamath-Siskiyou (e.g., Moist Mixed Conifer, Spruce-fir, Red Fir forest types) that are typically characterized by infrequent, high-severity fire. Relatively pristine and intact moist forest stands that are naturally young, mature, and/or old need no silvicultural management as they have not been altered and do not need to be restored. Rather they should be left alone to pack away carbon, supply clean, clear water, and provide other ecological services. For moist forests, ERT is only recommended for dense young plantations. The best available science concludes that VDT (leaving skips and gaps and using variable tree spacing, unlike an industrial-thinning regime) can accelerate the onset of some characteristics of late-successional (mature and old-growth) forests.[4]

Fire-Excluded Dry Forest Types

Dry forests are those that were dominated by high-frequency, low-severity fire regimes before European settlement (e.g., dry ponderosa pine and dry mixed-conifer forest types). While the best available science is clear and convincing as to the ecological basis for ERT in dry forest types,[5] the debate and dispute over dry forest ERT is mainly a debate as to just what is "dry"

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[4] *See*: Andrews L.S., Perkins J.P., Thrailkill J.A., Page N.J., Tapeline J.C. 2005. Silvicultural approaches to develop Northern Spotted Owl nesting sites, central coast ranges, Oregon. Western Journal of Applied Forestry 20: 13-27; Bailey J.D., Tappeiner J.C. 1998. Effects of thinning on structural development in 40-100 years Douglas-fir stands in western Oregon. For. Ecol. Manage 108: 99-113; Carey AB. 2007. Active and passive forest management for multiple values. USDA Pacific Northwest Research Station. Gen Tech Report PNW-GTR-721: 1-447; Harrington C.A., S.D. Roberts, and L.C. Brodie. 2005. Tree and understory responses to variable-density thinning in western Washington. in C.E. Peterson and D.A. Maguire e, ed. Balancing ecosystem values: innovative experiments for sustainable forestry. PNW-GTR-635. USDA Forest Service, Portland, OR; Hayes J.P., Weikel J.M., Huso M.P. 2003. Response of birds to thinning young Douglas-fir forests. Ecological Applications 13(5): 1222-1232; Muir P.S., Mattingly R.L., Tappeiner J.C., Bailey J.D., Elliott W.E., Hagar J.C., Miller J.C., Peterson E.P., Starkey E.E. 2002. Managing for biodiversity in young Douglas-fir forests of western Oregon. Corvallis, OR: Bureau of Land Management, Forest and Rangeland Ecosystem Science Center. Report no. ISSN 1081-292X; Spies TA. 2002. The Ecological basis of forest ecosystem management in the Oregon Coast Range. in S.D. Hobbs JPH, R.L. Johnson, G.H. Reeves, T.A. Spies, J.C. Tappeiner II, and G.E. Wells, ed. Forest and Stream Management in the Oregon Coast Range. Corvallis, OR: Forest and Stream Management in the Oregon Coast Range; Wilson D.S., Pittman K.J. 2007. Density Management and Biodiversity in Young Douglas-fir Forests: Challenges of Managing Across Scales. Forest Ecology and Management 246: 123-134.

[5] *See*: Agee J.K., Skinner CN. 2005. Basic principles of forest fuel reduction treatments. Forest Ecology and Management 211: 83-96; Brown R.T., Agee J.K., Franklin J.F. 2004. Forest Restoration and Fire: Principles and the context of place. Conservation Biology 18: 903-912; Everett R.L., Baumgartner D., Olson P., Schellhaas R., Harrod R.J. 2007. Development of current stand structure in dry fir-pine forests of eastern Washington. Journal of the Torrey Botanical Society 134: 199-214; Franklin J.F., Hemstron M.A., Van Pelt R., Buchanan J.B. 2008. The Case for Active Management of Dry Forest Types in Eastern Washington: Perpetuating and Creating Old Forest Structures and Function. Olympia, WA: Washington State Department of Natural Resources; Gaines W.L., Harrod R.J., Dalhgreen M.C. 2010. The Okanogan-Wenatchee National Forest Restoration Strategy: a process for guiding restoration projects within the context of ecosystem management Okanogan-Wenatchee National Forest.; Harrod R.J., Peterson D.W., Povak N.A., Dodson E.K.. 2009. Thinning and prescribed fire effects on overstory tree and snag structure in dry coniferous forest of the interior Pacific Northwest. . Forest Ecology and Management. 258: 712-721; Hessburg P.F., Agee J.K., Franklin J.F. 2005. Dry forests and wildland fires of the inland Northwest USA: contrasting the landscape ecology of the pre-settlement and modern eras. Forest Ecology and Management 211: 117-

forest (see "Intermediate Forest Types" below). What some have classified as dry forest doesn't have a classic fire regime (high-frequency, low intensity), but sometimes mixed-severity fire.[6]

Intermediate Forest Types

The disputes among scientists and among conservationists on the science of ecological restoration generally center on where the line is drawn between "dry" and "moist" forest types. Forest types are on a continuum and no bright line so bifurcates. In recommending policy, scientists will sometimes trifurcate forest types by adding a third category of "intermediate" (in between moist and dry; of a "mixed-severity" fire regime).[7] By lumping those "in between" types with the moist forest types, this report errs on the side of caution.

Drs. Norm Johnson and Jerry Franklin, in their recommendations pertaining to the management of both westside and eastside (the rest of federal public forestlands in Oregon and Washington that are not within the range of the northern spotted owl) also bifurcate their recommendations between moist and dry forest types.[8] In their report, the forest types generally characterized as "intermediate" (neither clearly moist, nor clearly dry) forests in this report, were included under their recommendations for dry forest management. Their reasoning is that with climate disruption, such forests are going to become drier.

To be conservative in estimating timber volumes that are a byproduct of ERT, intermediate forests in this report were included under the recommendations for moist forest management, thereby limiting ERT to plantations.

New peer-reviewed science may provide evidence-supporting ERT in certain non-plantation intermediate forest types to aide ecological restoration. A new peer-reviewed paper on the ecology of mixed-severity fire regimes has recently been published.[9] In the works is a companion paper addressing management issues of such forest types is expected to contribute greatly to this discussion.

139; Hessburg P.F., Salter R.B., James KM. 2007. Re-examining fire severity relations in pre-management era mixed conifer forests: inferences from landscape patterns of forest structure. Landscape Ecology 22: 5-24; Noss R.F., Franklin J.F., Baker W., Schoennagel T., Moyle P.B. 2006. Ecological Science Relevant to Management Policies for Fire-prone Forests of the Western United States. Society for Conservation Biology Scientific Panel on Fire in Western U.S. Forests; Youngblood A., Max T., Coe K. 2004. Stand structure in eastside old-growth ponderosa pine forests of Oregon and northern California. Forest Ecology and Management 199: 191-217.

[6] Hessburg, Paul F., R. Brion Sater, and Kevin M. James. 2007. Re-Examining Fire Severity Relations in Pre-Management Era Mixed Conifer Forests: Inferences from Landscape Patterns of Forest Structure. Landscape Ecology

[7] Noss, R. F., J. F. Franklin, W. L. Baker, T. Schoennagel, P. B. Moyle. 2006. Managing fire-prone forests in the western United States. Frontiers in Ecology and the Environment 4(9): 481-487. (Ecological Society of America. Washington, D.C.).

[8] Johnson, K. Norman and Jerry F. 2009. Restoration of Federal Forests in the Pacific Northwest: Strategies and Management Implications. (http://www.forestry.oregonstate.edu/cof/fs/PDFs/JohnsonExecutiveSummary.pdf). Accessed on September 22, 2009.

[9] Perry, David, A., Paul F. Hessburg, Carl N. Skinner, Thomas A Spies, Scott L. Stephens, Alan Henry Taylor, Jerry F. Franklin, Brenda McComb and Greg Riegel.et al. 2011. Ecology of Mixed Severity Fire Regimes in Washington, Oregon and Northern California. Forest Ecology and Management 262, 703-717.

The 20-Year Time Horizon

> *Both the Forest Service and the Bureau of Land Management share a commitment to sustained yield. Recently, that commitment has been subsumed by other concerns about sustainability. Also, in a world in which change and uncertainty seems to dominate, the notion of sustained yield of wood products may seem archaic.*
>
> *Professor K. Norman Johnson and Dr. Jerry F. Franklin*[10]

For this analysis, a 20-year restoration period was chosen for several reasons:

• Degraded forests should be restored sooner rather than later.

• Two decades is beyond the time-value of money, considering reasonable discount rates.[11]

• Two decades is a practical amount of time to consider given the amortization periods for investing in new milling, logging, yarding and/or hauling equipment necessary to optimally utilize small-diameter timber.

• Over this time scale, the treatments proposed in this analysis leave open multiple options for future management by increasing resilience to disturbance and climate disruption.

• After 20 years, the next generation can decide what levels of active versus passive management are appropriate and for what purposes.

• Forest policy will continue to evolve in response to new science and evolving public opinions and desires (e.g. two decades ago, old-growth liquidation peaked).

• Forecasting beyond two decades would be an exercise in futility and unreality in that any projections will likely be as accurate as forecasts made over two decades ago are today.

Determining the Potentially Suitable Forestlands for Ecological Restoration Thinning

ERT must be prioritized for the most degraded of forest types and those with high conservation values in jeopardy. This analysis applied several important constraints to identify specific forest conditions and acreage upon which such thinning could be applied. A full technical explanation of the modeling methodology, written by Derek Churchill, can be found in Appendix A.

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[10] Johnson, K. Norman and Jerry F. Franklin. 2009. Restoration of Federal Forests in the Pacific Northwest: Strategies and Management Implications. (http://www.forestry.oregonstate.edu/cof/fs/PDFs/JohnsonExecutiveSummary.pdf). Accessed on September 22, 2009.

[11] Business decisions do not consider anticipated revenues (or expenses) in the far future, because money in the future is worth less today. How much less is a function of the amount of time and interest rates.

Like most forestry analyses, this one began with the entire forestland base and then first eliminated various categories of forestlands from further consideration for ERT. Specific forest vegetation communities were then grouped into similar forest types. Then forest types were classified as either moist or dry types. Appropriate fractions of each forest type were then allocated to ERT and appropriate percentages of timber volume for removal were determined (Table 3). Finally, all was put through a timber-scheduling model that Dr. Peter Bettinger of the University of Georgia developed for this project. (Please see Table 1.)

The only kind of ERT this report proposes for moist forest types is VDT in previously managed dense young forests (i.e. plantations) to accelerate the onset of late-successional (mature and old-growth) forest characteristics. In dry forest types, TFB is proposed to conserve and restore old-growth character.

58% of the acreage in Late Successional Reserves is late-successional (mature or old-growth) forest, 30% of the acreage in the Matrix and AMAs is late successional.[12] Because these NWFP allocations (including the Riparian Reserves within them) contain a mix of forest types and conditions, including vast acreages of degraded forest stands in need of ecological restoration, this analysis disregarded these land allocations as indicators of appropriateness for ERT.

Rather, the focus was on forest types and forest conditions where a strong ecological rationale for active management exists as supported by the bulk of the scientific literature. Multiple filters were built into the analysis to exclude forest types and tree size classes where restoration treatments are not ecologically beneficial.

For dry forest types, some portion of mature and old-growth forest was allocated as potentially available for ERT. These stands have suffered from high-grade logging, fire-exclusion, and livestock grazing, and could benefit from ERT that retains all of the biggest and oldest trees of the desired species. That treatment of dry forests especially requires careful, site-specific evaluation and planning.

As not all candidate acres should or could be treated—because of steep slopes, unstable soils, distance from road or for maintaining a particular kind of wildlife habitat, etc.—a large portion of the candidate acres were dropped from further consideration. It is proposed to treat 10% to 60% of candidate acres, depending on the forest type and size class.

Of the candidate acres available for ERT, different proportions of the standing volume would be removed, based on forest type. The percent of volume removed was reduced for mature and old-growth forest types to reflect an emphasis on thinning small-diameter, ingrown trees.

The amount of land covered in the NWFP is approximately 24.5 million acres, of which 22.1 million acres is forested. In sum, it is proposed that ERT would be carried out—over a 20-year period—on 1.7 million acres, or 8% of the total forested acres.

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[12] Thomas, Jack Ward, et al. 1993. Forest Ecosystem Management Assessment: An Ecological, Economic and Social Assessment. Forest Service, Fish and Wildlife Service, National Marine Fisheries Service, Fish and Wildlife Service, National Park Service and Environmental Protection Agency. pp IV-54, IV-76.

Table 1. *Steps to Determine Ecological Restoration Thinning Opportunities*

Step	Activity	Result
1	Identify all federal forestlands under the Northwest Forest Plan (NWFP).	Place in consideration.
2	Determine Congressionally Withdrawn Areas (Wilderness, Wild and Scenic Rivers, etc.)	Remove from further consideration for ecological restoration thinning.
3	Determine Administratively Withdrawn Areas (Cascade-Siskiyou National Monument, research natural areas, areas of critical environmental concern, land allocations in specific land management plans that prohibit programmed timber cutting, etc.)	Remove from further consideration for ecological restoration thinning.
4	Identify Northern Spotted Owl and Marbled Murrelet Activity Areas under NWFP.	Remove from further consideration for ecological restoration thinning.
5	Identify Inventoried Roadless Areas identified under the Roadless Area Conservation Rule.	Remove from further consideration for ecological restoration thinning.
6	Identify the Late Successional Reserves, Adaptive Management Areas, Riparian Reserves and Matrix lands under NWFP.	Disregard all of these land allocations in assessing appropriateness for ERT; rather look to forest type and stand condition.
7	Identify land cover types in NWFP area.	157 identified (Appendix B).
9	Group land cover types into similar forest types.	24 identified.
0	Group forest types as either a candidate or non-candidate (some were non-forest) for ERT.	15 candidates determined (4 dry forest types and 11 moist forest types) (Table 3).
10	Determine to what extent these forest types have been modified by post-settlement activities.	Moist forest types hardly at all, save for plantations; dry forest types more so.
11	Determine if ERT can produce significant commercial wood volume as a byproduct.	Remove all upper elevation, riparian, hardwood-dominated and recently burned forest types from further consideration.
12	Focus on conifer-dominated stands.	Remove all stands with less than 80% conifers from further consideration.
13	Determine if restoration thinning could be ecologically beneficial.	Remove all moist mature and old-growth forest from further consideration, leaving plantations.
14	Allocate appropriate portions of forest stands still under consideration, factoring in that not all stands are appropriate for treatment (too far from roads, steep slopes, unstable soils, essential northern spotted owl habitat or for other species of wildlife, etc.)	Depending on the forest type, between 10% and 60% of a forest type would be treated (Table 3).
15	Determine volumes per acre to be removed based on forest types and on average stand sizes.	Volume removals will be more in smaller size classes, less in larger size classes.
16	Calculate commercial timber volumes that can result as a byproduct of ERT for the next two decades.	44% more than has come out under the NWFP and none of it is mature or old-growth trees.

Due to the huge area involved and methodological limitations of this report, the spatial locations of stands deemed appropriate for ERT are not shown in this report. At every juncture, however, conservative assumptions were chosen to account for, among other things, the lack of site specificity in this report. It may be that site-specific consideration results in more acres being available for ERT, but the goal was to determine an amount of commercial timber derived as a byproduct of ERT that has a high-likelihood of being achieved.

Ecological Restoration Thinning in Riparian Reserves

There is controversy about whether ecological restoration thinning (ERT) provides ecological benefits in riparian reserves. Removing trees is unlikely to benefit the recruitment of woody structure needed in both aquatic and terrestrial ecosystems. On the other hand, thinning is likely to increase the diversity of vegetation species and structure. The science is still being debated, in part because the positive and negative effects of logging are like "apples and oranges" that cannot be conveniently weighed and compared.

Because of this, ecological restoration thinning within Riparian Reserves should approached very cautiously. Not every acre—or even the majority of acres—within the riparian reserve system would see ecological benefit from restoration thinning. However, there are a subset of lands within Riparian Reserves—usually plantations—where ERT could produce significant ecological benefits.

Established by the Northwest Forest Plan, Riparian Reserves (RRs) widths are two site potential tree heights on each side of fish-bearing streams and one site potential tree height on each side of non-fish-bearing streams. Site potential tree height for productive, moist forests is typically around 200 feet. The NWFP allows careful thinning in riparian reserves under certain circumstances where ecological conditions will be maintained and improved.

Formal "watershed analysis," which examines site-specific conditions, can either increase or decrease the width of RRs. On most National Forest timber sales under the NWFP, commercial thinning has occurred in up to two-thirds of RRs. No-cut buffers are thus typically one-third of the RRs width.

Due to past clearcutting near streams some of the land within riparian reserves can be structurally simplified plantations that may benefit ecologically from carefully designed ERT. Depending on site-specific conditions, some of the land within them can be structurally simplified plantations can benefit ecologically from carefully designed ERT.

The definition of candidate acres potentially available for ERT in Riparian Reserves are the same as described elsewhere and excluded all acres that were (1) riparian forest types from the GAP (Gap Analysis Program) land cover types; (2) greater than 20% percent hardwoods by basal area; and (3) had an average tree diameter of greater than 20".

These and other filters focus candidate selection in Riparian Reserves on plantations in moist forest types. Only 4% of all RRs acres would be treated with ERT.

These and other filters focus candidate selection in Riparian Reserves on plantations in moist forest types. Only 4% of all RRs acres would be treated with ERT over two decades (2%/decade). Pacific Rivers Council recommends that "cumulative riparian area impacted by silvicultural treatment, yarding, and transportation does not exceed 10% over a ten-year period in any 6th field sub-watershed."[13]

[13] Persell, John, Mary Scurlock and Chris Frissell. 2012. Protecting Freshwater Resources on the Mt. Hood National Forest: Recommendations for Policy Change. Pacific Rivers Council, Portland OR.

Results

This analysis demonstrates that timber volume from federal administrative units under the Northwest Forest Plan can—for at least two decades—increase from recent historical levels. All of the timber volume can be generated as a byproduct of ERT. Neither mature or nor old-growth moist forest stands would be logged, nor would any older trees in dry forest stands.

Table 2: *Results for Acres Treated and Volumes by Federal Administrative Units.*

Federal Administrative Unit	Average Treated Area Per Year (acres)	Total Volume Available for Sale (mbf)	Average Volume Per Acre Available for Sale (mbf)	Average Volume Re-moved Per Year (mbf)	Average Volume Per Acre Re-moved (mbf)	Ave-rage Annual Sold Timber Volume 1995-2010	Projected Change in Average Annual Sale Quantity	
							(MBF)	(%)
Gifford Pinchot NF	6,027	1,088,588	104,672	54,429	9.0	19,100	35,329	185%
Mt. Baker-Snoqualmie NF	3,003	558,198	53,673	27,910	9.3	7,800	20,110	258%
Okanogan-Wenatchee NF	9,261	1,160,930	111,628	58,047	6.3	29,200	28,847	99%
Olympic NF	2,957	684,938	65,859	34,247	11.6	17,400	16,847	97%
Washington Total	***21,248***	***3,492,653***	***335,832***	***174,633***	**--**	***73,500***	**101,133**	**138%**
Coos Bay BLM	1,860	407,909	39,222	20,395	11.0	30,500	-10,105	-33%
Eugene BLM	2,237	465,309	44,741	23,265	10.4	29,600	-6,335	-21%
Lakeview BLM	521	90,360	8,688	4,518	8.7	5,600	-1,082	-19%
Medford BLM	3,536	636,848	61,235	31,842	9.0	33,300	-1,458	-4%
Rosburg BLM	2,637	498,123	47,896	24,906	9.4	27,300	-2,394	-9%
Salem BLM	2,437	536,585	51,595	26,829	11.0	34,700	-7,871	-23%
Oregon BLM Total	*13,230*	*2,635,135*	*253,378*	*131,757*	--	*161,000*	-29,243	-18%
Deschutes NF	4,926	650,528	62,551	32,526	6.6	27,600	4,926	18%
Fremont-Winema NF	2,234	353,275	33,969	17,664	7.9	6,300	11,364	180%
Mt. Hood NF	5,565	1,036,913	99,703	51,846	9.3	32,000	19,846	62%
Rogue-Siskiyou NF	5,733	1,011,989	97,307	50,599	8.8	39,100	11,499	29%
Siuslaw NF	2,290	546,223	52,521	27,311	11.9	26,200	1,111	4%
Umpqua NF	5,332	979,428	94,176	48,971	9.2	30,000	18,971	63%
Willamette NF	7,544	1,474,809	141,809	73,740	9.8	59,300	14,440	24%
Oregon USFS Total	*33,623*	*6,053,166*	*582,035*	*302,658*	--	*220,500*	*82,158*	*37%*
Oregon Total	***46,853***	***8,688,300***	***835,413***	***434,415***	**--**	***381,500***	**52,915**	**14%**
NorCal BLM	692	128,477	12,354	6,424	9.3	0	6,424	--
Klamath NF	5,126	891,617	85,732	44,581	8.7	25,000	19,581	78%
Lassen NF	238	48,913	4,703	2,446	10.3	3,100	-654	-21%
Mendocino NF	2,281	427,192	41,076	21,360	9.4	6,800	14,560	214%
Modoc NF	348	54,773	5,267	2,739	7.9	2,400	339	14%
Shasta-Trinity NF	7,429	1,326,924	127,589	66,346	8.9	37,400	28,946	77%
Six Rivers NF	2,361	420,540	40,437	21,027	8.9	7,600	13,427	177%
California Total	***18,476***	***3,298,435***	***317,157***	***164,922***	**--**	***82,300***	**82,622**	**100%**
GRAND TOTAL	***86,577***	***15,479,389***	***1,488,403***	***773,969***	**--**	***537,300***	***236,669***	***44%***

[1] All volumes are from commercial treatments and include sawlog and pulpwood/chip material.

The analysis shows that 774 million board feet (MMBF) per year of commercial timber could be obtained during a 20-year restoration period from ERT projects on degraded forestlands within the Northwest Forest Plan (NWFP)—a 44% increase of commercial timber compared to the recent years' average of 537 MMBF sold from 1995 to 2010.[14] (Please see Table 2.)

A portion of the timber volume that has been sold under the NWFP has been highly controversial in that it came from mature and old-growth forest, either as "green" or "salvage" sales. While the timber produced as a byproduct of restoration thinning will be commercially valuable, it won't come from the largest trees, treasured by a majority of Americans as an important natural legacy and a critical component of functioning ecosystems and watersheds. Most of the mills in the region have moved beyond dependence on large trees. The future of the timber industry in the Pacific Northwest is in building flexibility to respond to changing markets and to handle a variety of supply streams—mostly from non-federal lands. Those companies that continue to depend extensively on large logs from federal public lands will not survive.

Jobs in the Woods and the Mills

Using the generally accepted multiplier of 11.4 direct, indirect and induced jobs per million board feet of timber produced in western Oregon,[15] the additional increment of timber volume recommended in this report (~237 MMBF/year) would equate to 2,702 timber (logging, hauling, milling and related) jobs.

The Economic Landscape

Current logging industry infrastructure is not optimally aligned for ERT. Though there is an abundance of milling infrastructure suitable for processing small logs, a few mills still have outdated equipment that requires large trees.

To fully and most profitably acquire timber volume from ecological restoration projects on federal lands, the logging industry needs to retool to more efficiently handle smaller logs. It also needs to retool equipment to minimize damage to soils and other natural resources, by investing in state-of-the-art, low-ground-impact, and fuel-efficient logging, yarding, and hauling equipment. Federal tax credits should be offered to leverage private investment in this area.

Low timber prices for federal timber[16] caused by low domestic lumber and plywood prices will limit available funds from retained receipts to carry out non-commercial restoration activities (such as the removal of unnecessary roads and the storm-proofing of necessary roads) beyond what can be accomplished through contracting mechanisms, such as stewardship contracts.

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[14] The amount sold varied by Administration. Under President Clinton it averaged 546 MMBF/year, under President Bush it averaged 510 MMBF/year, and so far under President Obama it has averaged of 620 MMBF/year.

[15] Lettman, Gary. Economist with the Oregon Department of Forestry. November 17, 2009. Personal communication.

[16] Non-federal timber prices are booming due to the export of unprocessed logs to East Asia. Federal logs cannot be exported.

Congress needs to pay down the ecological debt to forests, the hydrological debt to watersheds and the carbon debt to our climate by helping fund non-commercial restoration activities.

The Social Landscape

A growing majority of people who live in the Pacific Northwest want protection of mature and old-growth forests. As the region continues to urbanize demographically and diversify economically—and as the role forests in climate stabilization become more widely known—these trends in public opinion will likely grow stronger, favoring protection of late-successional forests.

The timber industry has lost its social license to log older trees and roadless areas on public lands. Its best and only hope for any significant volume of timber to come from federal forestlands is for that timber to be a byproduct of scientifically sound ERT.

The majority of the conservation community supports scientifically sound ERT, as long as it is done in appropriate places in appropriate ways that protect—or at least mitigate—other resource values, like watersheds, wildlife, carbon sequestration, and recreation.

Historically, when the only kind of logging on federal public lands was the cutting of old-growth forests, logging was a zero-sum game between the conservation community and the timber industry: if one side wins, the other loses. Such no longer need be the case in that a significant and profitable volume of trees needs to be removed from younger moist forest stands and fire-excluded dry forest types to conserve and restore old-growth forests. For this to work, however, the last timber industry holdouts will have to give up their dreams to log old forests. Most companies have effectively done so already.

A major limitation to the number of ecological restoration projects that can be done is the recalcitrance of federal forest management agencies themselves. Many administrative units of the Forest Service have already moved toward restoration and away from liquidation or wholesale clearcutting of old forests. The best example is the Siuslaw National Forest in Oregon's Coast Range. Conservationists have not challenged a timber sale or stewardship contract on the Siuslaw since the early 1990s. Another excellent example is the Mount Baker-Snoqualmie National Forest in Washington. Within the Bureau of Land Management, some managers are still invested in a culture of forest liquidation and industrial exploitation.

Of Particular Concern: Marbled Murrelets

The marbled murrelet is listed as "threatened" under the Endangered Species Act. Proposed levels of VDT are compatible with adequate buffers remaining around marbled murrelet nest sites so as to not affect them by windthrow, which can create artificial edge conditions harmful to murrelets. To the degree it creates any "edges;" ERT edges will be soft. As the prime habitat of the species is moist mature and old-growth forest, we recommend no ERT in such habitat.

Of Particular Concern: Northern Spotted Owls

In order to ensure that recommendations in this report are consistent with the best available science to recover this imperiled species, the screens in this report were developed considering the recommendations of independent peer reviews on the 2008 and 2010 draft northern spotted owl recovery plans. As such, owl "activity centers," which include nest areas, were removed from further analysis as well as all mature and old-growth moist forests, which—in the main—is all nesting/roosting and foraging habitat for the imperiled species.

Ecological Restoration Thinning in Moist Forest Types

As owls rely on late-successional forests (mature and old growth) in moist forest types, it is recommended that ERT occur only in plantations, as moist forests otherwise are not degraded and do not need to be restored. At best, plantations that have not undergone VDT might be very marginal habitat for these species for the foreseeable future.

Ecological Restoration Thinning in Dry Forest Types

For the dry forest types, it is recommended to limit ERT on relatively small fractions of these forest types that are capable of supporting northern spotted owl. In existing habitat that must be treated as part of overall landscape restoration, lighter treatments designed to maintain canopy-closure requirements for the owl are recommended.

Two studies that do exist are suggestive that these conservative estimates are defensible. One study examined the conflict between fuels treatment and conservation of the northern spotted owl in the Eastern Cascades of Washington.[17] The other examined ponderosa pine forest restoration conflicts with Mexican spotted owl conservation in northern Arizona.[18] Both found the high-conflict overlap to be approximately one-third of the landscape. In most cases, site-specific analysis can avoid any conflicts as only 30-60% of various dry forest types are modeled for treatment.

ERT in degraded dry forest types are for the purposes of restoring the stand to a more natural condition so that:

- the remaining old live trees are more able to resist attack by insects and disease due to no longer having to compete as much with young trees for resources;
- stands are more able to respond in characteristic ways to wildfire (or prescribed fire); and

- habitat values are maintained or improved for various species of concern, including those not protected under the Endangered Species Act (e.g. white-headed woodpecker).

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[17] Gaines, William L., Richy J. Harrods, James Dicknson, Andrea L. Lyons and Karl Halupka. 2010. Integration of Northern spotted Owl Habitat and Fuels Treatments in the Eastern Cascades, Washington, USA. Forest Ecology and Management. Vol. 260, pages 2045-2052. http://ddr.nal.usda.gov/bitstream/10113/46554/1/IND44438966.pdf
[18] Prather, John W. and Reed F. Noss, and Thomas D. Sisk. 2008. Real Versus Perceived Conflicts Between Restoration of Ponderosa Pine Forests and Conservation of the Mexican Spotted Owl. Forest Policy and Economics Vol. 10, pages 140-150.

Complicating these goals is the fact that many of the dry forest stands before the introduction of livestock, fire-suppression and/or logging—when they were historically less dense, whether because of natural fire or native burning—were not particularly good habitat for the northern spotted owl. Ironically, as these dry forests became more dense and less suitable for species such as the white-headed woodpecker, they became better northern spotted owl habitat. The massive clearcutting of most of the threatened species best habitat (moist old forest types) has resulted in the need to retain and restore all northern spotted owl habitat. As recognized in the Northwest Forest Plan and the final Northern Spotted Owl Recovery Plan, existing older forests, even those denser than in the past, often need to be protected by thinning in adjacent young stands.

While ERT in dry forest types within the range of the northern spotted owl can proceed, it must be done very carefully with consideration of spreading out— both temporally and spatially—negative impacts.

Any ERT in nesting/roosting and foraging ("NRF") and dispersal habitat must conserve old live trees and maintain adequate canopy cover for the northern spotted owls ("treat and maintain"). Too much thinning downgrades nesting and roosting habitat to forage habitat and forage habitat to dispersal habitat. Too much thinning can further downgrade dispersal habitat into "non-habitat" for the imperiled owl ("mistreat and degrade"). As of now, there is very little peer-reviewed science that evaluates the effects of thinning on owls and their prey.

The Northern Spotted Owl Recovery Plan states defines NRF habitat for the imperiled species as having at least 60% canopy closure.[19] The ERT proposed in this report would avoid thinning in most NRF habitats.

Needed Research

There is a critical need for scientific research to examine the impacts from ERT on northern spotted owls and their prey, as there is virtually no peer-reviewed science on this important issue. In addition, deeper examinations are needed to assess the potential tradeoffs between causing short-term harm for a federally protected species in exchange for potential long-term benefit.

Adaptive Management

As more is learned about the effects of thinning on and near northern spotted owl (and the habitat of the ESA-threatened marbled murrelet), ERT estimates may need to be refined. Based on what is known now, the estimates for ERT in dry forest types are conservative and therefore attainable—as long as carefully conceived, designed, and executed.

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[19] U.S. Fish and Wildlife Service. 2011. Revised Recovery Plan for the Northern Spotted Owl (*Strix occidentalis caurina*). U.S. Fish and Wildlife Service, Portland, Oregon. xvi + 258 pp.

Of Particular Concern: Temporary Roads

Given the conservative approach used in this analysis, it is believed that the projected timber volume from ecological restoration projects can be accomplished without the construction of any new system roads. Some temporary roads will possibly be needed (see below), but can be kept to an absolute minimum and must be fully obliterated after their purpose has been served.

Ecologically and hydrologically, roads have adverse impacts. The more roads a watershed has and the greater the traffic on those roads, the greater the magnitude of peak flows, sediment production, landslide risk, and habitat fragmentation.[20] Roads are also expensive to maintain. There are already too many roads on federal forestlands managed under the Northwest Forest Plan.

Yet, on occasion, the building of a temporary road to achieve terrestrial and/or hydrological restoration objectives can be justified when the net conservation gains from the restoration activity that requires the temporary road clearly outweigh unavoidable negative effects of the temporary road.

Temporary roads should be low impact roads that are narrow and also avoid major earthwork, fills for stream crossings, steep slopes, stream crossings, etc. For example, a short-distance, low-standard, short-operating-season temporary road may be necessary to carry out mechanical treatment in high-priority stands of trees that would benefit from ERT. New temporary roads with high impact should be avoided, as they are expensive and difficult to fully decommission.

As even the best temporary road has lasting consequences, it is important to fully remove the temporary road immediately after its intended use has ended to allow for ecological recovery—both hydrological and terrestrial—and to minimize long-term impacts. If possible, the temporary road should be constructed, utilized and decommissioned in the same operating season.

In many cases, the best choice will be to not build any road at all, but to instead concentrate ecological restoration efforts elsewhere.

Conclusions and Observations

Conclusions and observations that can be drawn from this analysis include:

1. The ERT proposed is based on the best available peer-reviewed science. While the projected effects of climate change will possibly require a shift in emphasis from exclusively ecological restoration to also one of climate adaptation, the resulting management strategies are mostly similar. Management approaches can be adjusted as the peer-reviewed science of climate adaptation further develops.

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[20] Gucinski H, Furniss MJ, Ziemer RR, Brookes MH. 2001. Forest Roads: A Synthesis of Scientific Information. USDA Forest Service. Pacific Northwest Research Station. General Technical Report PNW-GTR-509; Jones J, Swanson F, Wemple B, Snyder K. 2000. Effects of roads on hydrology, geomorphology, and disturbance patches in stream networks. Conservation Biology 14: 76-85; Trombulak, S.C., and C.A. Frissell. 2000. Review of ecological effects of roads on terrestrial and aquatic communities. Conservation Biology 14: 18-30.

2. No mature and old growth trees needs to be cut to maintain or increase logging levels. There are adequate amounts of commercial timber that can come as a byproduct of ERT.

3. Conservative estimates were used in estimating the acreage and how much volume might be removed by ERT. The goal was to produce a realistic (high likelihood of being achieved) estimate.

4. The recommendations focus on VDT and TFB as techniques for ecological restoration because they are supported by the best available science.

5. This proposal is consistent with the Final Recovery Plan for the Northern Spotted Owl.

6. Upon completion of the two-decade ecological restoration period, society will have options. It can continue to leave the federal public forestlands on a trajectory to conserve or restore old-growth forests and watersheds to provide ecosystem services like water quality, in-system water storage, biodiversity, carbon storage and sequestration, and recreation or alternatively, society may decide that some level of commercial logging remains an appropriate use of the federal public forestlands. Ecologically thinned stands will have adequate densities of trees for either pathway.

7. Opportunities for additional ERT will exist after the 20-year projection of this analysis. There will be growth across the younger age classes and some stands that were too young for thinning during the 20-year restoration period will become suitable for ERT.

8. Thinning forests for whatever reason will result in a flux of carbon to the atmosphere, despite the minor fraction stored in long-lived wood products. In the case of degraded forests, the biological diversity, watershed and other benefits can outweigh these modest climatic costs.

9. As the best available peer-reviewed science further develops, it may be that additional ERT opportunities may be possible in intermediate (neither clearly moist, nor clearly dry) forest types.

10. Thinning treatments will accelerate tree growth and therefore development of key old forest characteristics (large trees, multiple canopy layers, diverse understories) faster than natural succession would in unnatural plantations in moist forests. In dry forests, thinning will create more characteristic density levels and species compositions. Untreated areas, including riparian areas and areas inaccessible from existing roads, will provide dense forest habitat and recruit ecologically valuable large snags and down wood. "Forest health" and landscape resilience will be achieved by the combination of structural conditions and habitats that exist in both treated and untreated areas.

11. ERT is only part of comprehensive forest and watershed restoration. All monies received by the federal forest agencies for the sale of timber that is a restoration byproduct should be fully retained by the federal forest management agencies to fund the non-commercial and administrative aspects of comprehensive forest and watershed restoration, such as road and

culvert work, prescribed fire, managed wildfire, non-commercial thinning, climate adaptation activities, and enhancement of unique habitats like meadows and aspen groves. In addition, it is likely necessary (given current and likely future timber prices) for additional congressional appropriations to fund ecological restoration.

Caveats

There are several matters to keep in mind when reviewing this report:

1. The estimated number of acres treated and volumes produced are the most accurate at the scale of the whole NWFP area. Results at the individual Federal Administrative Unit (FAU) level and by forest type should be interpreted with caution. Volume estimates for more productive FAUs are likely lower than actual and estimates for less productive FAUs likely higher than actual.

2. Like any model, the estimates of timber volume derived from this model have uncertainty and error associated with them. Given the vast geographic area involved, the tremendous variation in biophysical conditions, and the high diversity of forest types, an appropriate scale to summarize results and reduce the number of input datasets and parameters to a manageable level was chosen. The datasets that the model is built on are the most consistent, up-to-date, and accurate ever produced for the whole NWFP area. The treatment percentage assumptions and growth modeling are conservative and based on the best available science. Model outputs were closely scrutinized and informally validated by multiple sources to ensure they were reasonable. Overall, this model contains an appropriate level of complexity given its objectives, and that the results are a reasonable estimate of potential timber production.

3. The level of uncertainty associated with the model results was not determined. Various methods of calculating confidence intervals were explored, but estimating the error associated with the GNN (gradient nearest neighbor) data and the potential errors in combining the GNN and GAP (Gap Analysis Program) layers was beyond the scope of this project. Results from GNN accuracy assessments available for each GNN region show decent correlations between predicted and actual basal area and volume per acre (~56-75% correlation).[21] The errors in these predictions appear to be well balanced and not skewed in any direction, so they average out over large scales. The scale of this analysis is much larger than the minimum analysis area recommended by the creators of the GNN data (~40,000 acres). While no formal model validation was done, the results are consistent with volume per acre levels on current thinning sales. If anything, they are somewhat below typical MBF/acre averages. The number of treatment acres on each FAU is another test of the reasonableness of the model outputs.

4. The broad scale of this analysis did not allow us to explicitly exclude lands that are too steep, too far from an existing road, etc. to be appropriate for ERT. However, rather than accounting for every site-specific constraint to treatment, a fraction of each suitable forest type is assumed to be treated. These conservative assumptions cumulatively account for such factors

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[21] Individual accuracy assessments are available for each GNN modeling region at: http://www.fsl.orst.edu/lemma/main.php?project=nwfp&id=studyAreas

and that, after scientifically sound site-specific planning and analysis, these problematic acres will be identified and ERT planned accordingly.

5. This is not a sustained yield calculation. It is a conservative analysis of what timber volume could be removed in the context of ecological restoration, over the next two decades. There are more ERT opportunities in later decades, but this report did not model them.

6. If the regulatory agencies such as US Fish and Wildlife Service and National Marine Fisheries Service raise concerns about the cumulative effects of large-scale thinning conducted over a 20-year time frame, it could be mitigated by spreading the thinning effort (and its effects) over a longer period.

Table 3: *Candidate Forest Types and Treatment Levels*

Forest Type	Forest Category[1]	Percent Standing Volume/ Acre Removed	Percent of Candidate Acres Treated by Vega/Size Class			
			Open	Sap/Pole	Small/ Med	Large
East Cascade Dry Mixed Conifer	Dry	20-35%[2]	0%	60%	40%	30%
East Cascade Ponderosa Pine	Dry	20-35%[2]	0%	60%	60%	40%
Mediterranean Calif. Dry Mixed Conifer	Dry	20-35%[2]	0%	60%	40%	30%
Mediterranean Calif. Oak Conifer	Dry	20-35%[2]	0%	60%	60%	40%
East Cascade Mesic Mixed Conifer	Moist-EK	35%	0%	60%	20%	0%
Mediterranean Calif. Mesic Mix Conifer	Moist-EK	35%	0%	60%	20%	0%
Mediterranean Calif. Mixed Evergreen	Moist-EK	25%	0%	30%	30%	0%
Mediterranean Calif. Red Fir	Moist-EK	35%	60%	60%	30%	0%
Westside mixed hardwood conifer	Moist-W	35%	60%	60%	20%	0%
Cascade Silver Fir-W. Hemlock[3]	Moist-W	25%	40%	40%	10%	0%
Coast Redwood-S. Spruce/W. Hemlock[3]	Moist-W	35%	60%	60%	40%	0%
Dry Douglas-fir Madrone[3]	Moist-W	25%	40%	40%	40%	0%
Westside dry Douglas-fir-W. Hemlock[3]	Moist-W	35%	60%	60%	20%	0%
Westside mesic Douglas-fir-W. Hemlock[3]	Moist-W	35%	60%	60%	20%	0%
Regeneration (Plantation)[3]	All	35%	60%	60%	60%	0%

[1] The moist forest category is divided into EK (East Cascades and Klamath) and W (Westside). However, treating plantations is the focus for all moist forest types.
[2] In dry forest types, 35% of standing volume would be removed in the Sapling/Pole and Small/Medium classes, while only 20% in the Large class. None is projected to be removed from the Giant Class, though site-specific analysis may find that such is warranted.
[3] For these forest types, ecological restoration thinning is projected to occur on 50% of the candidate acres. No ERT is assumed in all other forest types.

Table 4: *Vegetation and Size Classes Used from GNN Data Layers*

Vege-ation Class[1]	Description	Size Class	Average QMD[2]	Canopy Cover	Basal Area Proportion of Hardwoods
1	Sparse: (CanCOV <10)			<10%	
2	Open (CANCOV 10-39)			10-39%	
3	Broadleaf, mod/closed	Sapling-Pole	<10"	=>40%	=>65%
4	Broadleaf, mod/closed	Small-Medium-Large	>10"	=>40%	=>65%
5	Mixed, mod/closed	Sapling-Pole	<10"	=>40%	20-64%
6	Mixed, mod/closed	Small-Medium	10-20"	=>40%	20-64%
7	Mixed, mod/closed	Large-Giant	>20"	=>40%	20-64%
8	Conifer, mod/closed	Sapling-Pole	<10"	=>40%	<20%
9	Conifer, mod/closed	Small-Medium	10-20"	=>40%	<20%
10	Conifer, mod/closed	Large	20-30"	=>40%	<20%
11	Conifer, mod/closed	Giant	>30"	=>40%	<20%

[1] Vegetation Class; Vegetation Class from Johnson and O'Neil (2002).
[2] Average QMD: This is the quadratic mean diameter at breast height (DBH) of the overstory. Quadratic mean diameter is the corresponding diameter of the average basal area. It is similar to the overall average diameter, but is typically slightly higher. Shaded classes (2, 8, 9) are the only classes considered as candidates for treatment. Class 10 is only a candidate in dry forest types.

Table 5: *Results for Acres Treated and Volume by Forest Group*

Forest Type	Forest Category[1]	Total Matrix, LSR, AMA (acres)[2]	Acres Treated	Acres Treated per Year	Total Volume (MBF)[3]	Average Volume per Year (MBF)	Average Volume per Acre (MBF)
Mediterranean Calif. Dry Mixed Conifer	Dry	2,177,177	295,624	14,781	2,738,362	136,918	9.3
Westside dry Douglas-fir-W. Hemlock	Moist-W	1,402,706	197,520	9,876	2,119,705	105,985	10.7
Westside mesic Douglas-fir-W. Hemlock	Moist-W	1,271,906	129,506	6,475	1,785,674	89,284	13.8
Regeneration (Plantation)	All	1,184,434	438,533	21,927	3,706,565	185,328	8.5
Mediterranean Calif. Mesic Mixed Conifer	Moist-EK	1,067,721	144,100	7,205	1,212,201	60,610	8.4
Cascade Silver Fir-W. Hemlock	Moist-W	855,659	88,117	4,406	618,463	30,923	7.0
Mediterranean Calif. Mixed Evergreen	Moist-EK	757,306	31,633	1,582	238,667	11,933	7.5
Mediterranean Calif. Oak Conifer	Dry	639,787	70,349	3,517	690,804	34,540	9.8
East Cascade Dry Mixed Conifer	Dry	389,768	111,672	5,584	605,084	30,254	5.4
East Cascade Mesic Mixed Conifer	Moist-EK	323,928	52,890	2,645	413,987	20,699	7.8
Westside mixed hardwood conifer	Moist-W	280,646	22,608	1,130	221,712	11,086	9.8
East Cascade Ponderosa Pine	Dry	246,149	66,209	3,310	353,855	17,693	5.3
Dry Douglas-fir Madrone	Moist-W	190,783	30,463	1,523	211,393	10,570	6.9
Coast Redwood-S. Spruce/W. Hemlock	Moist-W	159,873	22,805	1,140	317,788	15,889	13.9
Mediterranean Calif. Red Fir	Moist-EK	105,174	29,504	1,475	245,128	12,256	8.3
Non-candidate forest types		1,106,311	0	0	0	0	0.0
Non-forest		788,012	0	0	0	0	0.0
Totals		**12,947,342**	**1,731,533**	**86,577**	**15,479,389**	**773,969**	**8.9**

[1] The moist forest category is divided into EK (East Cascades and Klamath) and W (Westside). However, treating plantations is the focus for all moist forest types.
[2] Includes Riparian Reserves within Matrix, LSR, and AMA.
[3] All volumes are from commercial treatments. Volumes include sawlog and pulpwood/chip wood material.

Table 6: *Results for Acres by Federal Administrative Unit*

					Treated Area			
Federal Administrative Unit (FAU)	NWFP Area (acres)	Withdrawn, IRA, & Other Area (acres)[1]	Total Matrix, LSR, AMA, & RR within (acres)[2]	Total Candidate Area (acres)[3]	Total Acres	Percent of Cand-idate Area	% of Total LSR, Matrix, AMA & RR[4]	Per-cent of FAU[5]
N. California BLM	428,162	54,382	373,779	69,355	13,841	20%	4%	3%
Coos Bay BLM	321,905	24,127	297,778	113,102	37,201	33%	12%	12%
Deschutes NF	775,861	388,443	387,419	282,480	98,516	35%	25%	13%
Eugene BLM	315,076	14,426	300,650	162,022	44,748	28%	15%	14%
Gifford Pinchot NF	1,356,078	552,610	803,467	470,458	120,547	26%	15%	9%
Klamath NF	1,573,947	690,563	883,384	382,472	102,526	27%	12%	7%
Lakeview BLM	51,004	5,035	45,969	35,864	10,429	29%	23%	20%
Lassen NF	26,467	203	26,265	16,515	4,770	29%	18%	18%
Medford BLM	868,641	106,868	761,773	231,494	70,729	31%	9%	8%
Mendocino NF	778,452	356,674	421,778	166,385	45,628	27%	11%	6%
Modoc NF	50,412	10,473	39,939	30,669	6,962	23%	17%	14%
Mt. Baker-Sno. NF	1,746,288	1,201,157	545,131	275,027	60,050	22%	11%	3%
Mt. Hood NF	1,017,559	345,045	672,514	446,715	111,293	25%	17%	11%
Olympic NF	630,829	180,376	450,453	232,259	59,137	25%	13%	9%
Rogue-Siskiyou NF	1,719,499	757,363	962,136	425,174	114,660	27%	12%	7%
Roseburg BLM	425,267	25,722	399,546	168,941	52,749	31%	13%	12%
Salem BLM	401,604	21,066	380,538	181,870	48,746	27%	13%	12%
Shasta-Trinity NF	2,077,124	908,321	1,168,802	511,013	148,578	29%	13%	7%
Siuslaw NF	626,404	113,113	513,291	154,028	45,800	30%	9%	7%
Six Rivers NF	964,625	401,715	562,909	164,386	47,220	29%	8%	5%
Umpqua NF	985,130	274,595	710,535	408,011	106,633	26%	15%	11%
Wen/Okan NF	3,275,203	2,266,198	1,009,004	578,045	185,218	32%	18%	6%
Willamette NF	1,689,402	660,137	1,029,264	616,910	150,878	24%	15%	9%
Winema NF	337,066	136,048	201,018	165,307	44,674	27%	22%	13%
Other NWFP areas (NP, FW, etc)	2,435,945							
Total	**24,877,949**	**9,494,662**	**12,947,342**	**6,288,503**	**1,731,533**	**28%**	**12%**	**7%**

[1] IRA: Inventoried Roadless Areas. Other includes NSO and MM habitat acres.
[2] Includes Riparian Reserves within Matrix, LSR, and AMA.
[3] Total candidate acres.
[4] The percent of total acres in Matrix, AMA, and LSR that are treated is 15% if only forested acres are considered.
[5] The percent of total acres in the NWFP area that are treated is 8% if only forested acres are considered.

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About the Author

Andy Kerr (andykerr@andykerr.net) of The Larch Company (www.andykerr.net) consults on environmental and conservation issues. The Larch Company is a for-profit non-membership conservation organization that represents the interests of humans yet born and species that cannot talk. He is best known for his two decades with Oregon Wild (then Oregon Natural Resources Council), the organization best known for having brought you the northern spotted owl. Kerr has been intimately involved in the enactment of over 25 pieces of state and federal public lands conservation legislation.

He has lectured at all of Oregon's leading universities and colleges, as well as Harvard and Yale. Kerr has appeared numerous times on national television news and feature programs and has published numerous articles on environmental matters. He is a dropout of Oregon State University.

Kerr authored *OREGON DESERT GUIDE: 70 HIKES* (Mountaineers Books, 2000) and *OREGON WILD: ENDANGERED FOREST WILDERNESS* (Timber Press, 2004). Past and current clients include Advocates for the West, Campaign for America's Wilderness, Conservation Northwest, Idaho Conservation League, Klamath-Siskiyou Wildlands Center, National Public Lands Grazing Campaign, Oregon Wild, Soda Mountain Wilderness Council, The Wilderness Society, Western

Watersheds Project, Wilburforce Foundation and WildEarth Guardians. Current projects include advocating for additional Wilderness and Wild and Scenic Rivers in Oregon, legislating the protection and restoration of Pacific Northwest forests, facilitating voluntary grazing permit buyouts of federal public lands in the West, and conserving and restoring the Sagebrush Sea. A fifth-generation Oregonian, Kerr was born and raised in Creswell, a recovered timber town in the upper Willamette Valley. He presently splits his time between Ashland, a recovered timber town in Oregon's Rogue Valley, and Washington, DC, where the most important decisions affecting Oregon's wildlands, wildlife, and wild waters are made.

Other Contributors

Derek Churchill is a PhD candidate at the University of Washington focusing on landscape level restoration of dry forests. He received his Masters degree in silviculture and conservation biology at the University of Washington where he focused on uneven-aged management and variable density thinning in Douglas-fir forests. He started and currently runs his own forestry consulting business. He has completed projects with The Nature Conservancy, the US Fish and Wildlife Service, the US Forest Service, Northwest Natural Resources Group, King County, and over 50 private landowners and served as a forester for Conservation Northwest. His experience includes writing large-scale landscape restoration and management plans, volume and harvest modeling, developing a Forest Stewardship Council-monitoring template, designing and managing over 35 harvest operations on more than 3,500 acres, and overseeing a 35,000 acre forest inventory project. He is also a founding member of the Vashon Forest Stewards, a community forestry group that works with small private landowners on thinning and restoration projects. Former work experience includes: forest technician at Fort Lewis, founding director of a wilderness service program for low-income youth, and an Outward Bound instructor for 10 years. He serves on the board of the Pinchot Partners and the Vashon Land Trust.

Peter Bettinger is an Associate Professor of Forestry and Natural Resources at the University of Georgia. Dr. Bettinger is one of the nation's foremost timber harvest schedulers. He received his PhD from Oregon State University. His graduate committee included both Professors Norm Johnson and John Sessions, who generally have diametrically opposing views of how forests should be managed.

Conservation Biology Institute was contracted to prepare summary metrics for each forest type and federal administrative unit. Jim Strittholt and Nancy Staus did the work.

Appendix A
Modeling Methodology

By Derek Churchill*

The modeling process for this analysis was designed at the scale of the entire Northwest Forest Plan (NWFP) area. Estimates of potential commercial timber volume outputs from ecologically appropriate thinning treatments are the most accurate at this scale. Results for individual Federal Administrative Units (FAU) were calculated, but should be used with caution.

The results of the model also rely on assuming that known sources of error in the datasets average out over large geographic areas. Based on the large scale of the analysis area and accuracy assessments done on the primary data layer (GNN) used,[22] we feel that this assumption is reasonable.[23] The model also required making decisions regarding what constitutes ecologically "appropriate" treatment levels for both percent volume removal and percent of candidate acres to treat in different forest types and size classes. Numerous staff members from conservation groups across the NWFP area, as well as Forest Service staff and private forestry consultants, were consulted and/or reviewed these treatment levels.

All results from models of ecological systems have error and uncertainty associated with them. The estimates of timber volume derived from this model are no exception. Given the vast geographic area involved, the tremendous variation in biophysical conditions, and the high diversity of forest types, the complex system being modeled had to be simplified into a manageable level of input datasets, components, and parameters. The datasets that the model is built on are the most consistent, up-to-date, and accurate ever produced for the whole NWFP area. The treatment percentage assumptions and growth modeling are conservative and based on the best available science. Model outputs were closely scrutinized and informally validated by multiple sources to ensure they were reasonable. Overall, we feel that this model contains an appropriate level of complexity given its objectives, and that the results are a solid estimate of potential volume production.

The modeling process consisted of six basic steps that are described below. All of the modeling assumptions and sources of uncertainty are laid out in these sections. The filters used to determine candidate acres and the treatment percentages used to derive the total number of acres treated were based on the policy guidelines provided by Andy Kerr and members of other conservation groups involved in this report and do not necessarily represent the policy views of the technical authors.

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[22] Individual accuracy assessments are available for each GNN modeling region at: http://www.fsl.orst.edu/lemma/main.php?project=nwfp&id=studyAreas

[23] The modeling approach was reviewed by Janet Ohmann of the Pacific Northwest Research Station in Corvallis, OR. She has been one of the lead scientists in developing the forest type (NW ReGap) and forest structure (GNN) datasets used in this model.

1. Assemble Datasets

All of the datasets used in the analysis are widely used, publically available, and were produced by federal land management agencies, the Pacific Northwest Research Station, or university scientists. All of the datasets were re-projected into the same geographic projection and datum, converted to 30-meter pixel raster layers, and combined and clipped into single layers for the entire NWFP area. These raster layers then were used for all the analysis using the raster calculator within ArcGIS, version 9.1.

Three primary data sources were used:

A. Land Use Allocation (LUA) Boundaries. A single GIS shapefile delineating the LUAs for the entire NWFP area was obtained from the Regional Ecosystem Office.[24] The "Land Use Allocation, Update 2002" version was used. However, Riparian Reserves (RRs) were not mapped in this shapefile. RR boundary shapefile layers were obtained from the websites of individual Federal Administrative Units (FAU), the Environmental Impact Statement website of the BLM Western Oregon Plan Revision (original NWFP boundaries), and the USFS Region 5 (California) GIS website. RR layers could not be obtained for the Deschutes, Fremont-Winema, Gifford Pinchot, and the Willamette National Forests and the California BLM. For these areas, RR layers were created from stream GIS layers, stream type information, and average site potential tree heights for each FAU. In addition, a GIS shapefile delineating Inventoried Roadless Areas (IRAs) was obtained from the Forest Service.[25]

B. Forest Types. Land cover grid files from the United States Geological Survey GAP Analysis Program were downloaded for zones covering the NWFP area in Washington, Oregon, and Northern California.[26] The vegetation types used in the GAP data are based on the National Ecological Classification System developed by NatureServe.[27] They are mapped using a combination of Landsat satellite imagery, digital elevation models, and other information.

C. Forest Structure. The latest release of Gradient Nearest Neighbor (GNN) data for the NWFP area were used (March 2010).[28] The data were produced by the Landscape Ecology, Modeling, Mapping and Analysis Project for NWFP effectiveness monitoring program. The GNN methodology uses a combination of Landsat satellite imagery and physiographic characteristics (elevation, slope, aspect, etc) to extrapolate inventory information from inventory plots across the entire region analyzed. The plots used come from multiple sources: FIA (Forest Inventory and Analysis), CVS (Continuous Vegetation Survey), Region 6 ecology plots, and other sources. The GNN data is displayed in a 30-meter pixel raster layer where every 30-meter pixel is assigned to a specific inventory plot. Summary metrics (basal area, trees per acre, volume per acre, etc.) of each plot are included within the attribute table of each GNN layer.

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[24] www.reo.gov/gis/data/gisdata/index.htm
[25] 2002 Roadless Rule FEIS: http://roadless.fs.fed.us/documents/feis/data/gis/
[26] http://www.gap.uidaho.edu/Northwest/NW_mapzonedownload.html; http://www.gap.uidaho.edu/Portal/California/CAReGAP.html
[27] http://www.natureserve.org/explorer/
[28] http://www.fsl.orst.edu/lemma/main.php?project=nwfp&id=studyAreas

2. Select and Group Candidate Forest Types

The GAP layers contained 157 different cover types for the NWFP area. To simplify the analysis for this project, these were combined into 24 groups based on similarity. These 24 groups were then classified into non-forest, candidate forest, and non-candidate forest categories. Candidate groups were selected based on the extent to which each type has been modified by post-settlement activities, and whether treatments are likely to be ecologically beneficial and produce significant commercial wood volume. Management activities within non-candidate types may still be ecologically desirable in some cases, but are low priority, economically costly, and/or require a high level of site-specific analysis to ensure they are indeed ecological beneficial. All upper-elevation, riparian, hardwood-dominated, and recently burned forest types were excluded.

Fifteen candidate forest groups were selected and are shown in Table 3. A complete list of the 157 NatureServe ecological system types and how they were grouped is provided in Appendix A. Descriptions from the NatureServe website of each of the ecological system types encompassed in the 15 candidate forest types are provided in the attached document by Dr. Peter Bettinger (Appendix B). One candidate type, "Regeneration" is not based on specific physiographic conditions and/or tree species as the rest of the candidate types are. Instead, it is based on the ability of the GAP model to recognize the uniform canopy of plantation stands. The GAP layers have a relatively low error rate in terms of misclassifying non-plantations as plantations. However, many plantation acres are classified as other forest types. As plantations are one of the main targets for treatments, this type, Regeneration, was included in the analysis.

3. Determine Candidate Acres

In addition to excluding forest types where treatments are not feasible or not likely to be ecologically beneficial (non-candidate forest types), a number of filters were used to determine the number of candidate acres for each candidate forest type on each FAU. These filters included:

A. Land Use Allocation. All acres within Matrix, Late-Successional Reserve (LSR), Riparian Reserve (RR), Adaptive Management Area (AMA) were initially eligible for consideration for ecological restoration thinning. Adaptive Management Reserves (AMR) and Managed Late Successional Reserves (MLSR) were grouped with the LSR category. All other allocations were excluded: Congressionally Reserved, Administratively Withdrawn, Northern Spotted Owl and Marbled Murrelet activity areas (LSR3 and LSR4), and non-designated areas. In addition, all Inventoried Roadless Areas (IRAs) were removed from consideration.

B. Size Class and Conifer Composition. Vegetation and size classes from the GNN data layers were used to exclude larger size classes and acres composed of 20% or more hardwood tree species by basal area. Definitions for the 11 classes are shown in Table 4. For moist forests, all acres with an average overstory diameter greater than 20" DBH were excluded. While this cutoff very likely excludes all moist old growth in moderate to high-productivity forest types, some mature and low productivity old-growth forest trees have average DBHs less than 20".

Therefore, this filter likely fails to exclude all mature and old growth in moist forest types. This limitation was addressed by treating only a portion of the candidate acres in a subsequent step.

In dry forest types, the large size class (class 10) was included. This increased the upper diameter threshold to 30" DBH. This was done as treating dense stands with large, old trees is a major restoration need in dry forests. However, large trees (>20" DBH) are not being removed when modeling treatment in these acres. The percent of volume removed per acre was lowered to 20% for this large size class to ensure that volume estimates are based only on the removal of smaller trees.

4. Derive Summary Metrics for Candidate Acres

For each vegetation/size class in each candidate forest type, a selection of summary metrics was derived from the GNN data. These metrics included volume of live trees per acre, mean and median age, basal area per acre, quadratic mean diameter of overstory trees, canopy cover, and percent basal area of hardwoods (see Appendix C). This was done by first combining the forest type layer, the LUA layer with all non-candidate designations removed, and the GNN layer in ArcGIS. Summary metrics were derived from an area-weighted average of these results. Volumes were converted from cubic feet (CF) to thousand board feet (MBF) by using a conversion factor of 0.0052 CF to MBF. The averages of the other metrics were examined to ensure that—on average—acres were in fact dense and appropriate for treatment.

Using both the GNN and the GAP layers introduced a source of classification error into the model. Undoubtedly, some areas classified as candidate acres are actually in non-candidate forest types. However, the opposite is also true and these errors are assumed to balance out over the large scale of the analysis area. An additional complication was identified in combining the GAP, GNN, and LUA layers in ArcGIS. The cells of the GNN layers do not align perfectly with the GAP layers and are offset by about ¼ of a pixel. This misalignment issue was closely examined and did not affect the results of the combine function in several test areas. The GAP layer tends to be fairly aggregated into large blocks, so any misalignment effects should be small, as they would occur on the edges of blocks.

Average age for many vegetation/size class–forest type combinations were found to be higher than expected based on local knowledge of typical conditions in multiple national forests. The distribution of ages in each candidate size class in each candidate forest type was examined and found to be right skewed, or toward the maximum age. There were plots with unrealistically high ages that pulled the average higher. The left side of the distribution is constrained by 0, the minimum possible age. Two factors accounted for the right skew. On many CVS/FIA plots, legacy older trees that are cored for age can skew the age average upwards, masking the younger age of the majority of the trees on the plot. Also, the accuracy reports for the GNN data show that there is a significant rate of misclassification in the GNN modeling process. Larger sizes classes are classified as smaller classes and visa-versa. For the overall model results, these classification errors balance out. For age results, however, the errors contribute to the right skew. The median age for each vegetation/size class–forest type combination was thus calculated to deal with this issue. However, even the median age was often found to be somewhat higher than expected. The median age values were still used, which had the effect of reducing growth rates in the volume modeling (see step 6).

A decision was made to calculate one set of summary metrics for each vegetation/size class in each forest type for the whole NWFP area. These metrics are thus broad averages that mask differences in local ecology and productivity. For example, the average volume per acre for acres in the small-medium (vegetation class 9) - westside mesic Douglas-fir-Western Hemlock group is likely to be higher in the highly productive Siuslaw National Forest versus the Gifford Pinchot National Forest, while the median age is likely to be lower. Initial model runs were done by calculating summary metrics for each FAU, but the number of acres and corresponding plots for many forest types in many FAUs was low (<4,000 acres). Thus, the potential error for summary metrics was high. Cumulatively, this added an unacceptable amount of uncertainty to the model. Differences in volume per acre and median age for each vegetation/size class in each forest type were examined across FAUs. These differences were generally less than 10%. Higher differences almost always occurred when few acres existed in one or both of the FAUs in that vegetation/size class – forest type combination. The exception was the Regeneration forest type, where the volume per acre and median age varied considerably. Thus the final model results likely show lower than actual volume output on more productive FAUs and higher than actual on less productive FAUs. However, these errors average out when the results are considered for the whole NWFP area.

5. Allocate Candidate Acres

The GAP, LUA, and GNN layers were combined in ArcGIS to determine the total number of candidate acres in each forest type in each FAU for the appropriate size classes (see Appendix D). The misalignment issue discussed above is also relevant to this step. To account for the reality that, from ecological and hydrological restoration standpoints, not all candidate acres could or should be treated, a significant portion of the candidate acres in each candidate forest type were then dropped. A different treatment percentage for each vegetation/size class in each forest type was determined. The same percentages were maintained for each forest group across all the FAUs. Sufficient information on localized conditions was not available to adjust the percentages for each FAU and was beyond the scope of this analysis. These percentages are shown in Table 3 and were based on several factors.

First, forest types and vegetation/size classes where mature and low-productivity old-growth forest is likely to occur were given lower percentages. An example is the small-medium classes in both the westside dry Douglas-fir-Western Hemlock forest and the westside mesic Douglas-fir-Western Hemlock forest. Significant areas of naturally regenerated, mature forest exist in these forest types as a result of large fires in the late 1880s and early 1900s in the western Cascades of southern Washington and central Oregon. The spatial location of these forest types, based on the GAP layer, were closely examined on the Gifford Pinchot National Forest and compared with the national forest's vegetation polygon layer, orthophotos, and data from recent stand exams. Both older plantations and 80-120 year old naturally regenerated stands were encompassed within these two forest types and the small medium size class. Based on this analysis, only 20% of the candidate acres within these forest types and class were treated. A similar rationale was used to set a conservative percent (10%) for the small-medium class in

Cascade Silver Fir Western Hemlock, where many stands with an average dbh <20" can be mature or even old growth. At the same time, this forest type was heavily clearcut—especially in western Washington—so some of these acres are plantation stands. Most of these plantation acres are picked up in the model in the Regeneration forest type.

Second, the goal for the candidate acres selected is that no new roads will need to be built to access them. Due to the poor level of accuracy of GIS road layers on many FAUs, a road access filter was not included. Adding a spatial, road access filter to the other filters would have pushed this limit of the spatial accuracy of the GNN data and increased the uncertainty of the results. However, an analysis of road access was done on six National Forests that have decent road GIS layers and all the Oregon BLM FAUs. Using a maximum yarding distance of 1,400', less than 20% of the candidate acres were inaccessible on all the FAUs.

Third, past treatments and the 20-year time horizon of the analysis were factored in. Acres in the "open" vegetation class (<40% canopy cover) in dry forest types were not treated. Prescribed fire or managed wildfire is often a preferable option to managing these types of stands. Additionally, it is unlikely such stands will have sufficient volume of small diameter trees within 20 years. Stands in moist and mesic forest types that have been treated in the past may not benefit ecologically from further treatments. To account for this, as well as untreated stands that are already diverse and structurally complex, no more than 60% of any vegetation class in any forest type was treated.

An additional metric was examined to ensure that treatment percentages were realistic: the average percent of candidate acres treated for each FAU. A maximum treatment of 50% of the candidate acres was used as a general guide. This was based on experience with many past Forest Service projects where many suitable acres are dropped from treatment consideration for a whole variety of reasons. In the final model results, the maximum percent of candidate acres treated was 39%. This is a conservative target, since most Forest Service projects treat more than 39% of candidate acres, as defined in this model.

The percent of standing volume to remove in treatments was also determined for each forest type (Table 3). These percentages are broad averages, and not meant to be prescriptive targets for appropriate ecological treatments. Prescriptions must always factor in site-specific factors. The percentages were generally set at 35% from experience with recent restoration-based prescriptions on National Forests across the NWFP area. On two forest types with more hardwoods (Douglas-fir-Madrone, and Mediterranean California-Mix Evergreen), the percent was set at 25%. Also, 25% was used for the Cascade Silver Fir Western Hemlock, as natural stands of this type are generally dense. For the large size classes in dry forest types, 20% removal was used to ensure that volume estimates were based only on removing small trees.

6. Calculate Available Timber Volumes

The final step in the analysis was to develop a harvest-scheduling program. The program, described in detail in the attached document by Dr. Peter Bettinger (Appendix B), uses the median age of each vegetation/size class and growth rate parameters for each forest type to grow acres out over time. Growth is based on a percent increase in total stand volume and does not use lists of individual trees. The percent increase in volume declines exponentially over time based on the following equation. The parameters (a, b, k) for each forest type are listed in Appendix B. Parameters from the dominant forest type on each FAU were used for the Regeneration type. Annual percent growth = b + 100 * k * e $^{(-a\ Age)}$

The program then schedules the treatment of groups of acres with the goal of evening out volume flow over the 20-year time horizon. The program begins by treating the small-medium class and then moves into the other two classes. This allows the smaller classes to grow out before being treated. The number of candidate acres and the treatment percentages by forest type are all inputs. The program is not spatially explicit and no minimum volume per acre harvest threshold was built in. It is available upon request.

The volume-per-acre removal results from the program were closely scrutinized to ensure they were reasonable and economically viable under average log markets. The results were comparable with rates from actual restoration treatments in different forest types (see Table 5) and the different FAUs (see Table 6). This served as an informal validation of the model and data sources used in this analysis. Volumes in the GNN data were in cubic feet. These were converted to thousand board feet (MBF) volumes using a conversion of 1 CCF (100 cubic feet) = 0.52 MBF or 1 MBF = 1.9231 CCF.

The volume numbers include both sawlog volume and small diameter pulp or chipwood. Current and past volume totals from the NWFP area include all wood removed, and we wanted to maintain consistency for comparison. Separating out sawlog from pulp or chip wood was beyond the scope of this report as it varies considerably by forest type and size class. While we acknowledge that some pulpwood material may not be economically viable to remove in some areas, small diameter material is often merchantable and markets for it will hopefully improve with time. Even if pulpwood material wood is not merchantable in some cases, analysis of the summary metrics for the forest types and size classes (e.g. average diameter at breast height, basal area, volume per acre shown in Appendix 3) shows that enough sawlog volume will be removed in all forest types and size classes to ensure economically viable sales under average log markets.

Results

The estimated number of acres treated and volumes produced are most accurate at the scale of the whole NWFP area. Results at the individual FAU level and by forest type are provided in the main report, but should be interpreted with caution. Volume estimates for more productive FAUs are likely lower than actual and estimates for less productive FAUs higher than actual. The results are shown in Tables 4 through 7.

Given the conservative approach used in this analysis, we believe that the projected timber volume from ecological restoration projects can be accomplished without the construction of any new system roads. Some temporary roads will likely be necessary, but can be kept to an absolute minimum and fully obliterated post treatment.

Appendix B
NatureServe Ecosystem Types in Northwest Forest Plan Area

Candidate Type & Code	Project Name	GAP/ ESLF Code	GAP Name
Yes 10	Mediterranean California Dry Mixed Conifer	4214	Mediterranean California Dry-Mesic Mixed Conifer Forest and Woodland
Yes 11	Westside dry Douglas-fir-W. Hemlock	4224	North Pacific Maritime Dry-Mesic Douglas-fir-Western Hemlock Forest
Yes 12	Westside mesic Douglas-fir-W. Hemlock	4226	North Pacific Maritime Mesic-Wet Douglas-fir-Western Hemlock Forest
Yes 13	Mediterranean California Mesic Mix Conifer	4215	Mediterranean California Mesic Mixed Conifer Forest and Woodland
Yes 14	Cascade Silver Fir-W. Hemlock	4272	North Pacific Dry-Mesic Silver Fir-Western Hemlock-Douglas-fir Forest
Yes 14	Cascade Silver Fir-W. Hemlock	4229	North Pacific Mesic Western Hemlock-Silver Fir Forest
Yes 15	Regeneration (Plantation)	8401	Introduced Upland Vegetation – Treed
Yes 15	Regeneration (Plantation)	8601	Harvested forest-tree regeneration
Yes 15	Regeneration (Plantation)	8602	Harvested forest-shrub regeneration
Yes 15	Regeneration (Plantation)	8604	Harvested forest-herbaceous regeneration
Yes 15	Regeneration (Plantation)	8603	Harvested forest-grass regeneration
Yes 16	Mediterranean California Mixed Evergreen	4230	Mediterranean California Mixed Evergreen Forest
Yes 17	Mediterranean California Oak Conifer	4217	Mediterranean California Lower Montane Black Oak-Conifer Forest and Woodland
Yes 17	Mediterranean California Oak Conifer	5403	California Lower Montane Blue Oak-Foothill Pine Woodland and Savanna
Yes 17	Mediterranean California Oak Conifer	4216	Mediterranean California Mixed Oak Woodland
Yes 17	Mediterranean California Oak Conifer	5401	California Central Valley Mixed Oak Savanna
Yes 18	East Cascade Dry Mixed Conifer	4232	Northern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest
Yes 20	East Cascade Mesic Mixed Conifer	4205	East Cascades Mesic Montane Mixed-Conifer Forest and Woodland
Yes 20	East Cascade Mesic Mixed Conifer	4269	Sierran-Intermontane Desert Western White Pine-White Fir Woodland
Yes 21	Westside mixed hardwood conifer	4333	North Pacific Lowland Mixed Hardwood Conifer Forest and Woodland
Yes 22	East Cascade Ponderosa Pine	4240	Northern Rocky Mountain Ponderosa Pine Woodland and Savanna
Yes 22	East Cascade Ponderosa Pine	4301	East Cascades Oak-Ponderosa Pine Forest and Woodland
Yes 26	Dry Douglas-fir Madrone	4222	North Pacific Dry Douglas-fir-(Madrone) Forest and Woodland
Yes 28	Mediterranean California Red Fir	4219	Mediterranean California Red Fir Forest

Yes 30	Coast Redwood-Sitka Spruce/Western Hemlock	4223	North Pacific Hypermaritime Sitka Spruce Forest
Yes 30	Coast Redwood-Sitka Spruce/Western Hemlock	4271	North Pacific Hypermaritime Western Red-cedar-Western Hemlock Forest
Yes 30	Coast Redwood-Sitka Spruce/Western Hemlock	4202	California Coastal Redwood Forest
No	East Cascade-Lodgepole Pine	4267	Rocky Mountain Poor Site Lodgepole Pine Forest
No	East Cascade- Lodgepole Pine	4237	Rocky Mountain Lodgepole Pine Forest
No	Cascade-Subalpine-Spruce/Fir	4242	Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland
No	Cascades-Subalpine-Spruce/Fir	4103	Northern Rocky Mountain Western Larch Savanna
No	Cascades-Subalpine-Spruce/Fir	4243	Rocky Mountain Subalpine Mesic Spruce-Fir Forest and Woodland
No	Cascades-Subalpine-Spruce/Fir	4233	Northern Rocky Mountain Subalpine Woodland and Parkland
No	Cascades-Subalpine-Spruce/Fir	4225	North Pacific Maritime Mesic Subalpine Parkland
No	High Cascades-Mountain Hemlock	4228	North Pacific Mountain Hemlock Forest
No	Serpentine-mix-conifer-woodland	4218	California Montane Jeffrey Pine Woodland
No	Serpentine-mix-conifer-woodland	4208	Klamath-Siskiyou Lower Montane Serpentine Mixed Conifer Woodland
No	Serpentine-mix-conifer-woodland	4209	Klamath-Siskiyou Upper Montane Serpentine Mixed Conifer Woodland
No	Serpentine-mix-conifer-woodland	4221	Mediterranean California Mesic Serpentine Woodland and Chaparral
No	Serpentine-mix-conifer-woodland	9325	Med. California Serpentine Foothill and Lower Montane Riparian Woodland and Seep
No	West-Riparian Forest	9106	North Pacific Lowland Riparian Forest and Shrubland
No	MedCal-Riparian Forest	9330	Mediterranean California Foothill and Lower Montane Riparian Woodland
No	East-Riparian Forest	9156	Rocky Mountain Lower Montane Riparian Woodland and Shrubland
No	East-Riparian Forest	9170	Columbia Basin Foothill Riparian Woodland and Shrubland
No	East-Riparian Forest	9168	Great Basin Foothill and Lower Montane Riparian Woodland and Shrubland
No	MedCal-subalpine	4245	Sierra Nevada Subalpine Lodgepole Pine Forest and Woodland
No	MedCal-subalpine	4231	Northern California Mesic Subalpine Woodland
No	MedCal-subalpine	4220	Mediterranean California Subalpine Woodland
No	Aspen	4104	Rocky Mountain Aspen Forest and Woodland
No	Aspen	4302	Inter-Mountain Basins Aspen Mixed Conifer Forest-Woodland
No	Burned	8501	Recently burned forest
No	Burned	8503	Recently burned shrubland
No	High-Riparian Forest	9108	North Pacific Montane Riparian Woodland and Shrubland
No	High-Riparian Forest	9171	Rocky Mountain Subalpine-Montane Riparian Woodland
No	Juniper Woodland	4204	Columbia Plateau Western Juniper Woodland and Savanna
No	Other	4303	Inter-Mountain Basins Mountain Mahogany Woodland and Shrubland
No	Other	33	Non-specific Disturbed

No	Other	32	Unconsolidated Shore
No	Other	4268	California Coastal Closed-Cone Conifer Forest and Woodland
No	East-Riparian Forest	9155	Northern Rocky Mountain Lower Montane Riparian Woodland and Shrubland
No	East-Riparian Forest	3152	Inter-Mountain Basin Wash
No	Oak Woodland	4101	North Pacific Oak Woodland
No	Oak Woodland	5402	California Coastal Live Oak Woodland and Savanna
No	Non-Forest-alpine	5208	Rocky Mountain Alpine Tundra/Fell-field/Dwarf-shrub Map Unit
No	Non-Forest-alpine	5205	North Pacific Dry and Mesic Alpine Dwarf-Shrubland, Fell-field and Meadow
No	Non-Forest-alpine	7108	Mediterranean California Alpine Dry Tundra
No	Non-Forest-alpine	3130	North American Alpine Ice Field
No	Non-Forest-alpine	3118	North Pacific Alpine and Subalpine Bedrock and Scree
No	Non-Forest-alpine	5204	Mediterranean California Alpine Fell-Field
No	Non-Forest-alpine	3172	Mediterranean California Alpine Bedrock and Scree
No	Non-Forest-Chaparral	5311	Northern and Central California Dry-Mesic Chaparral
No	Non-Forest-Chaparral	5304	California Montane Woodland and Chaparral
No	Non-Forest-Chaparral	5425	Klamath-Siskiyou Xeromorphic Serpentine Savanna and Chaparral
No	Non-Forest-Chaparral	5305	California Xeric Serpentine Chaparral
No	Non-Forest-Developed	21	Developed, Open Space
No	Non-Forest-Developed	22	Developed, Low Intensity
No	Non-Forest-Developed	82	Cultivated Cropland
No	Non-Forest-Developed	23	Developed, Medium Intensity
No	Non-Forest-Developed	24	Developed, High Intensity
No	Non-Forest-Developed	88	High Structure Agriculture
No	Nor-Forest-Developed	31	Quarries Strip Mines and Gravel Pits
No	Non-Forest-grassland	7110	North Pacific Montane Grassland
No	Non-Forest-grassland	8404	Introduced Upland Vegetation - Annual Grassland
No	Non-Forest-grassland	7112	Northern Rocky Mountain Lower Montane, Foothill, and Valley Grassland
No	Non-Forest-grassland	81	Pasture/Hay
No	Non-Forest-grassland	7103	California Northern Coastal Grassland
No	Non-Forest-grassland	7157	North Pacific Alpine and Subalpine Dry Grassland
No	Non-Forest-grassland	5409	Willamette Valley Upland Prairie and Savanna
No	Non-Forest-grassland	7106	Columbia Basin Foothill and Canyon Dry Grassland
No	Non-Forest-grassland	7102	California Mesic Serpentine Grassland
No	Non-Forest-grassland	9103	Inter-Mountain Basins Greasewood Flat
No	Non-Forest-grassland	3179	Inter-Mountain Basins Playa
No	Non-Forest-grassland	8502	Recently burned grassland
No	Non-Forest-grassland	7107	Inter-Mountain Basins Semi-Desert Grassland
No	Non-Forest-grassland	7101	California Central Valley and Southern Coastal Grassland
No	Non-Forest-landslide	4304	North Pacific Broadleaf Landslide Forest and Shrubland
No	Non-Forest-landslide	5260	North Pacific Avalanche Chute Shrubland

No	Non-Forest-meadow	9265	Temperate Pacific Subalpine-Montane Wet Meadow
No	Non-Forest-meadow	7109	Mediterranean California Subalpine Meadow
No	Non-Forest-meadow	9217	Rocky Mountain Alpine-Montane Wet Meadow
No	Non-Forest-meadow	7118	Rocky Mountain Subalpine-Montane Mesic Meadow
No	Non-Forest-rock	3129	Rocky Mountain Cliff, Canyon and Massive Bedrock
No	Non-Forest-rock	7162	North Pacific Herbaceous Bald and Bluff
No	Non-Forest-rock	3155	North Pacific Montane Massive Bedrock, Cliff and Talus
No	Non-Forest-rock	3140	North Pacific Volcanic Rock and Cinder Land
No	Non-Forest-rock	3159	North Pacific Serpentine Barren
No	Non-Forest-rock	3128	Inter-Mountain Basins Volcanic Rock and Cinder Land
No	Non-Forest-rock	3170	Klamath-Siskiyou Cliff and Outcrop
No	Non-Forest-rock	3135	Rocky Mountain Alpine Bedrock and Scree
No	Non-Forest-rock	3167	Mediterranean California Serpentine Barrens
No	Non-Forest-rock	3177	North Pacific Maritime Coastal Sand Dune and Strand
No	Non-Forest-rock	3158	North Pacific Costal Cliff and Bluff
No	Non-Forest-rock	3165	Mediterranean California Northern Coastal Dune
No	Non-Forest-rock	3174	Columbia Plateau Ash and Tuff Badland
No	Non-Forest-rock	3160	Inter-Mountain Basins Active and Stabilized Dune
No	Non-Forest-rock	3171	Sierra Nevada Cliff and Canyon
No	Non-Forest-rock	3173	Inter-Mountain Basins Cliff and Canyon
No	Non-Forest-rock	3169	Central California Coast Ranges Cliff and Canyon
No	Non-Forest-rock	9297	Inter-Mountain Basin Alkaline Closed Depression
No	Non-Forest-shrubland	5261	North Pacific Montane Shrubland
No	Non-Forest-shrubland	5257	Inter-Mountain Basins Big Sagebrush Shrubland
No	Non-Forest-shrubland	5312	Northern Rocky Mountain Montane-Foothill Deciduous Shrubland
No	Non-Forest-shrubland	9187	Rocky Mountain Subalpine-Montane Riparian Shrubland
No	Non-Forest-shrubland	5202	Columbia Plateau Scabland Shrubland
No	Non-Forest-shrubland	5256	Great Basin Xeric Mixed Sagebrush Shrubland
No	Non-Forest-shrubland	5457	Northern California Coastal Scrub
No	Non-Forest-shrubland	7161	North Pacific Hypermaritime Shrub and Herbaceous Headland
No	Non-Forest-shrubland	5404	Inter-Mountain Basins Juniper Savanna
No	Non-Forest-shrubland	9101	California Central Valley Riparian Woodland and Shrubland
No	Non-Forest-shrubland	5269	Southern California Coastal Scrub
No	Non-Forest-shrubland	5258	Inter-Mountain Basins Mixed Salt Desert Scrub
No	Non-Forest-Shrub-Steppe	5454	Inter-Mountain Basins Big Sagebrush Steppe
No	Non-Forest-Shrub-Steppe	5455	Inter-Mountain Basins Montane Sagebrush Steppe
No	Non-Forest-Shrub-Steppe	5452	Columbia Plateau Steppe and Grassland
No	Non-Forest-Shrub-Steppe	5453	Columbia Plateau Low Sagebrush Steppe
No	Non-Forest-Shrub-Steppe	5456	Inter-Mountain Basins Semi-Desert Shrub-Steppe
No	Non-Forest-Volcanic	4329	North Pacific Wooded Volcanic Flowage
No	Non-Forest-water	11	Open Water
No	NON-FOREST-wet	9260	Temperate Pacific Freshwater Emergent Marsh

No	NON-FOREST-wet	9190	North Pacific Hardwood-Conifer Swamp
No	NON-FOREST-wet	3122	Temperate Pacific Freshwater Mudflat
No	NON-FOREST-wet	9173	North Pacific Shrub Swamp
No	NON-FOREST-wet	9222	North American Arid West Emergent Marsh
No	NON-FOREST-wet	9221	Willamette Valley Wet Prairie
No	NON-FOREST-wet	9166	North Pacific Bog and Fen
No	NON-FOREST-wet	9251	Northern California Claypan Vernal Pool
No	NON-FOREST-wet	9281	Temperate Pacific Tidal Salt and Brackish Marsh
No	NON-FOREST-wet	9248	Mediterranean California Subalpine-Montane Fen
No	NON-FOREST-wet	3116	Temperate Pacific Intertidal Mudflat
No	NON-FOREST-wet	9219	Temperate Pacific Freshwater Aquatic Bed
No	NON-FOREST-wet	9255	Mediterranean California Serpentine Fen
No	NON-FOREST-wet	9321	Columbia Plateau Silver Sagebrush Seasonally Flooded Shrub-Steppe
No	NON-FOREST-wet	8490	Introduced Wetland Vegetation
No	NON-FOREST-wet	9266	Mediterranean California Eelgrass Bed
No	NON-FOREST-wet	9230	North Pacific Maritime Eelgrass Bed
No	NON-FOREST-wet	9220	North Pacific Intertidal Freshwater Wetland
No	Non-Forest-No data	0	No data

Appendix C
Summary of Dr. Peter Bettinger's Growth Rate Parameters to Use in Conjunction with the "Simulate Harvests" Computer Program

The "Simulate Harvests" computer program was developed in December 2008 for an analysis of harvest potential on non-controversial forest lands in northern California, Oregon, and Washington. Average growth rates for forested areas in northern California, Oregon, and Washington, which are necessary for the Simulate Harvests program, were then requested for the region.

In Fall 2008, an in-depth analysis of the growth rates of four forest types on the Mt. Hood National Forest was conducted. Initially, we obtained the Mt. Hood FIA data from Janet Ohmann of the USDA Forest Service Pacific Northwest Research Station. The data included the year each plot was measured, and tree-level contributions to the plot-level estimates of trees per unit area, basal area, and cubic volume. Cubic volume was converted to board foot volume using some basic conversions derived from McArdle and Meyer (1930). Plot-level measurements were then extracted from the tree-level Mt. Hood data. An assessment of whether a plot was conifer or mixed was subsequently made (if greater than 65% conifer by basal area, it was considered conifer). An assessment of whether a plot was low elevation or high elevation was also made, based on the majority of trees per unit area that were considered "low elevation" or "high elevation" trees. Growth rates were then estimated for low elevation confers and high elevation conifers on both sides of the Cascades. There were too few plots to estimate a growth rate for mixed stands. A number of plots were excluded if they seemingly were thinned or partially harvested between measurement periods. In addition, some plots with a high conifer quadratic mean diameter, high age, high trees per unit area, and low basal area were considered remnant / regeneration areas, and excluded from the analysis since an age was not clear, and since the volume was probably contained in the remnant trees. Growth rates were then compared to classical, published rates. Given the broad coverage of the limited number of plots, we determined that the growth rates of current stands were somewhat less than the growth rates suggested by the classic reports (Figure 1).

An estimated growth rate for each forest type was developed using the equation: $b + 100 (k\ e^{(-a\ Age)})$.

This is a non-linear relationship that requires three parameters (a, b, and k). Each of these parameters is provided in the text below for the 43 forest types in the area of interest.

For other forested types in the California, Oregon, and Washington region, we were asked to review other classic reports and estimate a growth rate for various forest types. Given this information and the relationship between the current and classic growth rates of the Mt. Hood National Forest, we adjusted the classic growth rates for the other areas accordingly. Due to the broad coverage of the forest types and the lack of information on specific site qualities assumed in the analysis, an average site quality was assumed in the determination of growth rates. A few forest types lacked information necessary to adequately determine growth rates. In these cases, a conservative growth rate trajectory was suggested.

In the summary of forest types that follows, the description (or summary) of the forest types was obtained from *NatureServe Explorer* (http://www.natureserve.org/explorer). The "code" is the project code for each forest type. The "GAP/ESLF code" is the ESLF code from the GAP GIS files used for the project.

The plantation/regeneration types found in the GAP data are not a forest type and occur across NWFP area. Thus no *NatureServe* description exists. An area weighted average of the growth rate parameters for the other 14 types was calculated for this type. To ensure that this was based on actual growth data, the parameters from the actual forest type closest to these averages was used. The result was that the parameters for the Mediterranean California Mesic Mix Conifer type were used for all plantation/regeneration acres. The result is that growth and resulting volumes from plantation/regeneration acres in more productive types will be underestimated, while acres from less productive types will be overestimated. These should average out over the whole NWFP area.

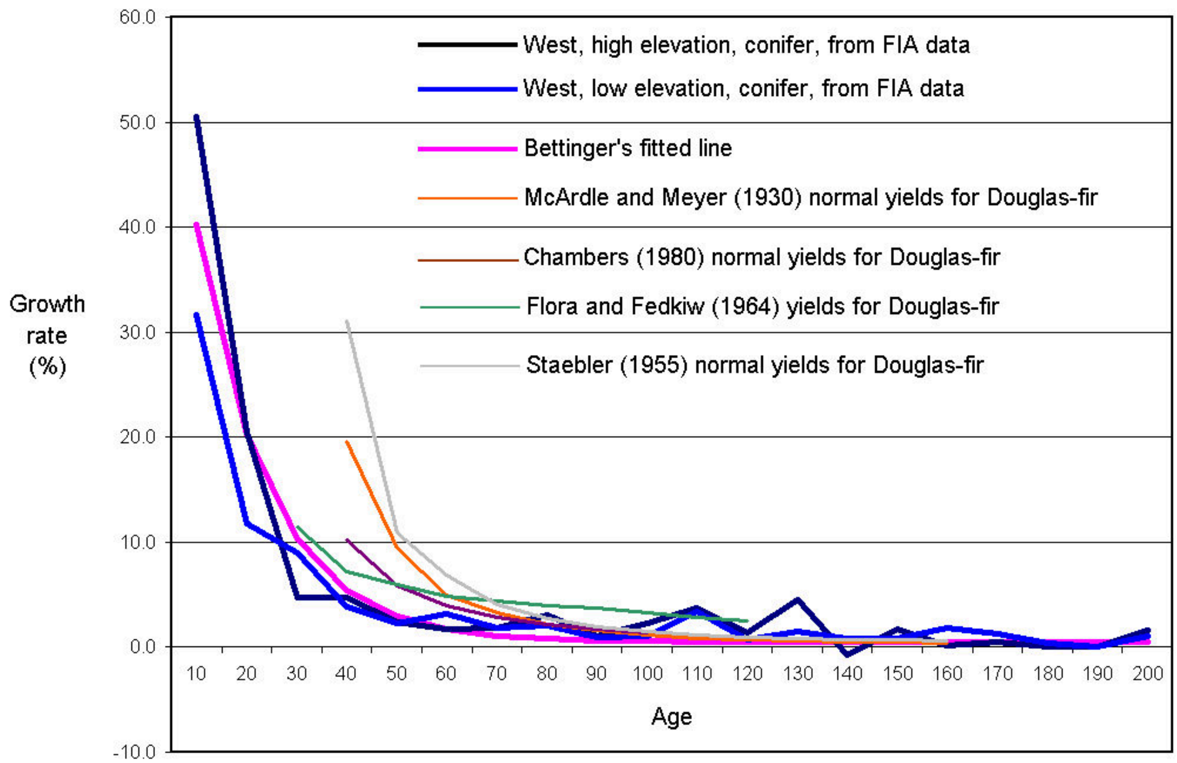

Figure 1. Growth rates from various classic publications along with recent FIA plot measurements from the Mt. Hood National Forest.

Scientific Name: Mediterranean California Dry-Mesic Mixed Conifer Forest and Woodland
Code: 10
GAP Code: 4214
Unique NatureServe Identifier: CES206.916
Summary: These mixed-conifer forests, always with at least two conifer species codominating, occur on all aspects in lower montane zones (600-1800 m elevation in northern California; 1200-2150 m in southern California). This system occurs in a variety of topo-edaphic positions, such as upper slopes at higher elevations, canyon sideslopes, ridgetops, and south- and west-facing slopes which burn relatively frequently. Often, several conifer species co-occur in individual stands. *Pseudotsuga menziesii, Pinus ponderosa*, and *Calocedrus decurrens* are the most common conifers. Other conifers that can occasionally be present include *Pinus jeffreyi, Pinus attenuata*, and *Pinus lambertiana* (not as common in this as in Mediterranean California Mesic Mixed Conifer Forest and Woodland [CES206.915]). Common subcanopy trees include *Quercus chrysolepis* and *Quercus kelloggii*. *Arbutus menziesii* and *Lithocarpus densiflorus* may be common with the oaks in northern areas. *Pseudotsuga macrocarpa* and *Pinus coulteri* can be present but are not dominant species in this system in the Transverse Ranges of southern California. Codominant *Abies concolor - Calocedrus decurrens* communities in southern California are also included in this system. In the Transverse Ranges, where Great Basin and Mojavean elements are transitioning into the montane zones, *Juniperus californica* and *Pinus monophylla* can be mixed with the other conifers. Understories are variable, except in the Sierra Nevada, where in some stands there can be dense understory mats of *Chamaebatia foliolosa* (and other low, spreading shrubs) which foster relatively high-frequency, low-intensity ground fires. In Oregon, shrubs such as *Holodiscus discolor, Toxicodendron rydbergii, Mahonia nervosa, Mahonia aquifolium*, and *Symphoricarpos mollis* are common in addition to graminoids such as *Festuca californica, Elymus glaucus*, and *Danthonia californica*. In the north, where *Calocedrus decurrens* and *Pinus ponderosa* drop out, this system shifts to North Pacific Dry Douglas-fir-(Madrone) Forest and Woodland (CES204.845).
Growth Rate Parameters: b = 0.7**;** k = 0.35**;** a = 0.05
Area Covered (acres): WA =0**;** OR =479,706**;** CA =2,207,622
Comments: This growth rate is slightly lower than what Dunning and Reineke (1933) suggested for empirical yields of second-growth pine forests (ponderosa pine, Douglas-fir, white fir, red fir) in California (SI_{50} = 60).

Scientific Name: North Pacific Maritime Dry-Mesic Douglas-fir-Western Hemlock Forest
Code: 11
GAP Code: 4224
Unique NatureServe Identifier: CES204.001
Summary: This ecological system comprises much of the major lowland forests of western Washington, northwestern Oregon, eastern Vancouver Island, and the southern Coast Ranges in British Columbia. In southwestern Oregon, it becomes local and more small-patch in nature. It occurs throughout low-elevation western Washington, except on extremely dry or moist to very wet sites. In Oregon, it occurs on the western slopes of the Cascades, around the margins of the Willamette Valley, and in the Coast Ranges. These forests occur on the drier to intermediate moisture habitats and microhabitats within the Western Hemlock Zone of the Pacific Northwest. Climate is relatively mild and moist to wet. Mean annual precipitation is mostly 90-254 cm (35-100 inches) (but as low as 20 inches in the extreme rainshadow) falling predominantly as winter rain. Snowfall ranges from rare to regular, and summers are relatively dry. Elevation ranges from sea level to 610 m (2000 feet) in northern Washington to 1067 m (3500 feet) in Oregon. Topography ranges from relatively flat glacial tillplains to steep mountainous terrain. This is generally the most extensive forest in the lowlands on the west side of the Cascades and forms the matrix within which other systems occur as patches. Throughout its range it occurs in a mosaic with North Pacific Maritime Mesic-Wet Douglas-fir-Western Hemlock Forest (CES204.002); in dry areas it occurs adjacent to or in a mosaic with North Pacific Dry Douglas-fir-(Madrone) Forest and Woodland (CES204.845), and at higher elevations it intermingles with either North Pacific Dry-Mesic Silver Fir-

Western Hemlock-Douglas-fir Forest (CES204.098) or North Pacific Mesic Western Hemlock-Silver Fir Forest (CES204.097). Overstory canopy is dominated by *Pseudotsuga menziesii*, with *Tsuga heterophylla* generally present in the subcanopy or as a canopy dominant in old-growth stands. *Abies grandis, Thuja plicata*, and *Acer macrophyllum* codominants are also represented. In the driest climatic areas, *Tsuga heterophylla* may be absent, and *Thuja plicata* takes its place as a late-seral or subcanopy tree species. *Gaultheria shallon, Mahonia nervosa, Rhododendron macrophyllum, Linnaea borealis, Achlys triphylla*, and *Vaccinium ovatum* typify the poorly to well-developed shrub layer. *Acer circinatum* is a common codominant with one or more of these other species. The fern *Polystichum munitum* can be codominant with one or more of the evergreen shrubs on sites with intermediate moisture availability (mesic). If *Polystichum munitum* is thoroughly dominant or greater than about 40-50% cover, then the stand is probably in the more moist North Pacific Maritime Mesic-Wet Douglas-fir-Western Hemlock Forest (CES204.002). Young stands may lack *Tsuga heterophylla* or *Thuja plicata*, especially in the Puget Lowland. *Tsuga heterophylla* is generally the dominant regenerating tree species. Other common associates include *Acer macrophyllum, Abies grandis*, and *Pinus monticola*. In southwestern Oregon, *Pinus lambertiana, Calocedrus decurrens*, and occasionally *Pinus ponderosa* may occur in these forests. Soils are generally well-drained and are mesic to dry for much of the year. This is in contrast to North Pacific Maritime Mesic-Wet Douglas-fir-Western Hemlock Forest (CES204.002), which occurs on sites where soils remain moist to subirrigated for much of the year and fires were less frequent.
Growth Rate Parameters: b = 0.5; k = 0.8; a = 0.07
Area Covered (acres): WA = 279,408; OR = 1,304,980; CA = 0
Comments: The growth rate is less than what McArdle and Meyer (1930), Chambers (1980), and Staebler et al. (1955) suggest for normal stands (SI_{50} = 110 or Site III), and slightly less than what Flora and Fedkiw (1964) suggest for young naturally-regenerated stands (SI_{100}=140). The growth rates are, however, consistent with recent FIA data from the Mt. Hood National Forest.

Scientific Name: North Pacific Maritime Mesic-Wet Douglas-fir-Western Hemlock Forest
Code: 12
GAP Code: 4226
Unique NatureServe Identifier: CES204.002
Summary: This ecological system is a significant component of the lowland and low montane forests of western Washington, northwestern Oregon, and southwestern British Columbia. It occurs throughout low-elevation western Washington, except on extremely dry sites and in the hypermaritime zone near the outer coast where it is rare. In Oregon, it occurs on the western slopes of the Cascades, around the margins of the Willamette Valley, and on the west side of the Coast Ranges, and is reduced to locally small patches in southwestern Oregon. In British Columbia, it occurs on the eastern (leeward) side of Vancouver Island, commonly and rarely on the windward side, and in the southern Coast Ranges. These forests occur on moist habitats and microhabitats, mainly lower slopes or valley landforms, within the Western Hemlock Zone of the Pacific Northwest. <u>They differ from North Pacific Maritime Dry-Mesic Douglas-fir-Western Hemlock Forest (CES204.001) primarily in having more hydrophilic undergrowth species, moist to subirrigated soils, high abundance of shade- and moisture-tolerant canopy trees, as well as higher stand productivity</u>, due to higher soil moisture and lower fire frequency. Climate is relatively mild and moist to wet. Mean annual precipitation is mostly 90-254 cm (35-100 inches) (but as low as 20 inches in the extreme rainshadow) and falls predominantly as winter rain. Snowfall ranges from rare to regular (but consistent winter snowpacks are absent or minimal) and summers are relatively dry. Elevation ranges from sea level to 610 m (2000 feet) in northern Washington to 1067 m (3,500 feet) in Oregon. Topography ranges from relatively flat glacial tillplains to steep mountainous terrain. This is an extensive forest in the lowlands on the west side of the Cascades. Overstory canopy is dominated by *Pseudotsuga menziesii, Tsuga heterophylla*, and/or *Thuja plicata*, as well as *Chamaecyparis lawsoniana* in western Oregon, away from the coast. *Pseudotsuga menziesii* is usually at least present to more typically codominant or dominant. *Acer macrophyllum* and *Alnus rubra* (the latter primarily where there has been historic logging disturbance) are commonly found as canopy or subcanopy codominants, especially at

lower elevations. In a natural landscape, small patches can be dominated in the canopy by these broadleaf trees for several decades after a severe fire. *Polystichum munitum, Oxalis oregana, Rubus spectabilis*, and *Oplopanax horridus* typify the poorly to well-developed herb and shrub layers. *Gaultheria shallon, Mahonia nervosa, Rhododendron macrophyllum*, and *Vaccinium ovatum* are often present but are generally not as abundant as the aforementioned indicators; except where *Chamaecyparis lawsoniana* is a canopy codominant, they may be the dominant understory. *Acer circinatum* is a very common codominant as a tall shrub. Stands included are best represented on lower mountain slopes of the coastal ranges with high precipitation, long frost-free periods, and low fire frequencies. Young stands may lack *Tsuga heterophylla* or *Thuja plicata*, especially in the Puget Lowland. *Tsuga heterophylla* is generally the dominant regenerating tree species. Other common associates include *Abies grandis*, which can be a codominant especially in the Willamette Valley - Puget Trough - Georgia Basin ecoregion.
Growth Rate Parameters: b = 0.5**;** k = 0.9**;** a = 0.06
Area Covered (acres): WA = 478,662**;** OR = 951,019**;** CA = 2
Comments: The growth rate is less than what McArdle and Meyer (1930), Chambers (1980), and Staebler et al. (1955) suggest for normal stands (SI_{50} = 110 or Site III), and similar to what Flora and Fedkiw (1964) suggest for young naturally-regenerated stands (SI_{100}=140). The growth rate suggested here is slightly higher than that suggested for GAP Code 4224.

Scientific Name: Mediterranean California Mesic Mixed Conifer Forest and Woodland
Code: 13
GAP Code: 4215
Unique NatureServe Identifier: CES206.915
Summary: This ecological system occurs in cool ravines and north-facing slopes (typically with 100-150 cm annual precipitation; 50% as snow). It is found from 800-1000 m (2,400-3,000 feet) elevation in the Sierra Nevada and 1250-2200 m (3800-6700 feet) in the Klamath Mountains. The most characteristically co-occurring conifers are *Abies concolor var. lowiana, Calocedrus decurrens*, and *Pinus lambertiana*. *Pinus jeffreyi, Pinus ponderosa*, and *Pseudotsuga menziesii* occur frequently but are not dominant. In limited locations in the central Sierra Nevada, *Sequoiadendron giganteum* dominates, usually with *Abies concolor*, and at the highest elevations also with *Abies magnifica*. *Acer macrophyllum* is common in lower elevation mesic pockets; *Chrysolepis chrysophylla* also occurs in the western Klamaths. Common understory species include *Corylus cornuta, Cornus nuttallii*, and at higher elevations *Chrysolepis sempervirens*. In areas of recent fire or other disturbance, *Arctostaphylos patula, Ceanothus integerrimus, Ceanothus cordulatus, Ceanothus parvifolius*, and *Ribes* spp. are more common. Fire of highly variable patch size and return interval maintains the structure of these woodlands.
Growth Rate Parameters: b **=** 0.3; k = 0.6; a = 0.06
Area Covered (acres): WA **=** 0; OR = 811,949; CA = 427,129
Comments: This growth rate is slightly less than that suggested by Schumacher (1926) for normal yields of white fir in California (SI_{50} = 60).

Scientific Name: North Pacific Dry-Mesic Silver Fir-Western Hemlock-Douglas-fir Forest
Code: 14
GAP Code: 4272
Unique NatureServe Identifier: CES204.098
Summary: This forested system occurs only in the Pacific Northwest mountains, primarily west of the Cascade Crest. It generally occurs in an elevational band between *Pseudotsuga menziesii - Tsuga heterophylla* forests and *Tsuga mertensiana* forests. It dominates mid-montane dry to mesic maritime and some submaritime climatic zones from northwestern British Columbia to northwestern Oregon. In British Columbia and in the Olympic Mountains, this system occurs on the leeward side of the mountains only. In the Washington Cascades, it occurs on both windward and leeward sides of the mountains (in other words, it laps over the Cascade Crest to the "eastside"). Stand-replacement fires are regular with mean return intervals of about 200-500 years. Fire frequency tends to decrease with increasing elevation and

continentality but still remains within this typical range. A somewhat variable winter snowpack that typically lasts for 2-6 months is characteristic. The climatic zone within which it occurs is sometimes referred to as the "rain-on-snow" zone because of the common occurrence of major winter rainfall on an established snowpack. *Tsuga heterophylla* and/or *Abies amabilis* dominate the canopy of late-seral stands, though *Pseudotsuga menziesii* is usually also common because of its long life span, and *Chamaecyparis nootkatensis* can be codominant, especially at higher elevations. *Abies procera* forests (usually mixed with silver fir) are included in this system and occur in the Cascades from central Washington to central Oregon and rarely in the Coast Range of Oregon. *Pseudotsuga menziesii* is a common species (unlike the mesic western hemlock-silver fir forest system) that regenerates after fires and therefore is frequent as a codominant, except at the highest elevations; the prevalence of this species is an important indicator in relation to the related climatically wetter North Pacific Mesic Western Hemlock-Silver Fir Forest (CES204.097). *Abies lasiocarpa* sometimes occurs as a codominant on the east side of the Cascades and in submaritime British Columbia. Understory species that tend to be more common or unique in this type compared to the wetter North Pacific Mesic Western Hemlock-Silver Fir Forest (CES204.097) include *Achlys triphylla, Mahonia nervosa, Xerophyllum tenax, Vaccinium membranaceum, Rhododendron macrophyllum*, and *Rhododendron albiflorum*. *Vaccinium ovalifolium*, while still common, only dominates on moister sites within this type, unlike in the related type where it is nearly ubiquitous.
Growth Rate Parameters: b = 0.5; k = 0.7; a = 0.08
Area Covered (acres): WA = 761,678; OR = 302,833; CA = 0
Comments: The growth rate is less than what Wiley and Chambers (1981), Chambers and Wilson (1972), and Barnes (1962) suggest for normal stands (SI_{50} = 100 or SI_{100}=140), yet is consistent with recent FIA data from the Mt. Hood National Forest.

Scientific Name: North Pacific Mesic Western Hemlock-Silver Fir Forest
Code: 14
GAP Code: 4229
Unique NatureServe Identifier: CES204.097
Summary: This forested system occurs only in the Pacific Northwest mountains entirely west of the Cascade Crest from coastal British Columbia to Washington, and probably occurs in southeastern Alaska. It generally occurs in an elevational band between *Pseudotsuga menziesii - Tsuga heterophylla* or hypermaritime zone forests and *Tsuga mertensiana* forests. It dominates mid-montane maritime climatic zones on the windward side of Vancouver Island, the Olympic Peninsula, and the wettest portions of the North Cascades in Washington (north of Snoqualmie River). A somewhat variable winter snowpack that typically lasts for 2-6 months is characteristic. The climatic zone within which it occurs is sometimes referred to as the "rain-on-snow" zone because of the common occurrence of major winter rainfall on an established snowpack. *Tsuga heterophylla* and/or *Abies amabilis* dominate the canopy of late-seral stands, and *Chamaecyparis nootkatensis* can be codominant, especially at higher elevations. *Thuja plicata* is also common and sometimes codominates in British Columbia. In Alaska, *Abies amabilis* occurs in nearly pure stands and in mixture with *Picea sitchensis* and *Tsuga heterophylla*. *Pseudotsuga menziesii* is relatively rare to absent in this system, as opposed to the similar but drier North Pacific Dry-Mesic Silver Fir-Western Hemlock-Douglas-fir Forest (CES204.098). The major understory dominant species is *Vaccinium ovalifolium*. Understory species that help distinguish this system from the drier silver fir system (they are much more common here) include *Oxalis oregana, Blechnum spicant*, and *Rubus pedatus*. Windthrow is a common small-scale disturbance in this system, and gap creation and succession are important processes.
Growth Rate Parameters: b = 0.5; k = 0.7; a = 0.08
Area Covered (acres): WA = 116,054; OR = 28,919; CA = 0
Comments: The growth rate is less than what Wiley and Chambers (1981), Chambers and Wilson (1972), and Barnes (1962) suggest for normal stands (SI_{50} = 100 or SI_{100}=140), yet is consistent with recent FIA data from the Mt. Hood National Forest.

Scientific Name: Mediterranean California Mixed Evergreen Forest
Code: 16
GAP Code: 4230
Unique NatureServe Identifier: CES206.919
Summary: This ecological system occurs from the Santa Cruz Mountains (and locally in the Santa Lucia Mountains), California, north into southwestern Oregon throughout the outer and middle Coast Ranges on Franciscan Formation soils (metasedimentary sandstones, schists, and shales) with moderate to high rainfall. This system occurs just inland from the redwood belt of this region. It also occurs in southern California in more mesic, protected, cooler sites of the Transverse and Peninsular ranges. Historic fire frequency in this system was higher than for redwood-dominated systems (every 50-100 years). It is characterized by mixes of coniferous and broad-leaved evergreen trees. Characteristic trees include *Pseudotsuga menziesii, Quercus chrysolepis, Lithocarpus densiflorus, Arbutus menziesii, Umbellularia californica*, and *Chrysolepis chrysophylla*. On the eastern fringe of this system, in the western Siskiyous, other conifers occur such as *Pinus ponderosa* and *Chamaecyparis lawsoniana*. In southern California (Transverse and Peninsular ranges), *Pseudotsuga macrocarpa* replaces *Pseudotsuga menziesii* but co-occurs with *Quercus chrysolepis* and sometimes *Quercus agrifolia*. *Calocedrus decurrens* is occasional. In the southern portion of the range, *Lithocarpus densiflorus, Arbutus menziesii, Umbellularia californica*, and *Chrysolepis chrysophylla* become less important or are absent. In the Santa Lucia Mountains, stands of *Abies bracteata* are included in this system and are an unusual and unique component. These stands are a mixture of *Abies bracteata* and *Quercus chrysolepis*. The more northerly stands tend to have dense or diverse shrub understories, with *Corylus cornuta, Vaccinium ovatum, Rhododendron macrophyllum, Gaultheria shallon, Quercus sadleriana, Mahonia nervosa*, and *Toxicodendron diversilobum* being common. Southern stands are less diverse and more sparse; *Toxicodendron diversilobum* is the most constant shrub, with *Ribes* spp. occasionally present, along with much *Polystichum munitum*. Especially in the south, stands are restricted to fire-protected sites (extremely steep, northerly, mesic slopes and coves) where fires from adjacent chaparral systems do not carry.
Growth Rate Parameters: b = 0.7; k = 0.35; a = 0.05
Area Covered (acres): WA = 0; OR = 659,625; CA = 310,447
Comments: This growth rate is slightly lower than what Dunning and Reineke (1933) suggested for empirical yields of second growth pine forests (ponderosa pine, Douglas-fir, white fir, red fir) in California (SI_{50} = 60).

Scientific Name: California Lower Montane Blue Oak-Foothill Pine Woodland and Savanna
Code: 17
GAP Code: 5403
Unique NatureServe Identifier: CES206.936
Summary: This ecological system is primarily found in the valley margins and foothills of the Sierra Nevada and Coast Ranges of California from approximately 120-1200 m (360-3600 feet) in elevation on rolling plains or dry slopes. Over a century of anthropogenic changes (especially cutting of oak) have altered the density and distribution of woody vegetation. A high-quality occurrence often consists of open park-like stands of *Pinus sabiniana*, with oaks and other various broadleaf tree and shrub species, including *Quercus douglasii, Quercus wislizeni, Quercus agrifolia* (primarily central and southern Coast Ranges), *Quercus lobata, Aesculus californica, Arctostaphylos* spp., *Cercis canadensis var. texensis (= Cercis occidentalis), Ceanothus cuneatus, Frangula californica (= Rhamnus californica), Ribes quercetorum, Juniperus californica*, and *Pinus coulteri* (central and southern Coast Ranges). *Pinus sabiniana* tends to drop out all together in the driest and more southerly sites, which are often dominated by *Quercus douglasii*. The California central coast region may have open stands of just *Juniperus californica*, with a grassy understory. These stands belong here due to proximity to other blue oak and gray pine stands or chaparral, and due to the heavy native or non-native grass cover. This is distinguished from Great Basin pinyon-juniper stands, which have little herbaceous understory, and *Pinus monophylla* rather than *Pinus sabiniana*. These stands of only juniper are caused by repeated removal of the oaks by

humans and feral pig populations. Northern extensions of this system include *Quercus garryana* as the dominant oak, where it becomes successional to Mediterranean California Lower Montane Black Oak-Conifer Forest and Woodland (CES206.923). *Pinus sabiniana* density also varies based on intensity or frequency of fire, being less abundant in areas of higher intensity or frequency, hence it is often more abundant on steep, rocky or more mesic north-facing slope exposures. Historically, understory vegetation included mixed chaparral to perennial bunchgrass. Currently, most occurrences have understories dominated by dense cover of annual species, both native and non-native. Variable canopy densities in existing occurrences are likely due to variation in soil moisture regime, natural patch dynamics of fire, and land use (fire suppression, livestock grazing, herbivory, etc.).
Growth Rate Parameters: b = 0.6; k = 0.2; a = 0.05
Area Covered (acres): WA = 0; OR = 3; CA = 117,216
Comments: This growth rate is consistent with what Plumb and McDonald (1981) suggest for oak growth in California.

Scientific Name: Mediterranean California Lower Montane Black Oak-Conifer Forest and Woodland
Code: 17
GAP Code: 4217
Unique NatureServe Identifier: CES206.923
Summary: This ecological system is found throughout California's middle and inner North Coast Ranges, as well as the southern and eastern Klamath Mountains from 600-1600 m (1800-4850 feet) elevation, and the lower slopes of the western Sierra Nevada. It occurs in valleys and lower slopes on a variety of parent materials, including granitics, metamorphic and Franciscan metasedimentary parent material and deep, well-developed soils. It is characterized by woodlands or forests of *Pinus ponderosa* with one or more oaks, including *Quercus kelloggii, Quercus garryana, Quercus wislizeni*, or *Quercus chrysolepis*. *Pseudotsuga menziesii* may co-occur with *Pinus ponderosa*, particularly in the North Coast Ranges and Klamath Mountains. On most sites, the oaks are dominant, forming a dense subcanopy under a more open canopy of the conifers. On many sites, *Quercus kelloggii* is the dominant; in late-seral stands on more mesic sites, conifers such as *Pinus ponderosa* or *Pseudotsuga menziesii* will form a persistent emergent canopy over the oak. Stands may have shrubby understories (in the Klamath Mountains and Sierra Nevada) and, more rarely, grassy understories (in North Coast Ranges). Common shrubs include *Arctostaphylos viscida, Arctostaphylos manzanita, Ceanothus integerrimus*, and *Toxicodendron diversilobum*. Grasses can include *Festuca californica, Festuca idahoensis*, and *Melica* spp. Historical fire in this system was likely high frequency but of low intensity. Conifer species, such as *Pseudotsuga menziesii*, become more abundant with wildfire suppression.
Growth Rate Parameters: b = 0.6; k = 0.2; a = 0.05
Area Covered (acres): WA = 0; OR = 269,162; CA = 274,517
Comments: This growth rate is consistent with what Plumb and McDonald (1981) suggest for oak growth in California.

Scientific Name: Mediterranean California Mixed Oak Woodland
Code: 17
GAP Code: 4216
Unique NatureServe Identifier: CES206.909

Summary: This ecological system is found throughout the Sierra Nevada and Coast Range foothills and lower montane elevations from 600-1600 m (1800-4850 feet) on steep, rocky slopes where snow and cold temperatures occur. Fire frequency and intensity drive composition of this system, with *Quercus chrysolepis* dominant with less frequent fires. With frequent annual burning (at lower elevations and on warmer sites), this system is an open to dense woodland of large oaks with well-developed grassy understories of native perennial bunchgrass. The predominant oaks with the higher frequency fires include *Quercus kelloggii* and *Quercus garryana*, with *Quercus garryana var. garryana* codominant in

the central and northern Coast Ranges and *Quercus garryana var. breweri* often codominant in the northwestern Coast Ranges as well as portions of the Sierra Nevada. *Quercus chrysolepis* becomes dominant with less frequent fires (but in Oregon this species is not important and occurs in a different system, either Mediterranean California Mixed Evergreen Forest (CES206.919) or Mediterranean California Dry-Mesic Mixed Conifer Forest and Woodland [CES206.916]). The perennial bunchgrass component includes *Festuca idahoensis, Festuca californica, Elymus glaucus*, and *Danthonia californica* (close to the coast). A variety of native forbs also occur. Other characteristic species include *Toxicodendron diversilobum, Juniperus occidentalis*, and *Ceanothus cuneatus*. This system is similar to North Pacific Oak Woodland (CES204.852) but does not include a conifer component, and *Quercus garryana* is not the only oak.
Growth Rate Parameters: b = 0.6; k = 0.2; a = 0.05
Area Covered (acres): WA = 0; OR = 8,963; CA = 72,828
Comments: This growth rate is consistent with what Plumb and McDonald (1981) suggest for oak growth in California.

Scientific Name: Northern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest
Code: 18
GAP Code: 4232
Unique NatureServe Identifier: CES306.805
Summary: This ecological system is composed of highly variable montane coniferous forests found in the interior Pacific Northwest, from southernmost interior British Columbia, eastern Washington, eastern Oregon, northern Idaho, western and north-central Montana, and south along the east slope of the Cascades in Washington and Oregon. In central Montana it occurs on mountain islands (the Snowy Mountains). This system is associated with a submesic climate regime with annual precipitation ranging from 50 to 100 cm, with a maximum in winter or late spring. Winter snowpacks typically melt off in early spring at lower elevations. Elevations range from 460 to 1920 m. Most occurrences of this system are dominated by a mix of *Pseudotsuga menziesii* and *Pinus ponderosa* (but there can be one without the other) and other typically seral species, including *Pinus contorta, Pinus monticola* (not in central Montana), and *Larix occidentalis* (not in central Montana). *Picea engelmannii* (or *Picea glauca* or their hybrid) becomes increasingly common towards the eastern edge of the range. The nature of this forest system is a matrix of large patches dominated or codominated by one or combinations of the above species; *Abies grandis* (a fire-sensitive, shade-tolerant species not occurring in central Montana) has increased on many sites once dominated by *Pseudotsuga menziesii* and *Pinus ponderosa*, which were formerly maintained by low-severity wildfire. Presettlement fire regimes may have been characterized by frequent, low-intensity ground fires that maintained relatively open stands of a mix of fire-resistant species. Under present conditions the fire regime is mixed severity and more variable, with stand-replacing fires more common, and the forests are more homogeneous. With vigorous fire suppression, longer fire-return intervals are now the rule, and multi-layered stands of *Pseudotsuga menziesii, Pinus ponderosa*, and/or *Abies grandis* provide fuel "ladders," making these forests more susceptible to high-intensity, stand-replacing fires. They are very productive forests which have been priorities for timber production. They rarely form either upper or lower timberline forests. Understories are dominated by graminoids, such as *Pseudoroegneria spicata, Calamagrostis rubescens, Carex geyeri*, and *Carex rossii*, that may be associated with a variety of shrubs, such as *Acer glabrum, Juniperus communis, Physocarpus malvaceus, Symphoricarpos albus, Spiraea betulifolia*, or *Vaccinium membranaceum* on mesic sites. *Abies concolor* and *Abies grandis X concolor* hybrids in central Idaho (the Salmon Mountains) are included here but have very restricted range in this area. *Abies concolor* and *Abies grandis* in the Blue Mountains of Oregon are probably hybrids of the two and mostly *Abies grandis*.
Growth Rate Parameters: b = 0.6; k = 0.8; a = 0.07
Area Covered (acres): WA = 498,694; OR = 4,246; CA = 3,750

Comments: The growth rate is much lower than what Meyer (1938) suggests for normal yields of ponderosa pine (SI_{50}=50), and are slightly higher than the gross yields Cochran (1979) suggests for grand fir / white fir (SI_{50}=70), yet are consistent with recent FIA data from the Mt. Hood National Forest.

Scientific Name: East Cascades Mesic Montane Mixed-Conifer Forest and Woodland
Code: 20
GAP Code: 4205
Unique NatureServe Identifier: CES204.086
Summary: This ecological system occurs on the upper east slopes of the Cascades in Washington, south of Lake Chelan and south to Mount Hood in Oregon. Elevations range from 610 to 1220 m (2000-4000 feet) in a very restricted range occupying less than 5% of the forested landscape in the east Cascades. This system is associated with a submesic climate regime with annual precipitation ranging from 100 to 200 cm (40-80 inches) and maximum winter snowpacks that typically melt off in spring at lower elevations. This ecological system is composed of variable montane coniferous forests typically below Pacific silver fir forests along the crest east of the Cascades. This system also includes montane forests along rivers and slopes, and in mesic "coves" which were historically protected from wildfires. Most occurrences of this system are dominated by a mix of *Pseudotsuga menziesii* with *Abies grandis* and/or *Tsuga heterophylla*. Several other conifers can dominate or codominate, including *Thuja plicata, Pinus contorta, Pinus monticola*, and *Larix occidentalis*. *Abies grandis* and other fire-sensitive, shade-tolerant species dominate forests on many sites once dominated by *Pseudotsuga menziesii* and *Pinus ponderosa*, which were formerly maintained by wildfire. They are very productive forests in the eastern Cascades which have been priority stands for timber production. *Mahonia nervosa, Linnaea borealis, Paxistima myrsinites, Acer circinatum, Spiraea betulifolia, Symphoricarpos hesperius, Cornus nuttallii, Rubus parviflorus*, and *Vaccinium membranaceum* are common shrub species. The composition of the herbaceous layer reflects local climate and degree of canopy closure and contains species more restricted to the Cascades, for example, *Achlys triphylla, Anemone deltoidea*, and *Vancouveria hexandra*. Typically, stand-replacement fire-return intervals are 150-500 years with moderate-severity fire-return intervals of 50-100 years.
Growth Rate Parameters: b = 0.6; k = 0.6; a = 0.07
Area Covered (acres): WA = 330,667; OR = 110,770; CA = 5
Comments: The growth rate is less than what Meyer (1938) suggests for normal yields of ponderosa pine (SI_{50}=50), is consistent with the gross yields Cochran (1979) suggests for grand fir / white fir (SI_{50}=70), and is consistent with recent FIA data from the Mt. Hood National Forest.

Scientific Name: Sierran-Intermontane Desert Western White Pine-White Fir Woodland
Code: 20
GAP Code: 4269
Unique NatureServe Identifier: CES204.101
Summary: This interior Pacific Northwest ecological system occurs on the Modoc Plateau and Warner Mountains of California, north into the Fremont National Forest along the east slope of the southern Cascades in Oregon, and may also occur in isolated high-elevation ranges of northern Nevada. These forests and woodlands range from just above the zone of ponderosa pine in the montane zone, to the upper montane zone. Elevations range from 1370 m to over 2135 m (4500-7000 feet). Occurrences are found on all slopes and aspects, although more frequently on drier areas, including northwest- and southeast-facing slopes, but also occurs on northerly slopes and ridges. This ecological system generally occurs on basalts, andesite, glacial till, basaltic rubble, colluvium, or volcanic ash-derived soils, and sometimes on granitics (Carson Range). These soils have characteristic features of good aeration and drainage, coarse textures, circumneutral to slightly acidic pH, an abundance of mineral material, rockiness, and periods of drought during the growing season. Climatically, this system occurs somewhat in the rainshadow of the Sierras and Cascades and has a more continental regime, similar to the northern Great Basin. This system tends to be more woodland than forest in character, and the undergrowth is more open and drier, with little shrub or herbaceous cover. Tree regeneration is less prolific than in other

mixed-montane conifer systems of the Cascades, Sierras and California Coast Ranges. *Pinus monticola* is the dominant conifer in most places, but *Abies concolor var. lowiana* is usually present, at least in the understory, and occasionally as the dominant in the canopy, replacing *Pinus monticola*, particularly at lower elevations, and *Pinus ponderosa* is also often present. In the Warner Mountains, the *Abies concolor var. lowiana* stands range from 1675 to 2135 m (5500-7000 feet) in elevation, and the mixed *Pinus monticola - Abies concolor* is usually above 2135 m (7000 feet). Mixed stands with *Pinus contorta*, in moister locations, as well as *Pinus jeffreyi* and sometimes *Populus tremuloides* occasionally occur. Southern stands (around Babbitt Peak and in the Carson Range) can sometime have *Abies magnifica* in them, sometimes replacing *Abies concolor*. These forests and woodlands are marked by the absence of *Pseudotsuga menziesii, Pinus lambertiana*, and *Calocedrus decurrens*, and the generally drier, continental climatic conditions. In addition, the overall floristic affinities are with the Great Basin rather than Pacific Northwest. Understories are typically open, with moderately low shrub cover and diversity, and include *Arctostaphylos patula, Arctostaphylos nevadensis, Chrysolepis sempervirens, Ceanothus* sp., and *Ribes viscosissimum*. Common herbaceous taxa include *Arnica cordifolia, Festuca* sp., *Poa nervosa, Carex inops, Pyrola picta*, and *Hieracium albiflorum*. In openings, *Wyethia mollis* can be abundant.
Growth Rate Parameters: b = 0.6; k = 0.6; a = 0.07
Area Covered (acres): WA = 0; OR = 599; CA = 2,406
Comments: The growth rate is less than what Meyer (1938) suggests for normal yields of ponderosa pine (SI_{50}=50), is consistent with the gross yields Cochran (1979) suggests for grand fir / white fir (SI_{50}=70), and is consistent with recent FIA data from the Mt. Hood National Forest.

Scientific Name: North Pacific Lowland Mixed Hardwood Conifer Forest and Woodland
Code: 21
GAP Code: 4333
Unique NatureServe Identifier: CES204.073
Summary: This lowland mixed hardwood - conifer forest system occurs throughout the Pacific Northwest. It occurs on valley terraces, margins, and slopes at low elevations in the mountains of the Pacific Northwest Coast and interior valleys west of the high Cascade Mountains. These forests are composed of large conifers, including *Pseudotsuga menziesii, Thuja plicata, Abies grandis, Tsuga heterophylla*, and/or *Picea sitchensis*, with deciduous hardwood trees present and usually codominant. Major dominant broadleaf species are *Acer macrophyllum, Quercus garryana, Alnus rubra, Frangula purshiana*, and *Cornus nuttallii*. Conifers tend to increase with succession in the absence of major disturbance although the hardwoods, particularly *Acer macrophyllum*, persist in the overstory. The understory is characterized by deciduous shrubs such as *Acer circinatum, Corylus cornuta, Oemleria cerasiformis, Rubus ursinus, Symphoricarpos albus*, and *Toxicodendron diversilobum*, but evergreen shrubs, including *Gaultheria shallon* and *Mahonia nervosa* and forbs, such as *Polystichum munitum* and *Oxalis oregana*, can be dominant.
Growth Rate Parameters: b = 0.5; k = 0.8; a = 0.07
Area Covered (acres): WA = 29,413; OR = 272,918; CA = 9
Comments: This growth rate is consistent with recent west-side, low-elevation conifer growth rates from FIA plots on the Mt. Hood National Forest.

Scientific Name: East Cascades Oak-Ponderosa Pine Forest and Woodland
Code: 22
GAP Code: 4301
Unique NatureServe Identifier: CES204.085
Summary: This narrowly restricted ecological system appears at or near lower treeline in foothills of the eastern Cascades in Washington and Oregon within 65 km (40 miles) of the Columbia River Gorge. It also appears in the adjacent Columbia Plateau ecoregion. Elevations range from 460 to 1920 m. Most occurrences of this system are dominated by a mix of *Quercus garryana* and *Pinus ponderosa* or *Pseudotsuga menziesii*. Isolated, taller *Pinus ponderosa* or *Pseudotsuga menziesii* over *Quercus garryana*

trees characterize parts of this system. Clonal *Quercus garryana* can create dense patches across a grassy landscape or can dominate open woodlands or savannas. The understory may include dense stands of shrubs or, more often, be dominated by grasses, sedges or forbs. Shrub-steppe shrubs may be prominent in some stands and create a distinct tree / shrub / sparse grassland habitat, including *Purshia tridentata, Artemisia tridentata, Artemisia nova*, and *Chrysothamnus viscidiflorus*. Understories are generally dominated by herbaceous species, especially graminoids. Mesic sites have an open to closed sodgrass understory dominated by *Calamagrostis rubescens, Carex geyeri, Carex rossii, Carex inops*, or *Elymus glaucus*. Drier savanna and woodland understories typically contain bunchgrass steppe species such as *Festuca idahoensis* or *Pseudoroegneria spicata*. Common exotic grasses that often appear in high abundance are *Bromus tectorum* and *Poa bulbosa*. These woodlands occur at the lower treeline/ecotone between *Artemisia* spp. or *Purshia tridentata* steppe or shrubland and *Pinus ponderosa* and/or *Pseudotsuga menziesii* forests or woodlands. In the Columbia River Gorge, this system appears as small to large patches in transitional areas in the Little White Salmon and White Salmon river drainages in Washington and Hood River, Rock Creek, Moiser Creek, Mill Creek, Threemile Creek, Fifteen Mile Creek, and White River drainages in Oregon. *Quercus garryana* can create dense patches often associated with grassland or shrubland balds within a closed *Pseudotsuga menziesii* forest landscape. Commonly the understory is shrubby and composed of *Ceanothus integerrimus, Holodiscus discolor, Symphoricarpos albus*, and *Toxicodendron diversilobum*. Fire plays an important role in creating vegetation structure and composition in this habitat. Decades of fire suppression have led to invasion by *Pinus ponderosa* along lower treeline and by *Pseudotsuga menziesii* in the gorge and other oak patches on xeric sites in the east Cascade foothills. In the past, most of the habitat experienced frequent low-severity fires that maintained woodland or savanna conditions. The mean fire-return interval is 20 years, although variable. Soil drought plays a role, maintaining an open tree canopy in part of this dry woodland habitat.
Growth Rate Parameters: b = 0.6; k = 0.6; a = 0.07
Area Covered (acres): WA = 269; OR = 25,798; CA = 9
Comments: The growth rate is less than what Meyer (1938) suggests for normal yields of ponderosa pine (SI_{50}=50), is consistent with the gross yields Cochran (1979) suggests for grand fir / white fir (SI_{50}=70), and is consistent with recent FIA data from the Mt. Hood National Forest.

Scientific Name: Northern Rocky Mountain Ponderosa Pine Woodland and Savanna
Code: 22
GAP Code: 4240
Unique NatureServe Identifier: CES306.030
Summary: This inland Pacific Northwest ecological system occurs in the foothills of the northern Rocky Mountains in the Columbia Plateau region and west along the foothills of the Modoc Plateau and eastern Cascades into southern interior British Columbia. These woodlands and savannas occur at the lower treeline/ecotone between grasslands or shrublands and more mesic coniferous forests typically in warm, dry, exposed sites. Elevations range from less than 500 m in British Columbia to 1600 m in the central Idaho mountains. Occurrences are found on all slopes and aspects; however, moderately steep to very steep slopes or ridgetops are most common. This ecological system generally occurs on glacial till, glacio-fluvial sand and gravel, dune, basaltic rubble, colluvium, to deep loess or volcanic ash-derived soils, with characteristic features of good aeration and drainage, coarse textures, circumneutral to slightly acidic pH, an abundance of mineral material, rockiness, and periods of drought during the growing season. In the Oregon "pumice zone" this system occurs as matrix-forming, extensive woodlands on rolling pumice plateaus and other volcanic deposits. These woodlands in the eastern Cascades, Okanagan, and northern Rockies regions receive winter and spring rains, and thus have a greater spring "green-up" than the drier woodlands in the central Rockies. *Pinus ponderosa* (primarily *var. ponderosa*) is the predominant conifer; *Pseudotsuga menziesii* may be present in the tree canopy but is usually absent. In southern interior British Columbia, *Pseudotsuga menziesii* or *Pinus flexilis* may form woodlands or fire-maintained savannas with and without *Pinus ponderosa var. ponderosa* at the lower treeline transition into grassland or shrub-steppe. The understory can be shrubby, with *Artemisia tridentata, Arctostaphylos*

patula, Arctostaphylos uva-ursi, Cercocarpus ledifolius, Physocarpus malvaceus, Purshia tridentata, Symphoricarpos oreophilus or *Symphoricarpos albus, Prunus virginiana, Amelanchier alnifolia*, and *Rosa* spp. common species. Understory vegetation in the true savanna occurrences is predominantly fire-resistant grasses and forbs that resprout following surface fires; shrubs, understory trees and downed logs are uncommon. These more open stands support grasses such as *Pseudoroegneria spicata, Hesperostipa* spp., *Achnatherum* spp., dry *Carex* species (*Carex inops*), *Festuca idahoensis*, or *Festuca campestris*. The more mesic portions of this system may include *Calamagrostis rubescens* or *Carex geyeri*, species more typical of Northern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest (CES306.805). Mixed fire regimes and ground fires of variable return intervals maintain these woodlands typically with a shrub-dominated or patchy shrub layer, depending on climate, degree of soil development, and understory density. This includes the northern race of Interior Ponderosa Pine old-growth (USFS Region 6, USFS Region 1). Historically, many of these woodlands and savannas lacked the shrub component as a result of 3- to 7-year fire-return intervals.
Growth Rate Parameters: b = 0.6; k = 0.6; a = 0.07
Area Covered (acres): WA = 110,059; OR = 128,197; CA = 769
Comments: The growth rate is less than what Meyer (1938) suggests for normal yields of ponderosa pine (SI_{50}=50), is consistent with the gross yields Cochran (1979) suggests for grand fir / white fir (SI_{50}=70), and is consistent with recent FIA data from the Mt. Hood National Forest.

Scientific Name: North Pacific Dry Douglas-fir-(Madrone) Forest and Woodland
Code: 26
GAP Code: 4222
Unique NatureServe Identifier: CES207.362
Summary: This ecological system encompasses forests dominated by *Pseudotsuga menziesii* that are limited to the southern interior region of British Columbia. Sites are generally level to moderately sloping with medium-textured soils. Douglas-fir dominates the overstory and tree regeneration in most stands. *Populus tremuloides* may appear within the matrix of *Pseudotsuga menziesii*. Undergrowth has sparse to moderate shrub cover, and several grass species and low-growing dry-land forbs. Moss cover is typically patchy.
Growth Rate Parameters: b = 0.2; k = 0.6; a = 0.07
Area Covered (acres): WA = 8,884; OR = 192,841; CA = 14,130
Comments: This growth rate is consistent with recent measurements of growth rates from FIA plots from the Mt. Hood National Forest.

Scientific Name: Mediterranean California Red Fir Forest
Code: 28
GAP Code: 4219
Unique NatureServe Identifier: CES206.913
Summary: This ecological system includes high-elevation (1600-2700 m [4850-9000 feet]) forests and woodlands dominated by *Abies magnifica (= var. magnifica), Abies X shastensis (= Abies magnifica var. shastensis)*, and/or *Abies procera*. This system is typically found on deep, well-drained soils throughout this elevation zone from the central Sierra Nevada north and west into southern Oregon. Heavy snowpack is a major source of soil moisture throughout the growing season. The limiting factors can be either cold-air drainages or ponding, or coarser soils (pumice versus ash, for example). Other conifers that can occur in varying mixtures with *Abies magnifica* include *Pinus contorta var. murrayana, Pinus monticola, Tsuga mertensiana, Pinus jeffreyi*, and *Abies concolor*. At warmer and lower sites of the North Coast Ranges and Sierra Nevada, *Abies concolor* can codominate with *Abies magnifica*. *Pinus contorta* in Oregon indicates lower productivity where it intergrades with *Abies X shastensis*. This system ranges from dry to moist, and some sites have mesic indicator species, such as *Ligusticum grayi* or *Thalictrum fendleri*. Common understory species include *Quercus vacciniifolia, Ribes viscosissimum, Chrysolepis sempervirens, Ceanothus cordulatus* (in seral stands), *Vaccinium membranaceum, Symphoricarpos*

mollis, and *Symphoricarpos rotundifolius*. Characteristic forbs include *Eucephalus breweri, Pedicularis semibarbata*, and *Hieracium albiflorum*. This system commonly occurs above mixed conifer forests with *Abies concolor* and overlaps in elevation with forests and woodlands of *Pinus contorta var. murrayana*. On volcanic sites of lower productivity, stands may be more open woodland in structure and with poor-site understory species such as *Wyethia mollis*. Driving ecological processes include occasional blow-down, insect outbreaks, and stand-replacing fire.
Growth Rate Parameters: b = 0.5; k = 0.8; a = 0.06
Area Covered (acres): WA = 0; OR = 54,662; CA = 70,715
Comments: The growth rate suggested is about one-half of what Schumacher (1928) suggested for normal stands of red fir on SI_{50} = 40.

Scientific Name: North Pacific Hypermaritime Sitka Spruce Forest
Code: 30
GAP Code: 4223
Unique NatureServe Identifier: CES204.841
Summary: This ecological system is restricted to the hypermaritime climatic areas near the Pacific Coast, along a fog belt from Point Arena, California, north to northern Vancouver Island, British Columbia. These forests are restricted to areas within 25 km of saltwater and are most abundant along the coast of Vancouver Island, southern portions of coastal British Columbia, and the Olympic Peninsula of Washington. Sites include the outermost coastal fringe where salt spray is prominent, riparian terraces and valley bottoms near the coast where there is major fog accumulation, and in the northern half of its range starting in central British Columbia, steep, well-drained productive slopes not directly adjacent to the outer coast but within the hypermaritime zone. Annual precipitation ranges from 65 to 550 cm, with the majority falling as rain. Winter rains can be heavy. In the southern portion of its range, summer drought does occur, but it is typically short in duration and ameliorated by frequent, dense coastal fog and cloud cover. This forest type also dominates lower elevations (to 350 m) on the leeward side of the Queen Charlotte Islands in British Columbia. In Washington and Oregon, it is found mostly below 300 m elevation. It also occurs as a very narrow strip or localized patches along the southern Washington, Oregon, and northern California coasts. Stands are typically dominated or codominated by *Picea sitchensis* but often have a mixture of other conifers present, such as *Tsuga heterophylla, Thuja plicata*, or *Chamaecyparis nootkatensis*. *Tsuga heterophylla* is very often codominant. In the southern extent (in Oregon, but not in California), *Chamaecyparis lawsoniana, Abies grandis, Pseudotsuga menziesii, Acer circinatum, Alnus rubra, Acer macrophyllum*, and *Frangula purshiana (= Rhamnus purshiana)* are occasional associates, while *Chamaecyparis nootkatensis* is completely absent. Wet coastal environments that support stands of *Chamaecyparis lawsoniana* in the absence of *Picea sitchensis* are also part of this system. The understory is rich with shade-tolerant shrubs and ferns, including *Gaultheria shallon, Vaccinium ovatum, Polystichum munitum, Dryopteris* spp., and *Blechnum spicant*, as well as a high diversity of mosses and lichens. The disturbance regime is mostly small-scale windthrow or other gap mortality processes (though there are occasional widespread intense windstorms) and very few fires, the latter mainly in Oregon. This type differs from Alaskan Pacific Maritime Sitka Spruce Forest (CES204.151) by having *Pseudotsuga menziesii* and *Thuja plicata* in addition to *Picea sitchensis* and *Tsuga heterophylla*. The climate has more seasonal rainfall than coastal areas to the north, with a pronounced drought in summer months.
Growth Rate Parameters: b = 0.4; k = 0.8; a = 0.05
Area Covered (acres): WA = 26,923; OR = 44,858; CA = 120
Comments: This growth rate is about one-half of that suggested by Meyer (1937) for fully-stocked, even-aged stands of Sitka spruce / western hemlock in the Northwest (SI_{100} = 120).

Scientific Name: North Pacific Hypermaritime Western Red-cedar-Western Hemlock Forest
Code: 30
GAP Code: 4271

Unique NatureServe Identifier: CES204.842

Summary: These forests occupy the outer coastal portions of British Columbia, southeastern Alaska, and northwestern Washington. Their center of distribution is the northern coast of British Columbia, as *Thuja plicata* approaches its northernmost limit in the southern half of southeastern Alaska. These forests occur mainly on islands but also fringe the mainland. They are never more than 25 km from saltwater; elevation ranges from 0 to 600 m, and below 245 m in Alaska (above 200 m, *Chamaecyparis nootkatensis* replaces *Thuja plicata*). The climate is hypermaritime, with cool summers, very wet winters, abundant fog, and without a major snowpack. Fire is absent from this system in Alaska and rare throughout the rest of the range. These forests are more influenced by gap disturbance processes and intense windstorms than by fire. The terrain is mostly gentle to rolling, of low topographic relief, and often rocky. Soils typically have a distinct humus layer overlying mineral horizons or bedrock; where the system is best developed in central British Columbia, the humus layers are very thick (mean 17-35 cm). Soils are often imperfectly drained, but this is not a wetland system. *Thuja plicata* and *Tsuga heterophylla* are the dominant tree species throughout, and *Chamaecyparis nootkatensis* joins them from northern Vancouver Island north. Canopy cover of trees is typically over 60%. *Pinus contorta* and *Tsuga mertensiana* can be present in some locations in the central and northern portion of the range. *Abies amabilis* occurs in British Columbia and northern Washington stands but is not typically found in southeastern Alaska. In Washington, nearly pure stands of *Tsuga heterophylla* are common and seem to be associated with microsites most exposed to intense windstorms. A shrub layer of *Gaultheria shallon, Vaccinium ovalifolium*, and *Menziesia ferruginea* is usually well-developed. The fern *Blechnum spicant* in great abundance is typical of hypermaritime conditions. *Oxalis oregana* (absent in Alaska) is important in the understory of moist sites in Washington. *Polystichum munitum* occurs at the northern end of its range in southeastern Alaska on well-drained sites. The abundance of *Thuja plicata* in relation to other conifers is one of the diagnostic characters of these forests; the other is the low abundance of *Pseudotsuga menziesii* (absent in Alaska) and *Picea sitchensis*. Where these forests are best developed, they occur in a mosaic with forested wetlands, bogs, and Sitka spruce forests (the latter in riparian areas and on steep, more productive soils).

Growth Rate Parameters: b = 0.5; k = 0.8; a = 0.05

Area Covered (acres): WA = 14,051; OR = 511; CA = 0

Comments: The growth rate is less than what Wiley and Chambers (1981), Chambers and Wilson (1972), and Barnes (1962) suggest for normal stands (SI_{50} = 100 or SI_{100}=140), yet are consistent with recent FIA data from the Mt. Hood National Forest.

Scientific Name: California Coastal Redwood Forest

Code: 30

GAP Code: 4202

Unique NatureServe Identifier: CES206.921

Summary: This system occurs from the Klamath Mountains south to Monterey Bay, California. At its northern extent, it transitions into southern examples of the coastal Sitka spruce and western hemlock systems that extend into coastal Alaska. However, the coastal redwood system generally can be found in areas of lower rainfall but still within the fog belt. In the northern portion, it occurs on upland slopes and in riparian zones and on riverine terraces that are flooded approximately every 50-100 years. In the southern portion of the range, annual precipitation may be as little as 50 cm, and the system is limited to coves and ravines. It is commonly found on moderately well-drained marine sediments (non-metamorphosed siltstones, sandstones, etc.). This system forms the tallest forests in North America, with individuals reaching 100 m high (tallest being 106-110 m [350-360 feet]). Typically, mature stands of *Sequoia sempervirens* produce a deep shade, so understories can be limited, but coarse woody debris from past disturbance can be quite large. *Pseudotsuga menziesii* is the common associate among the large trees. *Tsuga heterophylla* is found in old-growth stands, and *Lithocarpus densiflorus* occurs as a subcanopy in almost all stands (possibly as a result of fire suppression). The moist, coastal *Chamaecyparis lawsoniana* stands from southwestern Oregon and northwestern California, often mixed with *Sequoia sempervirens, Pseudotsuga menziesii*, or *Tsuga heterophylla*, are included in this system, as ecologically they function

in the same way and have the same overall floristic composition. Shade-tolerant understory species include *Rubus parviflorus, Oxalis oregana, Aralia californica, Mahonia nervosa (= Berberis nervosa), Gaultheria shallon*, and many ferns, such as *Blechnum spicant, Polystichum* spp., and *Polypodium* spp. Historically, ground fires likely exposed mineral soil for redwood seed germination. Less frequent disturbance can result in increases in *Tsuga heterophylla* in northern occurrences, as it is sensitive to fire and is a decreaser with fire and flood. Fire suppression has tended to result in increasing abundance of *Lithocarpus densiflorus, Umbellularia californica, Alnus rubra, Arbutus menziesii*, and *Acer macrophyllum*; all respond favorably to fire, flood, wind, and slides, becoming more abundant in areas of frequent disturbance.
Growth Rate Parameters: b = 0.5; k = 0.7; a = 0.08
Area Covered (acres): WA = 0; OR = 39,062; CA = 45,244
Comments: These parameters were set as an average of the 3 ecosystem types lumped into this category .

Summary Table

Project Code	ESLF/ GAP Code	B	k	A
10	4214	0.7	0.35	0.05
11	4224	0.5	0.8	0.07
12	4226	0.5	0.9	0.06
13	4215	0.3	0.6	0.06
14	4272	0.5	0.7	0.08
14	4229	0.5	0.7	0.08
15	8401	0.3	0.6	0.06
15	8601	0.3	0.6	0.06
15	8602	0.3	0.6	0.06
15	8603	0.3	0.6	0.06
15	8604	0.3	0.6	0.06
16	4230	0.7	0.35	0.05
17	5403	0.6	0.2	0.05
17	4217	0.6	0.2	0.05
17	4216	0.6	0.2	0.05
18	4232	0.6	0.8	0.07
20	4205	0.6	0.6	0.07
20	4269	0.6	0.6	0.07
21	4333	0.5	0.8	0.07
22	4301	0.6	0.6	0.07
22	4240	0.6	0.6	0.07
26	4222	0.2	0.6	0.07
28	4219	0.5	0.8	0.06
30	4223	0.5	0.8	0.05
30	4271	0.5	0.8	0.05
30	4202	0.5	0.8	0.05

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Appendix D
Ecological Restoration Thinning Candidate Forest Groups

Keys for main table below.

Forest Type	Code	Forest Category
Mediterranean California Dry Mixed Conifer	10	Dry
Westside dry Douglas-fir-W. Hemlock	11	Moist-West
Westside mesic Douglas-fir-W. Hemlock	12	Moist-West
Mediterranean California Mesic Mix Conifer	13	Moist-East/South
Cascade Silver Fir-W. Hemlock	14	Moist-West
Regeneration (Plantation)	15	All
Mediterranean California Mixed Evergreen	16	Moist-East/South
Mediterranean California Oak Conifer	17	Dry
East Cascade Dry Mixed Conifer	18	Dry
East Cascade Mesic Mixed Conifer	20	Moist-East/South
Westside mixed hardwood conifer	21	Moist-West
East Cascade Ponderosa Pine	22	Dry
Dry Douglas-fir Madrone	26	Moist-West
Mediterranean California Red Fir	28	Moist-East/South
Coast Redwood-S. Spruce/W. Hemlock	30	Moist-West

VEG Class Code	Name	Full Description	Canopy Cover	Basal Area Proportion of Hardwoods	Average Diameter
1	Sparse	Sparse: (CanCOV <10)	<10%		
2	Open	Open (CANCOV 10-39)	10-39%		
3	Hwd-sap/pol	Broadleaf, sap/pole, mod/closed	=>40%	=>65%	<10"
4	Hwd-small/large	Broadleaf, sm/med/lg, mod/closed	=>40%	=>65%	>10"
5	Mix-sap/pole	Mixed, sap/pole, mod/closed	=>40%	20-64%	<10"
6	Mix-small/med	Mixed, sm/med, mod/closed	=>40%	20-64%	10-20"
7	Mix-large/giant	Mixed, large+giant, mod/closed	=>40%	20-64%	>20"
8	Conifer-sap/pole	Conifer, sap/pole, mod/closed	=>40%	<20%	<10"
9	Conifer-small/med	Conifer, sm/med, mod/closed	=>40%	<20%	10-20"
10	Conifer-large	Conifer, large, mod/closed	=>40%	<20%	20-30"
11	Conifer-giant	Conifer, giant, mod/closed	=>40%	<20%	>30"

Forest Type Code	Veg Class Code	Number of Plots	Acres	BA (Ft2/AC)	% BA Hardwoods	QMD Dom (")	Canopy Cover	Average Age	Age Median	Volume (FT3/AC)	Volume (MBF/AC)
10	1	942	107,892	5	14%	6.7	4%	33	0	94	0.5
10	2	3522	671,716	45	17%	10.6	27%	65	54	994	5.2
10	3	1104	284,933	120	84%	7	73%	46	39	1818	9.5
10	4	548	154,999	194	79%	14.5	78%	107	63	4140	21.5
10	5	1431	511,368	119	41%	7.4	73%	56	43	2257	11.7
10	6	2514	1,202,155	180	37%	14.3	75%	100	78	4807	25
10	7	418	323,195	248	35%	27.4	79%	204	137	8446	43.9
10	8	2196	405,326	105	6%	7.6	65%	52	42	2058	10.7
10	9	5520	1,426,364	173	7%	14.6	71%	86	80	4910	25.5
10	10	2730	812,418	248	5%	24.1	75%	141	129	9235	48
10	11	870	286,027	278	5%	35.6	74%	212	190	12164	63.3
11	1	795	27,914	4	2%	8.8	3%	55	0	182	0.9
11	2	1815	80,684	25	10%	10.3	27%	42	32	577	3
11	3	474	10,860	107	79%	6.5	74%	31	27	2345	12.2
11	4	334	11,051	164	79%	13.2	73%	51	52	4467	23.2
11	5	1131	82,326	111	40%	7.6	76%	35	36	2291	11.9
11	6	1842	169,919	181	33%	14.2	79%	57	67	5861	30.5
11	7	320	19,218	222	29%	26.4	73%	124	107	9276	48.2
11	8	3291	583,297	106	3%	7.5	74%	39	30	2235	11.6
11	9	6204	1,567,149	199	3%	14.3	82%	74	72	6430	33.4
11	10	3822	1,081,220	272	2%	24.5	81%	149	137	11744	61.1
11	11	2064	581,752	305	2%	34.9	78%	211	200	15252	79.3
12	1	711	16,082	4	2%	7	3%	30	0	153	0.8
12	2	1647	44,518	27	20%	8.3	29%	35	29	627	3.3
12	3	354	11,136	79	78%	5.8	71%	22	27	1677	8.7
12	4	346	29,312	142	79%	15	67%	53	51	4868	25.3
12	5	738	49,135	109	41%	7.5	76%	40	35	2457	12.8
12	6	1854	191,186	185	35%	14.1	79%	55	64	6339	33
12	7	352	67,703	203	31%	25.7	68%	104	107	9081	47.2
12	8	2850	402,933	106	3%	7.3	75%	36	28	2210	11.5
12	9	5139	1,209,979	211	3%	14.4	84%	71	64	7105	36.9
12	10	3111	995,297	271	3%	24.6	81%	137	133	12410	64.5
12	11	1887	732,153	305	3%	35.3	78%	190	196	16331	84.9
13	1	723	40,247	4	5%	7.1	4%	26	0	96	0.5
13	2	2973	342,182	52	1%	11.6	28%	61	58	1221	6.3
13	3	453	7,496	111	88%	5.9	66%	35	38	1444	7.5
13	4	182	2,865	148	80%	14.4	66%	89	75	3583	18.6
13	5	870	27,494	114	39%	7	71%	61	46	2191	11.4
13	6	1500	63,180	187	36%	14.1	75%	79	80	5210	27.1
13	7	240	8,201	217	29%	26	76%	143	138	7713	40.1
13	8	2118	335,114	113	1%	7.8	66%	58	44	2394	12.4
13	9	5571	1,408,773	173	1%	14.7	69%	86	82	4898	25.5
13	10	2829	727,731	246	2%	23.8	74%	132	132	9280	48.3
13	11	814	166,586	281	1%	34.6	75%	207	192	12578	65.4

Forest Type Code	Veg Class Code	Number of Plots	Acres	BA (Ft2/AC)	% BA Hardwoods	QMD Dom (")	Canopy Cover	Average Age	Age Median	Volume (FT3/AC)	Volume (MBF/AC)
14	1	272	17,346	3	1%	6.6	3%	62	0	115	0.6
14	2	602	40,093	23	1%	7.3	29%	46	32	411	2.1
14	3	38	1,168	99	79%	6.4	82%	39	22	1926	10
14	4	31	622	171	73%	13.4	71%	63	51	5978	31.1
14	5	120	4,612	93	48%	7.1	82%	26	26	1926	10
14	6	202	14,629	188	37%	14.7	81%	60	52	6391	33.2
14	7	18	981	183	31%	20.4	75%	79	76	9207	47.9
14	8	1666	310,008	132	1%	6.9	77%	52	35	2997	15.6
14	9	3316	679,006	233	1%	14.3	86%	109	90	7751	40.3
14	10	1728	432,031	288	0%	24.2	85%	202	168	12917	67.2
14	11	714	217,686	325	0%	34.6	85%	262	238	17455	90.8
15	1	1620	202,111	4	7%	6	3%	44	0	120	0.6
15	2	4668	638,542	27	8%	7.7	27%	49	51	605	3.1
15	3	1077	74,691	115	84%	6.7	72%	34	30	1949	10.1
15	4	628	33,928	163	80%	13.4	71%	59	61	4153	21.6
15	5	1692	243,368	103	43%	6.9	73%	39	38	1977	10.3
15	6	2763	187,613	170	38%	13.2	76%	64	69	4853	25.2
15	7	496	15,176	217	35%	24.8	74%	123	119	7965	41.4
15	8	4980	1,108,186	78	3%	6.5	67%	36	36	1492	7.8
15	9	10011	791,689	162	3%	13.3	74%	68	51	4737	24.6
15	10	4722	186,623	234	2%	23.9	76%	155	137	9491	49.4
15	11	2142	61,371	284	2%	35	76%	204	197	14099	73.3
16	1	588	30,687	3	19%	4.1	3%	19	0	58	0.3
16	2	1848	121,362	39	17%	8.5	28%	66	47	814	4.2
16	3	843	154,172	160	83%	7.1	84%	42	36	2542	13.2
16	4	518	153,002	209	78%	14.2	81%	86	62	4550	23.7
16	5	826	185,114	129	43%	7.3	79%	54	42	2441	12.7
16	6	1424	355,086	210	41%	14.6	81%	107	77	6022	31.3
16	7	410	169,770	258	35%	25.8	80%	172	136	8911	46.3
16	8	1407	130,934	105	9%	7.6	70%	54	36	2058	10.7
16	9	3144	276,427	199	9%	14.5	77%	90	79	6184	32.2
16	10	1914	177,573	269	8%	23.8	78%	143	127	10620	55.2
16	11	636	65,466	292	8%	35.5	76%	209	187	13346	69.4
18	1	266	50,726	5	0%	7.9	3%	48	0	137	0.7
18	2	684	149,111	47	1%	12.8	29%	87	70	1177	6.1
18	3	25	102	99	91%	6.9	58%	28	46	1212	6.3
18	5	37	2,526	74	40%	6.2	67%	75	43	1265	6.6
18	6	56	1,954	124	33%	16.3	59%	74	74	3672	19.1
18	8	554	134,944	92	0%	7.5	63%	74	69	1782	9.3
18	9	1216	415,363	124	0%	13.8	65%	97	92	3255	16.9
18	10	190	18,669	152	1%	21.8	61%	115	132	4967	25.8
18	11	15	1,389	197	1%	30.7	60%	138	205	7878	41
20	1	522	12,710	5	4%	7.6	3%	53	0	159	0.8
20	2	1611	69,806	45	1%	12.9	27%	83	60	1227	6.4
20	3	282	672	105	83%	7	68%	56	46	1663	8.6

Forest Type Code	Veg Class Code	Number of Plots	Acres	BA (Ft2/AC)	% BA Hardwoods	QMD Dom (")	Canopy Cover	Average Age	Age Median	Volume (FT3/AC)	Volume (MBF/AC)
20	4	80	202	146	74%	12.9	72%	63	73	3396	17.7
20	5	480	5,649	100	39%	8.1	75%	51	59	1835	9.5
20	6	738	4,145	184	30%	14.2	73%	73	75	5083	26.4
20	7	106	4,966	207	32%	25	70%	124	108	8621	44.8
20	8	1725	137,844	105	0%	7.5	68%	67	47	2365	12.3
20	9	4329	542,677	168	1%	14.8	72%	100	89	4950	25.7
20	10	1890	166,075	230	1%	23.2	75%	149	140	8775	45.6
20	11	795	28,892	267	3%	34.6	71%	161	182	12551	65.3
22	1	738	97,837	6	2%	9.5	3%	53	0	134	0.7
22	2	2427	245,992	51	3%	13	27%	85	65	1221	6.3
22	3	387	12,414	86	84%	6.6	56%	65	0	838	4.4
22	4	54	438	113	81%	13.1	54%	68	88	2123	11
22	5	321	11,597	114	33%	7.9	60%	61	72	1753	9.1
22	6	495	4,358	115	37%	12.9	56%	91	91	2739	14.2
22	8	1227	110,257	98	2%	7.5	58%	71	69	1897	9.9
22	9	2619	230,213	123	1%	14.1	57%	94	92	3162	16.4
22	10	645	28,465	156	0%	22.4	63%	154	131	4833	25.1
22	11	219	440	245	1%	34.9	72%	207	206	11780	61.3
26	1	708	5,259	2	27%	3.9	2%	16	0	39	0.2
26	2	1881	24,869	36	18%	9.3	27%	51	40	830	4.3
26	3	669	18,982	137	83%	7.6	72%	46	32	2369	12.3
26	4	322	5,547	161	76%	13.2	69%	64	56	3746	19.5
26	5	1245	50,194	130	43%	7.7	76%	56	42	2540	13.2
26	6	2079	83,924	185	34%	13.6	77%	88	73	4973	25.9
26	7	354	7,557	208	31%	24.8	74%	122	119	7782	40.5
26	8	2247	57,770	119	7%	7.7	75%	45	31	2498	13
26	9	4605	186,617	186	5%	14.5	77%	76	67	5691	29.6
26	10	2496	87,123	249	4%	23.6	76%	120	128	9972	51.9
26	11	1320	42,355	294	4%	34.9	74%	166	184	14954	77.8
28	1	249	6,509	3	0%	3.1	3%	20	11	67	0.3
28	2	909	26,283	63	0%	15.2	28%	102	64	1700	8.8
28	3	16	29	93	78%	6.6	62%	19	26	1641	8.5
28	4	9	288	115	79%	16.1	58%	108	40	2306	12
28	5	34	143	81	46%	6.5	52%	65	39	1289	6.7
28	6	34	95	199	29%	14.5	80%	53	49	6582	34.2
28	7	6	21	213	32%	22.2	71%	72	81	9561	49.7
28	8	717	40,984	128	0%	7.6	68%	74	64	2702	14.1
28	9	2148	178,129	198	0%	15	72%	97	88	5378	28
28	10	834	50,890	245	0%	23.5	74%	163	136	8030	41.8
28	11	136	8,822	260	0%	32.1	74%	239	189	9399	48.9
30	1	78	284	1	1%	0.9	4%	6	0	3	0
30	2	108	1,119	23	19%	5.5	32%	28	16	502	2.6
30	3	56	1,462	165	67%	7.6	84%	37	20	4749	24.7
30	4	104	3,323	156	75%	15.8	66%	69	41	5483	28.5
30	5	156	4,978	109	36%	7.5	77%	31	24	2595	13.5

Forest Type Code	Veg Class Code	Number of Plots	Acres	BA (Ft2/AC)	% BA Hardwoods	QMD Dom (")	Canopy Cover	Average Age	Age Median	Volume (FT3/AC)	Volume (MBF/AC)
30	6	176	8,957	187	33%	14.9	80%	46	48	6848	35.6
30	7	104	6,474	195	33%	23.1	67%	90	95	8891	46.2
30	8	342	18,167	97	4%	7	75%	28	23	2129	11.1
30	9	462	62,553	221	3%	13.7	87%	49	43	7703	40.1
30	10	244	32,309	273	2%	24.7	83%	114	99	14397	74.9
30	11	216	25,394	309	3%	34.9	78%	151	138	17917	93.2
30	1	132	631	4	11%	5.1	4%	34	0	77	0.4
30	2	348	6,795	30	20%	6.5	27%	65	41	502	2.6
30	3	144	6,012	138	81%	7.3	84%	36	37	2082	10.8
30	4	384	25,709	215	80%	14.9	83%	75	64	4723	24.6
30	5	432	12,324	135	45%	6.5	83%	39	36	2521	13.1
30	6	752	27,079	208	42%	14	83%	96	74	5601	29.1
30	7	294	12,374	259	37%	25.3	78%	118	137	9074	47.2
30	8	276	11,095	94	7%	7.5	67%	41	30	1842	9.6
30	9	502	24,039	201	5%	14	77%	97	56	6051	31.5
30	10	272	10,657	258	5%	25.6	81%	141	113	10494	54.6
30	11	220	13,242	360	6%	38.5	81%	210	169	19919	103.6
17	1	249	24,708	5	39%	6.2	4%	25	0	79	0.4
17	2	872	122,268	40	45%	9.7	27%	48	48	735	3.8
17	3	806	148,170	98	86%	7.2	64%	43	39	1417	7.4
17	4	272	43,115	133	84%	13	65%	53	65	2490	12.9
17	5	445	64,403	115	44%	7.5	70%	62	48	2160	11.2
17	6	759	139,086	163	37%	13.6	71%	86	84	4019	20.9
17	7	189	16,020	203	34%	25	73%	141	137	6690	34.8
17	8	376	28,673	119	11%	7.6	68%	55	43	2534	13.2
17	9	931	91,864	180	8%	14.4	73%	86	79	5187	27
17	10	440	35,426	236	6%	23	76%	117	128	8263	43
17	11	200	7,068	253	6%	34.4	72%	193	192	10729	55.8
21	1	147	2,776	1	3%	3.1	1%	5	0	41	0.2
21	2	316	6,775	22	43%	8.1	29%	25	24	511	2.7
21	3	159	6,326	95	77%	5.8	77%	20	25	2200	11.4
21	4	171	17,611	146	80%	16	68%	55	51	5101	26.5
21	5	324	16,939	99	40%	7.5	72%	33	35	2189	11.4
21	6	559	43,025	176	39%	14.5	77%	56	65	6025	31.3
21	7	156	16,809	199	31%	26.4	70%	117	102	8817	45.8
21	8	629	26,337	78	7%	6.8	67%	30	27	1595	8.3
21	9	1129	56,535	185	8%	15	78%	57	56	6405	33.3
21	10	651	48,832	236	6%	24.5	76%	115	119	10564	54.9
21	11	413	41,446	282	6%	35.5	74%	164	176	14874	77.3

Appendix E

Summary of Candidate and Treatment Acres by Federal Administrative Unit and Forest Type

Keys for main tables below:

FAU Abbreviation	Federal Administrative Unit
CB	Coos Bay BLM, OR
Des	Deschutes NF, OR
Eug	Eugene BLM, OR
F-W	Fremont-Winema NF, OR
GP	Gifford Pinchot NF, WA
Kla	Klamath NF, WA
Lak	Lakeview BLM, WA
Las	Lassen NF, CA
MB-S	Mount Baker-Snoqualmie NF, WA
Med	Medford District BLM, OR
Men	Mendocino NF, CA
MH	Mount Hood NF, OR
Mod	Modoc NF, CA
N CA	Northern California BLM, CA
O-W	Okanogan-Wenatchee NF, WA
Oly	Olympic NF, WA
Ros	Roseburg BLM, OR
RR-S	Rogue River-Siskiyou NF, OR
S-T	Shasta-Trinity NF, CA
Sal	Salem, BLM, OR
Siu	Siuslaw NF, OR
SR	Six Rivers NF, CA
Ump	Umpqua NF, Oregon
Wil	Willamette NF, OR

Forest Type	Code	Forest Category
Mediterranean California Dry Mixed Conifer	10	Dry
Westside dry Douglas-fir-W. Hemlock	11	Moist-West
Westside mesic Douglas-fir-W. Hemlock	12	Moist-West
Mediterranean California Mesic Mix Conifer	13	Moist-East/South
Cascade Silver Fir-W. Hemlock	14	Moist-West
Regeneration (Plantation)	15	All
Mediterranean California Mixed Evergreen	16	Moist-East/South
Mediterranean California Oak Conifer	17	Dry
East Cascade Dry Mixed Conifer	18	Dry
East Cascade Mesic Mixed Conifer	20	Moist-East/South
Westside mixed hardwood conifer	21	Moist-West
East Cascade Ponderosa Pine	22	Dry
Dry Douglas-fir Madrone	26	Moist-West
Mediterranean California Red Fir	28	Moist-East/South
Coast Redwood-S. Spruce/W. Hemlock	30	Moist-West

Federal Admini-strative Unit	Forest Type Code	Total Matrix, LSR, AMA + (RR within)	Total Candidate Acres	Actual Treat Acres	Percent Treat	Riparian Reserve Percent Treat
CB	10	3,081	1,661	683	41%	0%
CB	11	56,735	33,339	9,666	29%	50%
CB	12	82,863	33,035	7,148	22%	50%
CB	13	1,346	470	97	21%	0%
CB	14	0	0	0		50%
CB	15	48,733	24,762	14,504	59%	50%
CB	16	28,054	4,353	891	20%	0%
CB	18	0	0	0		0%
CB	20	694	226	40	18%	0%
CB	22	0	0	0		0%
CB	26	3,031	2,130	726	34%	50%
CB	28	0	0	0		0%
CB	30	5,092	1,720	445	26%	50%
CB	17	7	1	1	40%	0%
CB	21	38,569	11,404	2,999	26%	50%
CB	50	13,778				
Des	10	13,519	11,974	4,334	36%	0%
Des	11	602	515	151	29%	50%
Des	12	0	0	0		50%
Des	13	96,688	92,318	20,394	22%	0%
Des	14	2,769	2,359	472	20%	50%
Des	15	63,283	58,205	32,706	56%	50%
Des	16	0	0	0		0%
Des	18	2,937	2,308	856	37%	0%
Des	20	31,009	25,862	5,020	19%	0%
Des	22	90,288	84,645	33,002	39%	0%
Des	26	401	341	120	35%	50%
Des	28	4,099	3,952	1,462	37%	0%
Des	30	0	0	0		50%
Des	17	0	0	0		0%
Des	21	0	0	0		50%
Des	50	17,473				
Eug	10	1,315	794	312	39%	0%
Eug	11	131,461	87,376	18,424	21%	50%
Eug	12	34,684	17,080	2,851	17%	50%
Eug	13	144	58	12	21%	0%
Eug	14	204	162	30	18%	50%
Eug	15	46,500	28,149	16,092	57%	50%
Eug	16	946	680	88	13%	0%
Eug	18	0	0	0		0%
Eug	20	502	231	43	18%	0%
Eug	22	14	7	3	44%	0%
Eug	26	4,348	2,745	855	31%	50%
Eug	28	12	8	3	41%	0%
Eug	30	115	39	11	28%	50%
Eug	17	70	51	26	51%	0%

Eug	21	56,127	24,641	5,997	24%	50%
Eug	50	10,121				
F-W	10	14,011	13,163	4,606	35%	0%
F-W	11	0	0	0		50%
F-W	12	0	0	0		50%
F-W	13	99,066	91,933	16,376	18%	0%
F-W	14	5	4	1	14%	50%
F-W	15	19,978	18,400	10,335	56%	50%
F-W	16	1,131	950	163	17%	0%
F-W	18	0	0	0		0%
F-W	20	233	211	36	17%	0%
F-W	22	24,944	22,934	7,812	34%	0%
F-W	26	0	0	0		50%
F-W	28	18,922	17,713	5,346	30%	0%
F-W	30	0	0	0		50%
F-W	17	0	0	0		0%
F-W	21	0	0	0		50%
F-W	50	7,076				
GP	10	0	0	0		0%
GP	11	87,512	62,085	13,561	22%	50%
GP	12	166,637	112,472	22,583	20%	50%
GP	13	0	0	0		0%
GP	14	236,705	182,032	30,169	17%	50%
GP	15	119,594	85,127	48,738	57%	50%
GP	16	0	0	0		0%
GP	18	577	489	204	42%	0%
GP	20	39,236	24,398	4,317	18%	0%
GP	22	0	0	0		0%
GP	26	2,559	1,540	386	25%	50%
GP	28	0	0	0		0%
GP	30	0	0	0		50%
GP	17	0	0	0		0%
GP	21	4,626	2,315	587	25%	50%
GP	50	16,153				
Kla	10	388,328	170,839	56,772	33%	0%
Kla	11	0	0	0		50%
Kla	12	0	0	0	0%	50%
Kla	13	157,400	134,431	24,462	18%	0%
Kla	14	0	0	0		50%
Kla	15	15,286	8,921	5,040	56%	50%
Kla	16	106,668	23,174	3,992	17%	0%
Kla	18	191	165	55	33%	0%
Kla	20	444	373	115	31%	0%
Kla	22	2,256	1,287	359	28%	0%
Kla	26	1,277	809	271	33%	50%
Kla	28	27,163	24,118	7,645	32%	0%
Kla	30	971	231	113	49%	50%
Kla	17	47,768	18,122	3,701	20%	0%
Kla	21	4	2	1	35%	50%
Kla	50	62,600				
Lak	10	10,656	10,141	3,730	37%	0%

Lak	11	0	0	0		50%
Lak	12	0	0	0		50%
Lak	13	18,696	16,310	2,899	18%	0%
Lak	14	0	0	0		50%
Lak	15	3,583	3,259	1,840	56%	50%
Lak	16	379	338	61	18%	0%
Lak	18	413	392	142	36%	0%
Lak	20	219	117	13	11%	0%
Lak	22	3,631	3,097	1,150	37%	0%
Lak	26	0	0	0		50%
Lak	28	2,006	1,792	484	27%	0%
Lak	30	0	0	0		50%
Lak	17	786	418	111	27%	0%
Lak	21	0	0	0		50%
Lak	50	4,338				
Las	10	130	77	18	23%	0%
Las	11	0	0	0		50%
Las	12	0	0	0		50%
Las	13	3,320	3,022	236	8%	0%
Las	14	0	0	0		50%
Las	15	45	30	18	60%	50%
Las	16	0	0	0		0%
Las	18	0	0	0		0%
Las	20	0	0	0		0%
Las	22	595	584	8	1%	0%
Las	26	919	765	214	28%	50%
Las	28	0	0	0		0%
Las	30	0	0	0		50%
Las	17	17,014	12,037	4,276	36%	0%
Las	21	0	0	0		50%
Las	50	1,544				
MBS	10	0	0	0		0%
MBS	11	46,738	31,772	5,889	19%	50%
MBS	12	84,252	47,546	9,957	21%	50%
MBS	13	0	0	0		0%
MBS	14	230,452	156,955	22,925	15%	50%
MBS	15	47,050	34,361	20,048	58%	50%
MBS	16	0	0	0		0%
MBS	18	0	0	0		0%
MBS	20	61	20	4	22%	0%
MBS	22	0	0	0		0%
MBS	26	1,223	640	182	28%	50%
MBS	28	0	0	0		0%
MBS	30	0	0	0		50%
MBS	17	0	0	0		0%
MBS	21	18,255	3,733	1,044	28%	50%
MBS	50	15,620				
Med	10	99,327	37,506	13,316	36%	0%
Med	11	4,035	1,825	505	28%	50%
Med	12	5,771	2,637	664	25%	50%
Med	13	53,634	38,340	5,721	15%	0%

Med	14	0	0	0		50%
Med	15	54,226	22,012	12,256	56%	50%
Med	16	160,174	34,639	6,791	20%	0%
Med	18	0	0	0		0%
Med	20	1,283	475	91	19%	0%
Med	22	4,030	1,423	131	9%	0%
Med	26	66,183	27,908	8,251	30%	50%
Med	28	855	809	239	30%	0%
Med	30	53	20	7	35%	50%
Med	17	211,553	63,213	22,593	36%	0%
Med	21	2,357	688	162	24%	50%
Med	50	42,941				
Men	10	332,951	147,960	41,590	28%	0%
Men	11	0	0	0		50%
Men	12	0	0	0		50%
Men	13	5,955	4,667	454	10%	0%
Men	14	0	0	0		50%
Men	15	6,867	3,934	2,276	58%	50%
Men	16	221	34	6	17%	0%
Men	18	0	0	0		0%
Men	20	0	0	0		0%
Men	22	0	0	0		0%
Men	26	0	0	0		50%
Men	28	1,664	1,461	464	32%	0%
Men	30	3	0	0	40%	50%
Men	17	25,503	8,329	838	10%	0%
Men	21	0	0	0		50%
Men	50	40,044				
MH	10	2	2	1	27%	0%
MH	11	169,294	127,223	27,796	22%	50%
MH	12	102,117	62,663	11,673	19%	50%
MH	13	0	0	0		0%
MH	14	122,021	97,177	11,316	12%	50%
MH	15	98,592	75,442	39,889	53%	50%
MH	16	0	0	0		0%
MH	18	840	742	187	25%	0%
MH	20	67,542	56,091	10,509	19%	0%
MH	22	24,952	15,902	6,198	39%	0%
MH	26	11,026	9,519	3,335	35%	50%
MH	28	973	833	189	23%	0%
MH	30	0	0	0		50%
MH	17	0	0	0		0%
MH	21	2,675	1,122	200	18%	50%
MH	50	25,495				
Mod	10	1,050	1,011	293	29%	0%
Mod	11	0	0	0		50%
Mod	12	0	0	0		50%
Mod	13	25,887	22,558	4,686	21%	0%
Mod	14	0	0	0		50%
Mod	15	472	436	247	57%	50%
Mod	16	0	0	0		0%

Mod	18	0	0	0		0%
Mod	20	0	0	0		0%
Mod	22	2	2	1	43%	0%
Mod	26	0	0	0		50%
Mod	28	7,355	6,663	1,736	26%	0%
Mod	30	0	0	0		50%
Mod	17	0	0	0		0%
Mod	21	0	0	0		50%
Mod	50	618				
N CA	10	126,009	34,718	8,650	25%	0%
N CA	11	0	0	0		50%
N CA	12	0	0	0		50%
N CA	13	1,968	1,689	251	15%	0%
N CA	14	0	0	0		50%
N CA	15	1,737	578	344	60%	50%
N CA	16	41,414	3,511	709	20%	0%
N CA	18	87	42	14	34%	0%
N CA	20	0	0	0		0%
N CA	22	1,680	937	194	21%	0%
N CA	26	172	56	22	39%	50%
N CA	28	20	20	5	24%	0%
N CA	30	28,902	3,717	1,549	42%	50%
N CA	17	72,397	24,085	2,102	9%	0%
N CA	21	0	0	0		50%
N CA	50	59,702				
O-W	10	0	0	0		0%
O-W	11	66	60	34	56%	50%
O-W	12	340	304	99	33%	50%
O-W	13	0	0	0		0%
O-W	14	36,134	31,429	4,543	14%	50%
O-W	15	45,771	37,871	21,871	58%	50%
O-W	16	0	0	0		0%
O-W	18	383,154	313,020	109,916	35%	0%
O-W	20	174,659	138,349	31,945	23%	0%
O-W	22	92,117	57,010	16,810	29%	0%
O-W	26	0	0	0		50%
O-W	28	0	0	0		0%
O-W	30	0	0	0		50%
O-W	17	0	0	0		0%
O-W	21	1	1	0	60%	50%
O-W	50	100,531				
Oly	10	0	0	0		0%
Oly	11	67,267	48,988	13,074	27%	50%
Oly	12	156,325	92,527	18,241	20%	50%
Oly	13	0	0	0		0%
Oly	14	78,607	38,968	5,466	14%	50%
Oly	15	38,798	24,077	13,832	57%	50%
Oly	16	0	0	0		0%
Oly	18	0	0	0		0%
Oly	20	0	0	0		0%
Oly	22	0	0	0		0%

Oly	26	2,973	1,891	541	29%	50%
Oly	28	0	0	0		0%
Oly	30	37,066	24,088	7,422	31%	50%
Oly	17	0	0	0		0%
Oly	21	3,939	1,720	560	33%	50%
Oly	50	13,492				
Ros	10	115,917	41,017	14,583	36%	0%
Ros	11	103,362	59,384	13,134	22%	50%
Ros	12	30,098	14,740	2,647	18%	50%
Ros	13	20,102	8,125	1,292	16%	0%
Ros	14	7	5	1	11%	50%
Ros	15	60,816	31,301	17,319	55%	50%
Ros	16	6,199	1,303	237	18%	0%
Ros	18	0	0	0		0%
Ros	20	2,210	639	82	13%	0%
Ros	22	22	3	1	25%	0%
Ros	26	16,182	7,300	2,425	33%	50%
Ros	28	1	1	0	30%	0%
Ros	30	33	17	7	40%	50%
Ros	17	2,420	695	245	35%	0%
Ros	21	10,750	4,411	778	18%	50%
Ros	50	10,281				
RR-S	10	65,362	35,985	13,220	37%	0%
RR-S	11	44,618	28,823	8,668	30%	50%
RR-S	12	13,850	6,567	1,315	20%	50%
RR-S	13	223,612	152,931	23,971	16%	0%
RR-S	14	463	308	48	16%	50%
RR-S	15	98,369	57,404	31,953	56%	50%
RR-S	16	284,993	85,126	14,491	17%	0%
RR-S	18	0	0	0		0%
RR-S	20	140	111	10	9%	0%
RR-S	22	1,410	1,177	451	38%	0%
RR-S	26	25,679	15,892	4,735	30%	50%
RR-S	28	12,219	9,823	3,078	31%	0%
RR-S	30	29,276	15,675	5,831	37%	50%
RR-S	17	39,724	14,476	6,746	47%	0%
RR-S	21	5,754	875	141	16%	50%
RR-S	50	38,145				
S-T	10	510,715	231,695	72,878	31%	0%
S-T	11	0	0	0		50%
S-T	12	0	0	0		50%
S-T	13	160,039	147,850	26,559	18%	0%
S-T	14	0	0	0		50%
S-T	15	29,555	19,889	10,939	55%	50%
S-T	16	15,339	4,175	692	17%	0%
S-T	18	1,569	786	298	38%	0%
S-T	20	1,770	1,630	410	25%	0%
S-T	22	3	3	1	44%	0%
S-T	26	6,629	4,037	871	22%	50%
S-T	28	26,515	23,292	7,914	34%	0%
S-T	30	365	69	39	56%	50%

S-T	17	198,885	77,584	27,977	36%	0%
S-T	21	0	0	0		50%
S-T	50	130,946				
Sal	10	1	0	0	30%	0%
Sal	11	113,069	70,119	15,795	23%	50%
Sal	12	103,638	52,483	10,045	19%	50%
Sal	13	2	2	0	17%	0%
Sal	14	5,926	3,666	405	11%	50%
Sal	15	48,021	26,435	14,963	57%	50%
Sal	16	0	0	0		0%
Sal	18	0	0	0		0%
Sal	20	815	307	45	15%	0%
Sal	22	0	0	0	60%	0%
Sal	26	15,419	9,967	3,137	31%	50%
Sal	28	606	329	88	27%	0%
Sal	30	1,454	680	237	35%	50%
Sal	17	0	0	0		0%
Sal	21	49,609	17,882	4,030	23%	50%
Sal	50	24,289				
Siu	10	92	23	7	32%	0%
Siu	11	46,588	17,138	3,048	18%	50%
Siu	12	232,751	77,457	16,246	21%	50%
Siu	13	0	0	0		0%
Siu	14	345	297	32	11%	50%
Siu	15	59,109	30,215	17,579	58%	50%
Siu	16	0	0	0		0%
Siu	18	0	0	0		0%
Siu	20	638	115	3	2%	0%
Siu	22	0	0	0		0%
Siu	26	16,217	4,747	1,372	29%	50%
Siu	28	443	186	57	31%	0%
Siu	30	43,072	16,825	5,741	34%	50%
Siu	17	0	0	0		0%
Siu	21	37,292	7,027	1,716	24%	50%
Siu	50	46,918				
SR	10	365,749	125,353	37,745	30%	0%
SR	11	0	0	0		50%
SR	12	0	0	0		50%
SR	13	13,955	8,332	1,107	13%	0%
SR	14	0	0	0		50%
SR	15	15,327	5,306	3,026	57%	50%
SR	16	98,737	14,592	2,442	17%	0%
SR	18	0	0	0		0%
SR	20	0	0	0		0%
SR	22	0	0	0		0%
SR	26	0	0	0		50%
SR	28	0	0	0		0%
SR	30	13,471	2,765	1,402	51%	50%
SR	17	22,553	8,038	1,497	19%	0%
SR	21	0	0	0		50%
SR	50	23,191				

Ump	10	115,079	61,457	20,422	33%	0%
Ump	11	166,095	107,489	21,400	20%	50%
Ump	12	36,809	21,440	3,411	16%	50%
Ump	13	182,074	108,019	15,182	14%	0%
Ump	14	17,234	12,830	1,435	11%	50%
Ump	15	100,307	72,601	39,668	55%	50%
Ump	16	12,120	7,048	1,009	14%	0%
Ump	18	0	0	0		0%
Ump	20	421	190	28	15%	0%
Ump	22	205	172	87	51%	0%
Ump	26	10,405	6,174	1,635	26%	50%
Ump	28	2,282	2,121	786	37%	0%
Ump	30	0	0	0		50%
Ump	17	1,106	510	237	46%	0%
Ump	21	14,199	7,960	1,334	17%	50%
Ump	50	11,407				
Wil	10	13,881	7,599	2,464	32%	0%
Wil	11	365,266	244,519	46,375	19%	50%
Wil	12	221,771	130,570	22,625	17%	50%
Wil	13	3,833	2,568	399	16%	0%
Wil	14	124,787	89,465	11,276	13%	50%
Wil	15	162,415	116,372	63,049	54%	50%
Wil	16	928	600	62	10%	0%
Wil	18	0	0	0		0%
Wil	20	2,052	1,515	180	12%	0%
Wil	22	0	0	0		0%
Wil	26	6,142	4,498	1,384	31%	50%
Wil	28	37	30	9	31%	0%
Wil	30	0	0	0		50%
Wil	17	0	0	0		0%
Wil	21	36,489	19,175	3,057	16%	50%
Wil	50	47,621				

Federal Administrative Unit	Forest Type Code	Open			Sapling-Pole			Small-Medium			Large		
		Candidate Acres	Percent Acres Treat	Acres Treat	Canddate Acres	Percent Acres Treat	Acres Treat	Candidate Acres	Percent Acres Treat	Acres Treat	Candidate Acres	Percent Acres Treat	Acres Treat
CB	10	28	0%	0	376	60%	226	804	40%	322	453	30%	136
CB	11	442	60%	265	10,178	60%	6,107	16,468	20%	3,294	6,251	0%	0
CB	12	694	60%	416	5,892	60%	3,535	15,981	20%	3,196	10,468	0%	0
CB	13	13	0%	0	83	60%	50	239	20%	48	135	0%	0
CB	14	0	40%	0	0	40%	0	0	10%	0	0	0%	0
CB	15	1,275	60%	765	14,032	60%	8,419	8,867	60%	5,320	588	0%	0
CB	16	234	0%	0	908	30%	272	2,063	30%	619	1,149	0%	0
CB	18	0	0%	0	0	60%	0	0	40%	0	0	30%	0
CB	20	2	0%	0	20	60%	12	143	20%	29	61	0%	0
CB	22	0	0%	0	0	60%	0	0	60%	0	0	40%	0
CB	26	27	40%	11	648	40%	259	1,141	40%	456	314	0%	0
CB	28	0	60%	0	0	60%	0	0	30%	0	0	0%	0

CB	30	35	60%	21	264	60%	159	664	40%	266	757	0%	0
CB	17	0	0%	0	0	60%	0	0	60%	0	1	40%	0
CB	21	609	60%	365	2,792	60%	1,675	4,794	20%	959	3,210	0%	0
CB	50												
Des	10	2,184	0%	0	2,812	60%	1,687	5,537	40%	2,215	1,442	30%	433
Des	11	87	60%	52	79	60%	47	258	20%	52	92	0%	0
Des	12	0	60%	0	0	60%	0	0	20%	0	0	0%	0
Des	13	10,702	0%	0	17,611	60%	10,567	49,133	20%	9,827	14,872	0%	0
Des	14	455	40%	182	375	40%	150	1,403	10%	140	126	0%	0
Des	15	25,052	60%	15,031	12,759	60%	7,655	16,699	60%	10,019	3,696	0%	0
Des	16	0	0%	0	0	30%	0	0	30%	0	0	0%	0
Des	18	360	0%	0	429	60%	258	1,422	40%	569	97	30%	29
Des	20	6,104	0%	0	5,094	60%	3,056	9,819	20%	1,964	4,846	0%	0
Des	22	27,406	0%	0	15,433	60%	9,260	35,100	60%	21,060	6,707	40%	2,683
Des	26	21	40%	8	12	40%	5	266	40%	106	42	0%	0
Des	28	355	60%	213	1,105	60%	663	1,952	30%	585	540	0%	0
Des	30	0	60%	0	0	60%	0	0	40%	0	0	0%	0
Des	17	0	0%	0	0	60%	0	0	60%	0	0	40%	0
Des	21	0	60%	0	0	60%	0	0	20%	0	0	0%	0
Des	50												
Eug	10	20	0%	0	90	60%	54	530	40%	212	155	30%	46
Eug	11	1,325	60%	795	12,195	60%	7,317	51,560	20%	10,312	22,296	0%	0
Eug	12	309	60%	185	1,697	60%	1,018	8,235	20%	1,647	6,839	0%	0
Eug	13	2	0%	0	8	60%	5	37	20%	7	10	0%	0
Eug	14	3	40%	1	45	40%	18	101	10%	10	13	0%	0
Eug	15	2,963	60%	1,778	14,135	60%	8,481	9,723	60%	5,834	1,329	0%	0
Eug	16	8	0%	0	64	30%	19	231	30%	69	378	0%	0
Eug	18	0	0%	0	0	60%	0	0	40%	0	0	30%	0
Eug	20	3	0%	0	27	60%	16	133	20%	27	68	0%	0
Eug	22	0	0%	0	0	60%	0	1	60%	1	6	40%	2
Eug	26	154	40%	61	631	40%	252	1,353	40%	541	607	0%	0
Eug	28	2	60%	1	2	60%	1	4	30%	1	0	0%	0
Eug	30	4	60%	3	8	60%	5	9	40%	3	18	0%	0
Eug	17	4	0%	0	7	60%	4	30	60%	18	10	40%	4
Eug	21	938	60%	563	5,404	60%	3,242	10,963	20%	2,193	7,337	0%	0
Eug	50												
F-W	10	2,260	0%	0	1,310	60%	786	9,417	40%	3,767	176	30%	53
F-W	11	0	60%	0	0	60%	0	0	20%	0	0	0%	0
F-W	12	0	60%	0	0	60%	0	0	20%	0	0	0%	0
F-W	13	11,810	0%	0	9,562	60%	5,737	53,195	20%	10,639	17,366	0%	0
F-W	14	0	40%	0	1	40%	0	1	10%	0	2	0%	0
F-W	15	7,790	60%	4,674	2,452	60%	1,471	6,983	60%	4,190	1,174	0%	0
F-W	16	97	0%	0	78	30%	23	465	30%	139	310	0%	0
F-W	18	0	0%	0	0	60%	0	0	40%	0	0	30%	0
F-W	20	22	0%	0	27	60%	16	101	20%	20	61	0%	0
F-W	22	9,784	0%	0	4,533	60%	2,720	8,228	60%	4,937	389	40%	156
F-W	26	0	40%	0	0	40%	0	0	40%	0	0	0%	0
F-W	28	587	60%	352	3,824	60%	2,294	8,998	30%	2,699	4,304	0%	0
F-W	30	0	60%	0	0	60%	0	0	40%	0	0	0%	0
F-W	17	0	0%	0	0	60%	0	0	60%	0	0	40%	0
F-W	21	0	60%	0	0	60%	0	0	20%	0	0	0%	0

F-W	50												
GP	10	0	0%	0	0	60%	0	0	40%	0	0	30%	0
GP	11	1,437	60%	862	10,797	60%	6,478	31,105	20%	6,221	18,747	0%	0
GP	12	765	60%	459	16,613	60%	9,968	60,782	20%	12,156	34,311	0%	0
GP	13	0	0%	0	0	60%	0	0	20%	0	0	0%	0
GP	14	3,906	40%	1,562	48,465	40%	19,386	92,205	10%	9,221	37,456	0%	0
GP	15	23,737	60%	14,242	40,793	60%	24,476	16,701	60%	10,020	3,897	0%	0
GP	16	0	0%	0	0	30%	0	0	30%	0	0	0%	0
GP	18	26	0%	0	135	60%	81	252	40%	101	77	30%	23
GP	20	418	0%	0	3,357	60%	2,014	11,517	20%	2,303	9,106	0%	0
GP	22	0	0%	0	0	60%	0	0	60%	0	0	40%	0
GP	26	12	40%	5	216	40%	86	739	40%	295	574	0%	0
GP	28	0	60%	0	0	60%	0	0	30%	0	0	0%	0
GP	30	0	60%	0	0	60%	0	0	40%	0	0	0%	0
GP	17	0	0%	0	0	60%	0	0	60%	0	0	40%	0
GP	21	64	60%	39	558	60%	335	1,068	20%	214	625	0%	0
GP	50												
Kla	10	37,079	0%	0	30,478	60%	18,287	75,007	40%	30,003	28,276	30%	8,483
Kla	11	0	60%	0	0	60%	0	0	20%	0	0	0%	0
Kla	12	0	60%	0	0	60%	0	0	20%	0	0	0%	0
Kla	13	25,099	0%	0	15,555	60%	9,333	75,645	20%	15,129	18,132	0%	0
Kla	14	0	40%	0	0	40%	0	0	10%	0	0	0%	0
Kla	15	4,147	60%	2,488	1,283	60%	770	2,970	60%	1,782	521	0%	0
Kla	16	4,661	0%	0	3,013	30%	904	10,292	30%	3,088	5,207	0%	0
Kla	18	40	0%	0	26	60%	16	97	40%	39	2	30%	1
Kla	20	15	0%	0	135	60%	81	168	20%	34	55	0%	0
Kla	22	684	0%	0	95	60%	57	496	60%	298	11	40%	5
Kla	26	27	40%	11	166	40%	66	484	40%	193	132	0%	0
Kla	28	1,443	60%	866	2,978	60%	1,787	16,643	30%	4,993	3,054	0%	0
Kla	30	129	60%	77	17	60%	10	63	40%	25	22	0%	0
Kla	17	11,777	0%	0	1,869	60%	1,122	3,946	60%	2,368	530	40%	212
Kla	21	0	60%	0	1	60%	0	1	20%	0	0	0%	0
Kla	50												
Lak	10	1,670	0%	0	1,779	60%	1,067	6,552	40%	2,621	139	30%	42
Lak	11	0	60%	0	0	60%	0	0	20%	0	0	0%	0
Lak	12	0	60%	0	0	60%	0	0	20%	0	0	0%	0
Lak	13	1,848	0%	0	1,576	60%	945	9,766	20%	1,953	3,121	0%	0
Lak	14	0	40%	0	0	40%	0	0	10%	0	0	0%	0
Lak	15	742	60%	445	766	60%	459	1,559	60%	935	192	0%	0
Lak	16	37	0%	0	1	30%	0	203	30%	61	96	0%	0
Lak	18	35	0%	0	5	60%	3	328	40%	131	23	30%	7
Lak	20	0	0%	0	12	60%	7	30	20%	6	75	0%	0
Lak	22	1,162	0%	0	203	60%	122	1,676	60%	1,005	57	40%	23
Lak	26	0	40%	0	0	40%	0	0	40%	0	0	0%	0
Lak	28	41	60%	25	97	60%	58	1,338	30%	401	316	0%	0
Lak	30	0	60%	0	0	60%	0	0	40%	0	0	0%	0
Lak	17	232	0%	0	20	60%	12	163	60%	98	3	40%	1
Lak	21	0	60%	0	0	60%	0	0	20%	0	0	0%	0
Lak	50												
Las	10	36	0%	0	9	60%	5	28	40%	11	3	30%	1
Las	11	0	60%	0	0	60%	0	0	20%	0	0	0%	0

Las	12	0	60%	0	0	60%	0	0	20%	0	0	0%	0
Las	13	779	0%	0	54	60%	33	1,017	20%	203	1,172	0%	0
Las	14	0	40%	0	0	40%	0	0	10%	0	0	0%	0
Las	15	17	60%	10	2	60%	1	11	60%	7	0	0%	0
Las	16	0	0%	0	0	30%	0	0	30%	0	0	0%	0
Las	18	0	0%	0	0	60%	0	0	40%	0	0	30%	0
Las	20	0	0%	0	0	60%	0	0	20%	0	0	0%	0
Las	22	571	0%	0	13	60%	8	0	60%	0	0	40%	0
Las	26	4	40%	2	31	40%	12	501	40%	201	229	0%	0
Las	28	0	60%	0	0	60%	0	0	30%	0	0	0%	0
Las	30	0	60%	0	0	60%	0	0	40%	0	0	0%	0
Las	17	4,287	0%	0	1,632	60%	979	4,247	60%	2,548	1,870	40%	748
Las	21	0	60%	0	0	60%	0	0	20%	0	0	0%	0
Las	50												
MBS	10	0	0%	0	0	60%	0	0	40%	0	0	30%	0
MBS	11	225	60%	135	3,628	60%	2,177	17,885	20%	3,577	10,033	0%	0
MBS	12	683	60%	410	7,174	60%	4,304	26,214	20%	5,243	13,474	0%	0
MBS	13	0	0%	0	0	60%	0	0	20%	0	0	0%	0
MBS	14	2,629	40%	1,052	35,397	40%	14,159	77,147	10%	7,715	41,782	0%	0
MBS	15	6,141	60%	3,685	21,512	60%	12,907	5,760	60%	3,456	947	0%	0
MBS	16	0	0%	0	0	30%	0	0	30%	0	0	0%	0
MBS	18	0	0%	0	0	60%	0	0	40%	0	0	30%	0
MBS	20	0	0%	0	4	60%	2	10	20%	2	5	0%	0
MBS	22	0	0%	0	0	60%	0	0	60%	0	0	40%	0
MBS	26	36	40%	14	100	40%	40	320	40%	128	185	0%	0
MBS	28	0	60%	0	0	60%	0	0	30%	0	0	0%	0
MBS	30	0	60%	0	0	60%	0	0	40%	0	0	0%	0
MBS	17	0	0%	0	0	60%	0	0	60%	0	0	40%	0
MBS	21	110	60%	66	815	60%	489	2,447	20%	489	362	0%	0
MBS	50												
Med	10	4,814	0%	0	5,150	60%	3,090	19,637	40%	7,855	7,905	30%	2,371
Med	11	148	60%	89	458	60%	275	708	20%	142	512	0%	0
Med	12	531	60%	319	270	60%	162	915	20%	183	920	0%	0
Med	13	4,838	0%	0	4,013	60%	2,408	16,568	20%	3,314	12,921	0%	0
Med	14	0	40%	0	0	40%	0	0	10%	0	0	0%	0
Med	15	9,126	60%	5,476	5,055	60%	3,033	6,246	60%	3,748	1,585	0%	0
Med	16	4,921	0%	0	5,655	30%	1,697	16,982	30%	5,095	7,081	0%	0
Med	18	0	0%	0	0	60%	0	0	40%	0	0	30%	0
Med	20	45	0%	0	39	60%	24	338	20%	68	52	0%	0
Med	22	1,201	0%	0	66	60%	40	145	60%	87	11	40%	4
Med	26	2,010	40%	804	3,568	40%	1,427	15,049	40%	6,020	7,281	0%	0
Med	28	256	60%	154	32	60%	19	221	30%	66	299	0%	0
Med	30	0	60%	0	6	60%	3	8	40%	3	5	0%	0
Med	17	22,359	0%	0	6,457	60%	3,874	24,799	60%	14,879	9,599	40%	3,840
Med	21	76	60%	45	62	60%	37	400	20%	80	150	0%	0
Med	50												
Men	10	41,036	0%	0	9,787	60%	5,872	65,769	40%	26,308	31,368	30%	9,410
Men	11	0	60%	0	0	60%	0	0	20%	0	0	0%	0
Men	12	0	60%	0	0	60%	0	0	20%	0	0	0%	0
Men	13	1,019	0%	0	91	60%	54	1,999	20%	400	1,558	0%	0
Men	14	0	40%	0	0	40%	0	0	10%	0	0	0%	0

Men	15	2,665	60%	1,599	249	60%	150	879	60%	528	141	0%	0
Men	16	13	0%	0	15	30%	4	4	30%	1	2	0%	0
Men	18	0	0%	0	0	60%	0	0	40%	0	0	30%	0
Men	20	0	0%	0	0	60%	0	0	20%	0	0	0%	0
Men	22	0	0%	0	0	60%	0	0	60%	0	0	40%	0
Men	26	0	40%	0	0	40%	0	0	40%	0	0	0%	0
Men	28	401	60%	240	19	60%	11	707	30%	212	334	0%	0
Men	30	0	60%	0	0	60%	0	0	40%	0	0	0%	0
Men	17	6,893	0%	0	704	60%	422	612	60%	367	121	40%	48
Men	21	0	60%	0	0	60%	0	0	20%	0	0	0%	0
Men	50												
MH	10	1	0%	0	1	60%	1	0	40%	0	0	30%	0
MH	11	2,818	60%	1,691	24,867	60%	14,920	55,928	20%	11,186	43,610	0%	0
MH	12	794	60%	476	10,460	60%	6,276	24,605	20%	4,921	26,805	0%	0
MH	13	0	0%	0	0	60%	0	0	20%	0	0	0%	0
MH	14	2,053	40%	821	14,976	40%	5,990	45,046	10%	4,505	35,102	0%	0
MH	15	12,558	60%	7,535	32,357	60%	19,414	21,566	60%	12,940	8,960	0%	0
MH	16	0	0%	0	0	30%	0	0	30%	0	0	0%	0
MH	18	320	0%	0	116	60%	69	258	40%	103	49	30%	15
MH	20	3,858	0%	0	6,653	60%	3,992	32,584	20%	6,517	12,995	0%	0
MH	22	5,442	0%	0	4,561	60%	2,737	5,510	60%	3,306	389	40%	156
MH	26	735	40%	294	819	40%	327	6,784	40%	2,714	1,181	0%	0
MH	28	49	60%	29	104	60%	62	324	30%	97	356	0%	0
MH	30	0	60%	0	0	60%	0	0	40%	0	0	0%	0
MH	17	0	0%	0	0	60%	0	0	60%	0	0	40%	0
MH	21	38	60%	23	104	60%	62	576	20%	115	404	0%	0
MH	50												
Mod	10	329	0%	0	129	60%	78	496	40%	198	56	30%	17
Mod	11	0	60%	0	0	60%	0	0	20%	0	0	0%	0
Mod	12	0	60%	0	0	60%	0	0	20%	0	0	0%	0
Mod	13	3,259	0%	0	4,231	60%	2,539	10,738	20%	2,148	4,331	0%	0
Mod	14	0	40%	0	0	40%	0	0	10%	0	0	0%	0
Mod	15	139	60%	83	59	60%	36	213	60%	128	24	0%	0
Mod	16	0	0%	0	0	30%	0	0	30%	0	0	0%	0
Mod	18	0	0%	0	0	60%	0	0	40%	0	0	30%	0
Mod	20	0	0%	0	0	60%	0	0	20%	0	0	0%	0
Mod	22	0	0%	0	0	60%	0	1	60%	1	0	40%	0
Mod	26	0	40%	0	0	40%	0	0	40%	0	0	0%	0
Mod	28	826	60%	496	883	60%	530	2,367	30%	710	2,587	0%	0
Mod	30	0	60%	0	0	60%	0	0	40%	0	0	0%	0
Mod	17	0	0%	0	0	60%	0	0	60%	0	0	40%	0
Mod	21	0	60%	0	0	60%	0	0	20%	0	0	0%	0
Mod	50												
N CA	10	14,547	0%	0	4,961	60%	2,976	11,104	40%	4,441	4,107	30%	1,232
N CA	11	0	60%	0	0	60%	0	0	20%	0	0	0%	0
N CA	12	0	60%	0	0	60%	0	0	20%	0	0	0%	0
N CA	13	542	0%	0	137	60%	82	847	20%	169	163	0%	0
N CA	14	0	40%	0	0	40%	0	0	10%	0	0	0%	0
N CA	15	525	60%	315	17	60%	10	32	60%	19	4	0%	0
N CA	16	913	0%	0	320	30%	96	2,042	30%	613	236	0%	0
N CA	18	7	0%	0	1	60%	1	34	40%	14	0	30%	0

N CA	20	0	0%	0	0	60%	0	0	20%	0	0	0%	0
N CA	22	612	0%	0	45	60%	27	272	60%	163	8	40%	3
N CA	26	3	40%	1	8	40%	3	43	40%	17	1	0%	0
N CA	28	0	60%	0	0	60%	0	16	30%	5	4	0%	0
N CA	30	401	60%	241	462	60%	277	2,579	40%	1,031	276	0%	0
N CA	17	20,473	0%	0	1,126	60%	676	2,162	60%	1,297	324	40%	130
N CA	21	0	60%	0	0	60%	0	0	20%	0	0	0%	0
N CA	50												
O-W	10	0	0%	0	0	60%	0	0	40%	0	0	30%	0
O-W	11	50	60%	30	5	60%	3	4	20%	1	2	0%	0
O-W	12	75	60%	45	47	60%	28	128	20%	26	54	0%	0
O-W	13	0	0%	0	0	60%	0	0	20%	0	0	0%	0
O-W	14	1,047	40%	419	6,805	40%	2,722	14,017	10%	1,402	9,560	0%	0
O-W	15	14,875	60%	8,925	12,783	60%	7,670	8,793	60%	5,276	1,420	0%	0
O-W	16	0	0%	0	0	30%	0	0	30%	0	0	0%	0
O-W	18	66,316	0%	0	59,954	60%	35,972	179,189	40%	71,676	7,560	30%	2,268
O-W	20	9,265	0%	0	22,855	60%	13,713	91,160	20%	18,232	15,069	0%	0
O-W	22	28,638	0%	0	8,658	60%	5,195	18,649	60%	11,189	1,065	40%	426
O-W	26	0	40%	0	0	40%	0	0	40%	0	0	0%	0
O-W	28	0	60%	0	0	60%	0	0	30%	0	0	0%	0
O-W	30	0	60%	0	0	60%	0	0	40%	0	0	0%	0
O-W	17	0	0%	0	0	60%	0	0	60%	0	0	40%	0
O-W	21	1	60%	0	0	60%	0	0	20%	0	0	0%	0
O-W	50												
Oly	10	0	0%	0	0	60%	0	0	40%	0	0	30%	0
Oly	11	801	60%	480	12,031	60%	7,218	26,876	20%	5,375	9,280	0%	0
Oly	12	983	60%	590	13,814	60%	8,289	46,813	20%	9,363	30,916	0%	0
Oly	13	0	0%	0	0	60%	0	0	20%	0	0	0%	0
Oly	14	290	40%	116	9,703	40%	3,881	14,684	10%	1,468	14,291	0%	0
Oly	15	4,075	60%	2,445	12,219	60%	7,331	6,759	60%	4,056	1,024	0%	0
Oly	16	0	0%	0	0	30%	0	0	30%	0	0	0%	0
Oly	18	0	0%	0	0	60%	0	0	40%	0	0	30%	0
Oly	20	0	0%	0	0	60%	0	0	20%	0	0	0%	0
Oly	22	0	0%	0	0	60%	0	0	60%	0	0	40%	0
Oly	26	38	40%	15	358	40%	143	957	40%	383	537	0%	0
Oly	28	0	60%	0	0	60%	0	0	30%	0	0	0%	0
Oly	30	153	60%	92	3,669	60%	2,201	12,823	40%	5,129	7,443	0%	0
Oly	17	0	0%	0	0	60%	0	0	60%	0	0	40%	0
Oly	21	44	60%	26	614	60%	369	825	20%	165	236	0%	0
Oly	50												
Ros	10	2,443	0%	0	4,165	60%	2,499	17,615	40%	7,046	16,794	30%	5,038
Ros	11	2,048	60%	1,229	9,944	60%	5,966	29,692	20%	5,938	17,700	0%	0
Ros	12	435	60%	261	1,582	60%	949	7,187	20%	1,437	5,536	0%	0
Ros	13	292	0%	0	901	60%	540	3,759	20%	752	3,174	0%	0
Ros	14	0	40%	0	0	40%	0	4	10%	0	1	0%	0
Ros	15	6,859	60%	4,115	12,185	60%	7,311	9,820	60%	5,892	2,437	0%	0
Ros	16	223	0%	0	154	30%	46	635	30%	190	291	0%	0
Ros	18	0	0%	0	0	60%	0	0	40%	0	0	30%	0
Ros	20	68	0%	0	49	60%	30	260	20%	52	261	0%	0
Ros	22	2	0%	0	0	60%	0	1	60%	1	0	40%	0
Ros	26	1,326	40%	530	1,864	40%	746	2,872	40%	1,149	1,238	0%	0

Ros	28	0	60%	0	0	60%	0	1	30%	0	0	0%	0
Ros	30	1	60%	0	7	60%	4	6	40%	2	4	0%	0
Ros	17	255	0%	0	80	60%	48	264	60%	159	96	40%	39
Ros	21	174	60%	104	531	60%	319	1,774	20%	355	1,932	0%	0
Ros	50												
RR-S	10	3,148	0%	0	4,679	60%	2,807	19,653	40%	7,861	8,505	30%	2,552
RR-S	11	1,651	60%	991	9,155	60%	5,493	10,922	20%	2,184	7,095	0%	0
RR-S	12	446	60%	268	762	60%	457	2,953	20%	591	2,406	0%	0
RR-S	13	13,502	0%	0	17,427	60%	10,456	67,577	20%	13,515	54,425	0%	0
RR-S	14	62	40%	25	17	40%	7	163	10%	16	66	0%	0
RR-S	15	17,777	60%	10,666	17,527	60%	10,516	17,950	60%	10,770	4,150	0%	0
RR-S	16	14,452	0%	0	19,101	30%	5,730	29,202	30%	8,761	22,371	0%	0
RR-S	18	0	0%	0	0	60%	0	0	40%	0	0	30%	0
RR-S	20	0	0%	0	1	60%	0	48	20%	10	63	0%	0
RR-S	22	403	0%	0	291	60%	175	418	60%	251	64	40%	26
RR-S	26	1,785	40%	714	2,737	40%	1,095	7,317	40%	2,927	4,053	0%	0
RR-S	28	960	60%	576	836	60%	502	6,667	30%	2,000	1,360	0%	0
RR-S	30	1,871	60%	1,123	2,997	60%	1,798	7,276	40%	2,910	3,531	0%	0
RR-S	17	2,152	0%	0	1,418	60%	851	7,666	60%	4,599	3,239	40%	1,296
RR-S	21	38	60%	23	107	60%	64	270	20%	54	460	0%	0
RR-S	50												
S-T	10	53,745	0%	0	30,987	60%	18,592	101,968	40%	40,787	44,995	30%	13,499
S-T	11	0	60%	0	0	60%	0	0	20%	0	0	0%	0
S-T	12	0	60%	0	0	60%	0	0	20%	0	0	0%	0
S-T	13	23,975	0%	0	14,555	60%	8,733	89,130	20%	17,826	20,191	0%	0
S-T	14	0	40%	0	0	40%	0	0	10%	0	0	0%	0
S-T	15	7,193	60%	4,316	3,383	60%	2,030	7,655	60%	4,593	1,657	0%	0
S-T	16	1,465	0%	0	648	30%	194	1,657	30%	497	405	0%	0
S-T	18	14	0%	0	140	60%	84	242	40%	97	390	30%	117
S-T	20	165	0%	0	371	60%	222	938	20%	188	157	0%	0
S-T	22	1	0%	0	2	60%	1	1	60%	1	0	40%	0
S-T	26	115	40%	46	1,175	40%	470	888	40%	355	1,859	0%	0
S-T	28	3,197	60%	1,918	2,446	60%	1,468	15,096	30%	4,529	2,554	0%	0
S-T	30	56	60%	34	4	60%	2	7	40%	3	2	0%	0
S-T	17	26,711	0%	0	9,217	60%	5,530	28,922	60%	17,353	12,735	40%	5,094
S-T	21	0	60%	0	0	60%	0	0	20%	0	0	0%	0
S-T	50												
Sal	10	0	0%	0	0	60%	0	0	40%	0	0	30%	0
Sal	11	741	60%	445	12,400	60%	7,440	39,551	20%	7,910	17,427	0%	0
Sal	12	481	60%	288	7,912	60%	4,747	25,047	20%	5,009	19,043	0%	0
Sal	13	0	0%	0	0	60%	0	1	20%	0	0	0%	0
Sal	14	74	40%	30	481	40%	192	1,830	10%	183	1,281	0%	0
Sal	15	1,402	60%	841	13,642	60%	8,185	9,895	60%	5,937	1,497	0%	0
Sal	16	0	0%	0	0	30%	0	0	30%	0	0	0%	0
Sal	18	0	0%	0	0	60%	0	0	40%	0	0	30%	0
Sal	20	0	0%	0	18	60%	11	171	20%	34	118	0%	0
Sal	22	0	0%	0	0	60%	0	0	60%	0	0	40%	0
Sal	26	43	40%	17	925	40%	370	6,875	40%	2,750	2,124	0%	0
Sal	28	1	60%	1	19	60%	11	252	30%	76	56	0%	0
Sal	30	3	60%	2	126	60%	76	398	40%	159	152	0%	0
Sal	17	0	0%	0	0	60%	0	0	60%	0	0	40%	0

Sal	21	495	60%	297	3,016	60%	1,810	9,619	20%	1,924	4,752	0%	0
Sal	50												
Siu	10	0	0%	0	0	60%	0	4	40%	1	19	30%	6
Siu	11	419	60%	251	2,485	60%	1,491	6,531	20%	1,306	7,703	0%	0
Siu	12	1,947	60%	1,168	14,474	60%	8,684	31,968	20%	6,394	29,068	0%	0
Siu	13	0	0%	0	0	60%	0	0	20%	0	0	0%	0
Siu	14	23	40%	9	6	40%	2	199	10%	20	68	0%	0
Siu	15	860	60%	516	16,558	60%	9,935	11,879	60%	7,128	917	0%	0
Siu	16	0	0%	0	0	30%	0	0	30%	0	0	0%	0
Siu	18	0	0%	0	0	60%	0	0	40%	0	0	30%	0
Siu	20	0	0%	0	2	60%	1	7	20%	1	105	0%	0
Siu	22	0	0%	0	0	60%	0	0	60%	0	0	40%	0
Siu	26	148	40%	59	1,176	40%	470	2,107	40%	843	1,316	0%	0
Siu	28	8	60%	5	23	60%	14	125	30%	38	28	0%	0
Siu	30	233	60%	140	2,826	60%	1,696	9,764	40%	3,906	4,002	0%	0
Siu	17	0	0%	0	0	60%	0	0	60%	0	0	40%	0
Siu	21	877	60%	526	1,399	60%	839	1,753	20%	351	2,999	0%	0
Siu	50												
SR	10	27,320	0%	0	14,309	60%	8,585	40,422	40%	16,169	43,302	30%	12,991
SR	11	0	60%	0	0	60%	0	0	20%	0	0	0%	0
SR	12	0	60%	0	0	60%	0	0	20%	0	0	0%	0
SR	13	671	0%	0	781	60%	469	3,194	20%	639	3,685	0%	0
SR	14	0	40%	0	0	40%	0	0	10%	0	0	0%	0
SR	15	3,355	60%	2,013	808	60%	485	881	60%	529	262	0%	0
SR	16	3,908	0%	0	4,321	30%	1,296	3,819	30%	1,146	2,544	0%	0
SR	18	0	0%	0	0	60%	0	0	40%	0	0	30%	0
SR	20	0	0%	0	0	60%	0	0	20%	0	0	0%	0
SR	22	0	0%	0	0	60%	0	0	60%	0	0	40%	0
SR	26	0	40%	0	0	40%	0	0	40%	0	0	0%	0
SR	28	0	60%	0	0	60%	0	0	30%	0	0	0%	0
SR	30	564	60%	338	1,420	60%	852	531	40%	212	251	0%	0
SR	17	5,382	0%	0	1,267	60%	760	903	60%	542	487	40%	195
SR	21	0	60%	0	0	60%	0	0	20%	0	0	0%	0
SR	50												
Ump	10	5,940	0%	0	4,668	60%	2,801	23,666	40%	9,467	27,183	30%	8,155
Ump	11	4,054	60%	2,432	15,840	60%	9,504	47,319	20%	9,464	40,277	0%	0
Ump	12	466	60%	279	1,780	60%	1,068	10,320	20%	2,064	8,874	0%	0
Ump	13	6,002	0%	0	12,239	60%	7,343	39,193	20%	7,839	50,584	0%	0
Ump	14	1,096	40%	439	953	40%	381	6,153	10%	615	4,628	0%	0
Ump	15	19,847	60%	11,908	24,903	60%	14,942	21,363	60%	12,818	6,488	0%	0
Ump	16	747	0%	0	721	30%	216	2,642	30%	793	2,937	0%	0
Ump	18	0	0%	0	0	60%	0	0	40%	0	0	30%	0
Ump	20	2	0%	0	8	60%	5	115	20%	23	65	0%	0
Ump	22	26	0%	0	102	60%	61	42	60%	25	2	40%	1
Ump	26	579	40%	232	538	40%	215	2,970	40%	1,188	2,087	0%	0
Ump	28	91	60%	55	593	60%	356	1,250	30%	375	187	0%	0
Ump	30	0	60%	0	0	60%	0	0	40%	0	0	0%	0
Ump	17	34	0%	0	16	60%	10	217	60%	130	242	40%	97
Ump	21	473	60%	284	816	60%	490	2,801	20%	560	3,870	0%	0
Ump	50												
Wil	10	558	0%	0	506	60%	304	1,994	40%	798	4,541	30%	1,362

Wil	11	6,326	60%	3,795	37,086	60%	22,252	101,640	20%	20,328	99,467	0%	0
Wil	12	2,127	60%	1,276	19,368	60%	11,621	48,638	20%	9,728	60,437	0%	0
Wil	13	310	0%	0	389	60%	233	828	20%	166	1,041	0%	0
Wil	14	5,418	40%	2,167	14,162	40%	5,665	34,441	10%	3,444	35,445	0%	0
Wil	15	19,324	60%	11,594	53,194	60%	31,917	32,563	60%	19,538	11,290	0%	0
Wil	16	5	0%	0	44	30%	13	163	30%	49	388	0%	0
Wil	18	0	0%	0	0	60%	0	0	40%	0	0	30%	0
Wil	20	81	0%	0	91	60%	55	625	20%	125	718	0%	0
Wil	22	0	0%	0	0	60%	0	0	60%	0	0	40%	0
Wil	26	140	40%	56	1,289	40%	516	2,029	40%	812	1,039	0%	0
Wil	28	1	60%	1	4	60%	2	21	30%	6	4	0%	0
Wil	30	0	60%	0	0	60%	0	0	40%	0	0	0%	0
Wil	17	0	0%	0	0	60%	0	0	60%	0	0	40%	0
Wil	21	611	60%	367	2,600	60%	1,560	5,647	20%	1,129	10,315	0%	0
Wil	50												

Appendix F
The "Billion Board Feet *Promise*" of the Northwest Forest Plan[29]

When developing the Northwest Forest Plan, only "Option 9" developed by the Federal Ecosystem Management Assessment Team would cut enough timber to satisfy the political concerns of The White House. Option 9 was marketed as having a "Probable Sale Quantity" (PSQ) of approximately one-billion board feet annually.

The Northwest Forest Plan (NWFP) doesn't *promise* the timber industry one-billion board feet of timber, and logging one-billion board feet is not a goal of the NWFP. The Plan merely estimated that implementing the plan *might* lead to this level of logging, as stated in several places in the NWFP's Record of Decision:

> *The PSQ levels shown are estimates. They represent neither minimum levels that must be met nor maximum levels that cannot be exceeded. They are rough approximations because of the difficulty associated with predicting actual timber sale levels over the next decade, given the discretion that agency land managers possess in administering plans and deciding when and where to offer timber sales, as well as the complex nature of many of the standards and guidelines. They represent our best assessment of the average amount of timber likely to be awarded annually in the planning area over the next decade, following a start-up period.*[30]
>
> *PSQ levels are presented as an effect, not a goal, of the standards and guidelines.*[31]
>
> *…[I]t is recognized that the Aquatic Conservation Strategy objectives and the requirement to do watershed analysis before management activities can take place implies a higher level of uncertainty and a potential for future change with respect to future levels of sale offerings within Key Watersheds.*[32]

Even as scientists were writing the Northwest Forest Plan, most realized that the protection measures needed to ensure species viability made logging a billion board feet impossible.

> *One of those scientists, Jack Ward Thomas, soon afterward became chief of the U.S. Forest Service. Thomas recalls warning the Clinton Administration the plan 'wouldn't come anywhere close' to producing the billion board feet the administration had told the public it would.…*
>
> *But the plan still predicted the high "Probable Sale Quantity" of 1 billion board*

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[29] All of the information and most of the content for this appendix provided by Doug Heiken of Oregon Wild.

[30] U.S. Department of Agriculture, Forest Service; U.S. Department of the Interior, Bureau of Land Management. 1994. Record of Decision for Amendments to Forest Service and Bureau of Land Management planning documents within the range of the northern spotted owl. Standards and guidelines for management of habitat for late-successional and old-growth forest related species within the range of the northern spotted owl. April 13, 1994 (*hereinafter* 1994 NWFP ROD) at page 19.

[31] 1994 NWFP ROD at 66.

[32] 1994 NWFP ROD at E-20.

> *feet of timber, known as Option 9. Many in the timber industry saw the figure as a commitment,* [Oregon State University forestry professor K. Norman] *Johnson said.*
>
> *"It's what the administration said would happen," he said. "It was an attempt to provide the environmental protection of a very restrictive alternative while still maintaining the harvest of Option 9. We knew from the start it was impossible."*[33]

A few other points about that "billion board feet":

1. Initially, it was actually 0.958 billion board feet.[34] Rounding is generally fine, but not when rare old-growth forest is involved.

2. 844 (88%) of that initial 958 million board feet (MMBF) target targeted late-successional (mature and old-growth) forests.[35]

3. The PSQ was officially adjusted downward to 868 MMBF to reflect completion of BLM Resource Management Plans in Oregon and National Forest Land and Resource Management Plans in California.[36]

4. The PSQ was officially adjusted downward to 811 MMBF to reflect that stream densities across the landscape has been underestimated.[37]

5. Refinement of the Northwest Forest Plan to account for the actual implementation of "Survey and Management" required by the original plan reduced the PSQ to 760 MMBF.[38] This also accounted for the transfer of certain BLM lands to the Coquille Tribe. After "survey and manage" was "adjusted," over one million acres of late-successional (mature & old-growth) forest would remain available for logging.[39]

6. Had the federal forest agencies actually implemented "survey and manage" as it was originally adopted, and not tried to cripple or eliminate the program so they could meet artificial and unsustainable timber targets, the PSQ should have been adjusted down to 510 MMBF.[40]

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[33] Milstein, Michael. April 29, 2002. "Old Fight Over Old Growth Renewed." *Oregonian*, Portland, Oregon. Page A01.

[34] U.S. Department of Agriculture, Forest Service; U.S. Department of the Interior, Bureau of Land Management. 1994. Final Supplemental Environmental Impact Statement for management of habitat within the range of the northern spotted owl. Standards and guidelines for management of habitat for late-successional and old-growth forest related species within the range of the northern spotted owl. February 1994, at page 3&4-265.

[35] U.S. Department of Agriculture, Forest Service; U.S. Department of the Interior, Bureau of Land Management. 2000. Final Supplemental Environmental Impact Statement for Amendment to the Survey and Manage, Protection Buffer, and Other Mitigation Measures Standards & Guidelines. November 2000 (*hereinafter* 2000 FSEIS), at page 431.

[36] 2000 FSEIS at page 88.

[37] 2000 FSEIS at page 88.

[38] 2000 FSEIS, page 434.

[39] 2000 FSEIS, page 436.

[40] 2000 FSEIS, page 434.