Salmon Anchor Habitat Strategy
Invited Expert Responses

Prepared for

The Salmon Anchor Habitat Work Group/
Salmon Anchor Habitat Conference
Tillamook, Oregon
June 24-25, 2004

Institute for Natural Resources and Oregon Department of Forestry

Introduction (Abstract)

This document compiles written responses by experts in their respective fields to questions from the Salmon Anchor Habitat Work Group about the Salmon Anchor Habitat Strategy component of Oregon Department of Forestry Northwestern Oregon State Forest Management Plan.

The Salmon Anchor Habitat Strategy and Work Group

The 2003 Oregon Legislature directed the Oregon Department of Forestry (ODF) to convene a citizen work group to examine the Salmon Anchor Habitat Strategy. Introduced by ODF in the 2001 Northwestern Oregon State Forest Management Plan and described more specifically in the 2003 Implementation Plan, the Salmon Anchor Habitat (SAH) Strategy was designed to provide additional protection for 10 years to a series of drainages with intact salmon populations and habitat as active, structure-based forest management strategies are implemented across the Tillamook and Clatsop State Forests.

The 6-person Salmon Anchor Habitat Work Group consisted of representatives from Clatsop County, Tillamook County, Oregon Trout, Wild Salmon Center, the Council of Forest Trust Land Counties and the Oregon Forest Industries Council. The Institute for Natural Resources (INR) organized and moderated a series of meetings where SAH Work Group members identified issues and questions about the SAH Strategy and the effects of implementing it. Staff from ODF and the Oregon Department of Fish and Wildlife (ODFW) explained agency policies and how they were developed.

Salmon Anchor Habitat Work Group Invited Experts

The SAH Work Group members defined a set of key issues and questions they wanted addressed so they could make recommendations about the SAH Strategy. INR recruited fourteen experts to provide written responses to the questions, which were grouped into these topics:

- Salmonid Status, Science, Protection, Recovery
- Regulatory and Legal Assurances and Considerations, Policy Questions
- Silvicultural Issues and Strategies
- Monitoring
- Perceived Costs and Benefits of SAHs, Economic and Social Values

The SAH Work Group, invited experts, and ODF, ODFW and INR staff convened at the June 2004 Salmon Anchor Habitat Conference in Tillamook, Oregon. The experts gave oral presentations based on their written responses to questions the SAH Work Group had posed about the SAH Strategy, and interacted with group members during panel discussions on each topic. After the conference, the SAH Work Group met to finalize their recommendations, and presented a final report to the Oregon Board of Forestry in September, 2004.

How to use this document

This document contains:

- A table showing the questions and issues identified by the Salmon Anchor Habitat Work Group during a series of meetings in the spring and summer of 2004
- A Technical Summary of key points in the written expert responses to the questions identified by the SAH Work Group
- The full text of each written expert response

The technical summary is an overview of information presented by each expert, formatted as lists of key points. Readers are urged to consult the experts' complete responses to fully understand the context in which these key points were made, and the information cited to support them. Specific questions posed by the SAH Work Group that the experts responded to appear in *italics*.

Table of Contents

Salmon Anchor Habitat Work Group and Conference

List of Experts

Dr. Charley Dewberry, Gutenberg College

Rosemary Furfey, National Marine Fisheries Service, National Oceanic and Atmospheric Administration.

Dr. Richard Haynes, Portland Forestry Sciences Lab, Pacific Northwest Research Station, USDA Forest Service.

Alan Kanaskie, Oregon Department of Forestry

Dr. Phil Larsen, Western Ecology Division, United States Environmental Protection Agency

Jeff Lockwood, National Marine Fisheries Service, National Oceanic and Atmospheric Administration.

Kelly Moore, Oregon Watershed Enhancement Board

Pamela Overhulser, Oregon Department of Forestry.

Dr. Steven Radosevich, College of Forestry, Oregon State University

Dr. Hans Radtke, The Research Group, Corvallis, Oregon.

Dr. Gordon Reeves, Pacific Northwest Research Station, USDA Forest Service.

Dr. Randall Rosenberger, College of Forestry, Oregon State University

Dr. John Sessions, College of Forestry, Oregon State University

Dr. Jon Souder, author (with Dr. Sally Fairfax) of *State Trust Lands: History, Management, and Sustainable Use*. University of Kansas Press, 1996.

SALMON ANCHOR HABITAT WORKGROUP CONFERENCE
TILLAMOOK, OREGON, JUNE 24, 2004

Questions and Issues

A. SALMONID STATUS, SCIENCE, PROTECTION, RECOVERY
1. What are historic trends & cycles of North Coast salmonid populations? What factors influence these trends? 2. How should the FMP define “properly functioning aquatic habitats?” 3. What is the scientific basis for the SAH Strategy? 4. How does the SAH Strategy compare to state and federal aquatic and riparian strategies, and FPA rules? 5. Does the SAH strategy help or limit ODF in achieving the desired results of the FMP? Why? 6. To what extent does SAH Strategy effectiveness depend on other land ownerships in SAH watersheds? 7. Why focus on “healthy” stocks? 8. What alternatives to the SAH strategy may be available? 9. Are there alternatives to the metapopulation theory?
B. REGULATORY & LEGAL ASSURANCES & CONSIDERATONS, POLICY QUESTIONS
1. How does the SAH strategy relate or respond to Executive Order 99-01 to seek approval of an HCP?
2. To what degree would the SAH strategy elevate the stature of the Oregon Plan and the FMP in the eyes of NOAA Fisheries regarding "federal assurances" for the Oregon Plan and an HCP?
3. What, if any, level of increased regulatory certainty can Oregon expect from our federal partners if the SAH strategy is implemented?

4. How have courts defined legal relationships between forest trust counties and the state in relation to management of state forest lands?
5. What procedures were followed in developing the SAH Strategy and timber harvest levels?
6. What would be the benefits and/or costs of continuing the SAHs if the coho is delisted?
C. SILVICULTURAL ISSUES & STRATEGIES
1. How will Salmon Anchor Habitats be incorporated into, and affect, the Harvest and Habitat model?
2. What are potential Swiss needle cast treatment alternatives? 3. How are various landowners (federal, state, private) dealing with SNC?
4. What affect would longer rotations have on stand structure, increase in fiber production, wood quality, and harvest output over longer time-frames?
5. Are ODF's inventory of standing timber by species and age class based on accurate and ground-proofed surveys?
D. MONITORING
1. What are possible approaches for monitoring the effectiveness of SAH Strategies? 2. What is the appropriate time frame for monitoring SAH effectiveness?
E. PERCEIVED COSTS & BENEFITS OF SAHS, ECONOMIC AND SOCIAL VALUES
1. If clear cut harvests are limited within SAHs and some planned harvests are moved elsewhere within Clatsop and Tillamook State Forests, what are the longer term implications for harvests from those areas and for overall harvest levels, given that SAHs expire in January 2010?
2. What are the costs of SAHs to counties and the state in terms of revenue impacts?
3. What are the benefits of SAHs in terms of market and non-market values?

4.	What are the economic affects of ODF's proposed harvest increases over the long term compared with harvesting on a longer rotation?
5.	Are there alternative forest management prescriptions that could be applied to the SAH areas that will protect key habitats and processes, as well as provide greater timber revenues over a longer time frame than can be obtained by the short term high harvest regime currently in operation?

SALMON ANCHOR HABITAT WORKING GROUP

Summary of Technical Reports

This summary is based on responses from various experts to questions posed by the Salmon Anchor Habitat Work Group and should be used in conjunction with their full responses, which appear in the following sections. The sources of the summary points are noted for easy reference.

A. Salmon status, science, protection, recovery

1. What are historic trends & cycles of North Coast salmonid populations? What factors influence these trends?

(All points based on Reeves' response.)

- Little is known about historic Oregon salmon population cycles. .
- Variation in numbers and survival of Oregon coast salmon are strongly influenced by ocean and freshwater conditions. It is unclear whether currently favorable ocean conditions will persist for an extended time or are an anomaly.
- Oregon is at a shifting boundary between cool, nutrient-rich and warm, nutrient-poor ocean currents that varies on a 20-30 year cycle.
- Oregon salmon survival may reach 12% under productive, nutrient-rich ocean conditions and dip below 1% under poor conditions, resulting in a 10 or more-fold variation in salmon numbers.
- Since 2001, increasing numbers of salmon have returned to coastal Oregon streams, probably due to favorable ocean conditions.
- Coho numbers rose from ~2000 in the Tillamook and Nehalem Rivers to ~15,000 and ~30,000 respectively, but 2004 numbers for Columbia River spring Chinook appear to be only 1/3 of what was predicted.
- Estimated historical coho numbers in the Nehalem and Tillamook during favorable conditions were about 200-240,000 and 200-292,000 respectively.
- Scarcity of larger, complex estuaries (particularly important when ocean productivity is low) probably also influenced numbers and survival of coastal Oregon salmon.

- Amount and quality of freshwater habitat directly influence salmon numbers and survival, especially coho and Chinook, which spend extended time in freshwater.

- In all Oregon coast areas, salmon habitat is much less extensive than it was historically.

- Habitat quality consists of *diversity of habitat types*, and *complexity of habitat conditions*. Both affect fish numbers and survival.

- Ascertaining whether ocean conditions or freshwater habitats are most important for persistence of Oregon salmon populations is virtually impossible. The problem is just too complex, given current levels of understanding.

- Freshwater habitat may be relatively more important for coastal Oregon salmon than for salmon populations farther north.

2. How should the FMP define "properly functioning aquatic habitats?"

(All point based on Reeves' response, except as noted.)

- Standards used to define "properly functioning" have been developed for habitat components based on conditions in minimally disturbed habitat units.

- One parameter of properly functioning aquatic habitats is shallow and deep-seated debris flows that include large trees and large downed wood when they reach streams, where they reduce the risk of dam-break floods. (Dewberry)

- To recover freshwater salmon habitats, focus is shifting to policies and practices that integrate habitat management across several spatial scales.

- Rather than properly functioning habitats, it may be better to define *properly functioning aquatic conditions* (PFCs) for all scales of interest, but doing so at larger scales is tremendously challenging.

- Defining PFCs requires definition of the spatial unit of interest, and recognition that each spatial scale unit is different, with its own properties and management requirements. (Reeves)

- There is no single value for PFCs. To maintain landscape scale PFCs managers should consider 1) developing a variety of conditions or states in individual ecosystems within the landscape at any point in time, and 2) the pattern resulting from the range of ecological conditions present.

- Habitats units are pools or riffles from 10-100', and reaches- several habitat units in a uniform geomorphic setting up to >1000'. The ecosystem/watershed spatial scale can be a 6th-7th code hydrologic unit (HUC). A landscape is a mosaic of ecosystems occupying a larger area, such as multiple contiguous watersheds.

- PFCs at any spatial scale imply that conditions are within or near their *range of natural variability* (RNV). RNV is the range of conditions that a particular spatial scale experiences naturally over extended time, decades to centuries.

- RNV is not well established for aquatic ecosystems. Many areas have been extensively altered by humans, with key ecological processes eliminated. RNV expression may not be possible in these instances.

- At the central Oregon coast (landscape) scale, an estimated 60% of watersheds were in "good" condition for fish at any point in time prior to extensive human activity.

- Research suggests conditions for fish ranged from poor in most recently (80-100 yrs) and least recently (>300 yrs) disturbed areas to very good in systems intermediate in time (160-180 yrs) since the last major disturbance.

- Shifting to a landscape level focus will require an understanding of relationships between habitat units, watersheds, and multiple watershed landscapes if future aquatic system management and assessment policies are to be successful.

- Applying RNV and PFCs concepts to aquatic systems requires adopting a dynamic perspective of aquatic systems, and characterizing RNV at different spatial scales.

- Resilience is an ecosystem's ability to recover after a disturbance, which may take extended time depending on the system. Reduced resilience results in a decrease in diversity of conditions of a particular ecological state, or loss of a particular state, or both.

- The key to maintaining aquatic systems at all levels of organization within RNV is making management-related disturbance resemble natural disturbances as closely as possible.

- "Pulse" disturbances are infrequent, with enough time between them to enable ecosystem recovery to pre-disturbance conditions, maintaining resiliency. "Press" disturbances are frequent or continuous, and don't allow sufficient time for recovery, reducing ecosystem resiliency. Management actions should be more pulse-like and less like a press to achieve PFCs.

- PFCs need to be developed for each spatial scale and then appropriate policies and practices established to meet them by identifying the appropriate fraction of the watershed that should be in "good" condition at any point in time and how each ecological condition moves across the landscape over time.

3. What is the scientific basis for the SAH Strategy?

(All points based on Reeves' response, except as noted.)

- The overall concept of identification and priority conservation of high quality habitat and areas important to fish is firmly grounded in principles of conservation biology. (NOAA Fisheries)

- SAH watersheds appear to have been selected using some primary conservation biology tenets: the premise that best remaining habitats for species of concern should be given high levels of protection in the short term; "do no harm" and "retain the pieces."

- Once lost, key ecological processes may be very difficult or impossible to recover. Repairing damage can be costly and not always successful; some impacts simply cannot be repaired or reversed.

- SAHs are often where the species' abundances are greatest or habitats are in better shape, so their protection benefits multiple species and has a high cost:benefit ratio for potential biological and ecological attributes.

- Several scientific papers have identified northern Oregon Coast watersheds that are priorities for protection and restoration as fundamental elements of proposals to conserve and recover salmonids. (NOAA Fisheries)

- Loss of these core areas from which other areas can be recolonized as conditions improve in the future would probably reduce the likelihood of species recovery. (NOAA Fisheries)

- A watershed perspective is needed to identify highly productive habitat patches, and assess connectivity between these areas and between fish population segments, so habitat conservation and restoration strategies are most likely to be effective if carried out at the watershed scale. (NOAA Fisheries)

- It appears that SAH management standards were designed to meet conservation biology premises, but it is not clear how successful these standards would be.

4. How does the SAH Strategy compare to state and federal aquatic and riparian strategies, and FPA rules?

- This question was mostly addressed by the ODF table comparing OFPA, FMP and SAH management standards.

5. Does the SAH strategy help or limit ODF in achieving the desired results of the FMP? Why?

- This question seems to hinge on which "result" of the FMP one is talking about. The FMP represents tradeoffs among several different desired results, some of which cannot be maximized concurrently. (Editor's Note: The Sessions/Overhulser modeling exercise sheds some light on these tradeoffs.)

6. To what extent does SAH Strategy effectiveness depend on other land ownerships in SAH watersheds?

- In the short-term, given the level of harvesting planned to address Swiss needle cast, there may not be large differences between state and private timberland management. (Dewberry)

7. Why focus on "healthy" stocks?

(All points based on Dewberry's response)

- Over the last 100 years salmonid numbers have steadily declined, with no evidence that management strategies and techniques employed have successfully halted these declines.

- Fishery managers largely focus on hatcheries as the primary management tool, assuming that artificial propagation could maintain or enhance fishery production even with large fish harvests and loss of habitat.

- Spending time and effort improving degraded habitats, and focusing on poor runs and maintaining them with hatchery fish have not halted salmon declines.

- Habitat restoration is expensive, may not succeed and if it does, may take decades to a century to accomplish.

- New paradigm emerged in late 1980's/early 1990's- protection of small amounts of remaining high quality habitat was cornerstone of salmon protection and recovery.

8. What alternatives to the SAH strategy may be available?

- SAH Strategy assumes that all parts of a watershed are not equally valuable for salmon production, therefore it is efficient and effective because it focuses on where the fish are now and what is critical to them now. (Dewberry)

9. ***Are there alternatives to the metapopulation theory?***

(All points based on Dewberry's response.)

- A metapopulation is a population consisting of many local populations occupying discrete suitable habitat patches surrounded by unsuitable habitat, with extinctions, and individuals that migrate/stray and recolonize local populations.

- Contrast metapopulation with the classical concept of population in which a group of individuals that share the same environment, interact equally with all other individuals. The population is closed to migration.

- Salmon are characterized by separate local populations (e.g. in different tributaries) in a dynamic landscape with periodic disturbances that may cause local extinctions and recolonization by individuals that stray during migration.

- Metapopulation theory has been formulated several ways and can be applied at a variety of scales. The theory is particularly applicable to understanding salmonid life histories, whereas classical population theory is not.

B. Regulatory and legal assurances and considerations, policy questions

1. How does the SAH Strategy relate or respond to Executive Order 99-01 to seek approval of an HCP?

(All points based on Whitlock's response)

- The ESA establishes criteria for issuing Incidental Take Permit (ITPs), but does not dictate contents of HCPs, which are typically developed via an iterative process in which the applicant crafts conservation strategies with the goal of obtaining federal approval and surviving judicial challenge.

- The NW Oregon State Forests Draft HCP has undergone many changes and refinements over several years, resulting from discussions with federal agencies, stakeholders, and scientists.

- The SAH Strategy is part of the FMP, which is in turn an important aspect of the state's proposal for obtaining an ITP via an HCP.

- FMPs are adopted as rules, and thus have the force of law unless and until modified by the Board of Forestry, or repealed by operation of some higher law.

- The SAH Strategy is not at this time being considered as an HCP strategy, but to the extent that it describes a conservation strategy supportive of the HCP/ITP effort, it is consistent with Executive Order 99-01.

2. To what degree would the SAH strategy elevate the stature of the Oregon Plan and the FMP in the eyes of NOAA Fisheries regarding "federal assurances" for the Oregon Plan and an HCP?

(All points based on NOAA Fisheries' response)

- In the northern Oregon Coast area, there is little Federal forest land with key watersheds managed under the NW Forest Plan to help conserve anadromous fish.

- Identification and management of SAHs offers an opportunity to provide needed landscape-scale conservation and restoration of fish habitat that complements the structure-based management approach for terrestrial species in the FMP.

- NOAA Fisheries supported the salmonid emphasis area concept (similar to SAHs) as an essential watershed scale element of the HCP in draft HCP negotiations.

- One of the most appropriate mechanisms for coverage of activities in SAHs under the ESA is probably issuance of an incidental take permit under ESA section 10 which would be issued upon completion of an HCP that would be negotiated between NOAA Fisheries and non-federal partners.

- SAHs could be an important conservation strategy, but they likely would be only one part of an overall HCP for forest management. It also may be possible to cover SAH activities through a section 4(d) limit.

- SAHs could also be incorporated as an important landscape scale conservation strategy in a recovery plan for Oregon coast coho salmon.

3. What, if any, level of increased regulatory certainty can Oregon expect from our federal partners if the SAH strategy is implemented?

(NOAA Fisheries)

- NOAA Fisheries can only address its authority under the ESA and cannot represent other Federal agencies.

- Regarding coverage from potential liability under the ESA, Oregon can expect increased ESA-related regulatory certainty if NOAA Fisheries qualifies a state program under one of the ESA regulatory mechanisms in sections 7, 4(d), and 10.

4. How have courts defined legal relationships between forest trust counties and the state in relation to management of state forest lands?

(All points based on Souder's response)

- The Supreme Court did not feel there was a contract or trust, but rather that statutes under which lands were transferred to the state defined the relationship.

- The Supreme Court stated that counties have a "protected, recognizable interest" in a portion of the proceeds from Chapter 530 lands located within their county.

- The Supreme Court made no determination as to whether the State is legally obligated to obtain county concurrence with any change in revenue distribution.

- The Supreme Court suggested that the state cannot take any actions with regard to Chapter 530 lands that would totally deprive a county of its right to revenue.

- The Supreme Court implied that some revenue reduction may be acceptable, or that a substitute form of compensation that would "protect" the county's "right to revenues" might be sufficient.

- Counties have concurred with past practice that revenue division formula changes in subsequent statutes were also retroactively applied to lands transferred previously, generally because it has been favorable towards them, either by increasing revenues they receive or because it allowed faster reforestation.

- Neither the statute, case law nor other materials reviewed suggest that the BOF must produce a certain *level* of revenue, or produce revenue from every acre.

5. What procedures were followed in developing the SAH Strategy and timber harvest levels?

- ODF has addressed, and will address this question.

6. What would be the benefits and/or costs of continuing the SAHs if the coho is delisted?

(Ian Whitlock)

- To the extent that the SAH Strategy describes a conservation strategy supportive of the HCP/ITP effort, it is consistent with Executive Order 99-01.

- A "conservative" strategy may be more likely to win federal approval, and to survive judicial review.

- The status of coho salmon is in flux. It is typical for multi-species HCPs to cover not only presently listed species, but candidates for listing too.

C. Silvicultural Issues and Strategies

1. How will Salmon Anchor Habitats be incorporated into and affect the Harvest and Habitat model?

(All points based on Sessions and Overhulsers' response)

- The Harvest and Habitat (H&H) team is updating the 1999-2000 ODF timber harvest model by incorporating: 1) more ODF district staff involvement, 2) new stand level inventory data, 3) yield projections of timber outputs, cash flows and forest structure, 4) a harvesting and roading plan, 5) harvesting prescriptions that better reflect ODF management; 6) a structure definition refined to include more stand level characteristics, and 7) the most current FMP/HCP strategies, including those for owls, murrelets, landscape design for complex structure, and SAHs.

- Preliminary modeling results suggest that SAHs can be implemented without harvest level impacts by shifting harvests to other areas, but with more clearcutting, and achievement of FMP forest structure goals 10 years later than a "no-SAH" strategy.

- Preliminary modeling results suggest that SAHs can be implemented with higher harvests for the first 10 years and achievement of FMP structure goals 10 years sooner, but with more clearcutting, declining harvests in the second 10 years and lower, but steadily rising harvests thereafter, compared to a "no-SAH" strategy.

- It is critical to pay close attention to relationships between forest structure and habitat goals, timber volume and revenue outputs, and timber even flow goals when examining modeling results and trying to optimize multiple forest values.

2. What are potential Swiss needle cast treatment alternatives?

(All points based on Kanaskie's response)

- Healthy Douglas-fir retains foliage for 4+ years; SNC damaged trees may retain only 1 year's needles, and grow ~50% less volume per year than a healthy tree, mostly in stem diameter.

- SNC silvicultural treatment alternatives depend on stand age and characteristics, e.g. *establishment* (0-10 years old), *young stands* (10-30 years old), and *mature* (>30 years old).

- Stand density, species composition, location (distance from coast, aspect, and elevation), SNC severity, original seed source, desired future condition or objectives for managing stands all affect SNC treatment choice.

- Two basic SNC strategies: 1) replace pure Douglas-fir with mixed species stands that may include Douglas-fir, and; 2) mitigate SNC effects in existing Douglas-fir
- Silvicultural tools: plant non-Douglas fir species, plant Douglas-fir with genetic tolerance to SNC, conserve established Douglas-fir that grows well despite SNC, pre-commercial thinning, commercial thinning, clearcutting or other regeneration harvest, fungicide or sulfur application, and doing nothing.

- Which tool or tools to use depends mostly on the current and expected severity of damage from SNC, stand age, and stand density.

- Early clear-cut harvest makes sense in pure Douglas-fir stands with severe SNC, but stands with 50%+ non-Douglas-fir species can be managed without clearcuts.

- Pre-commercial thinning (PCT) does not make SNC more severe; a current recommendation is to PCT stands early so crop trees retain deep crowns.

- PCT in severe SNC stands is recommended and helps trees grow better in the face of SNC, but growth will be inversely related to SNC damage severity.

- In mixed species stands, it often is not necessary to cut Douglas-fir because SNC puts them at a competitive disadvantage compared to other species.

- Evidence suggests that commercial thinning to increase stand volume growth and tree size may not be appropriate in severe SNC stands and in some moderately damaged stands, but there may be some value in thinning to shift species composition and select the best-performing Douglas-fir.

- Thinning is often necessary to create/maintain future options, even though short term response may not be attractive, because un-thinned 11-30 yr stands lose foliage from SNC and crowns recede from tree competition, slowing growth, decreasing wind firmness and destabilizing stands as density increases.

- Chlorothalonil fungicide (Bravo, Daconil) applied in May-June for several years can increase stand volume growth by up to 60% but costs ($150/acre/year) and environmental concerns have worked against its widespread use.

- An ongoing study will soon provide information about cost and effectiveness of sulfur for reducing damage from SNC and improving Douglas-fir volume growth.

- SNC does not usually kill trees, so Douglas-fir continues to occupy sites, but produces much less wood than either mixed species or healthy Douglas-fir stands.

- Doing nothing might be appropriate in a few cases, such as low stand density and an abundance of non-Douglas-fir species, but allowing severely damaged pure Douglas-fir stands to remain usually will not meet most management objectives.

- Suspect seed sources, used in many Tillamook Burn plantations, argue for regeneration harvest because trees may be poorly suited to the sites for reasons other than SNC, and are therefore at long-term risk of damage from other agents.

- On northern Coast range public lands, commercial thinning is the most widely used option for stands >30 yrs. Thinning does not make SNC worse, and stands will respond by increasing volume growth. If stands have moderate to light SNC and are not yet overly dense, commercial thinning makes sense.

- Uneven age silviculture, managing several age classes of various tree species, can be applied to SNC-damaged forests. Severe SNC damage likely would prevent Douglas-fir from being fully functional, but increased abundance of other species may provide long term benefits.

3. How are various landowners (federal, state, private) dealing with SNC?

(Kanaskie)

State Forests:

- Long-term strategy is to actively manage SNC damaged stands to reduce the amount and proportion of Douglas-fir and increase other native species not affected by SNC.

- Resulting stands reflect ecologically appropriate species mix, including western hemlock, western red cedar, true firs, Sitka spruce, and red alder. Planted Douglas-fir is genetically well adapted, from parents that exhibit SNC tolerance.

- Severe SNC stands are targeted for traditional clear-cut or harvests that leave up to 30 or more mature trees per acre, and replanting w/20% Douglas-fir and other ecologically appropriate species.

- Districts attempt to "take the worst first", but other resource and operational considerations also influence stand selection for treatment.

- Most Douglas-fir stands <12 years old and <18 miles from the coast have been inter-planted or re-planted with non-susceptible species. PCT in young stands with moderate-light SNC damage, but only as necessary in stands with severe SNC to improve spacing of non-Douglas-fir species.

- >25 years, stands with light SNC are thinned normally, moderate SNC stands are thinned lightly, favoring non-Douglas-fir species, and severe SNC stands are thinned only if they have a significant component of non-Douglas-fir species.

Private Landowners:

- On land with severe SNC, managers are replacing Douglas-fir with mixed species or single non-Douglas-fir species well suited to the specific site.

- Most common treatment of stands <10 years is to interplant with non-Douglas-fir species, e.g. hemlock, cedar or Sitka spruce, with or without chemical or mechanical control of competing vegetation.

- In young (11-30 yr) stands, commercial thinning or early clear-cut harvest is common. When growth has practically stopped because of severe SNC, stands may be clearcut at 25-35 years.

- Some companies aerially apply sulfur to reduce SNC damage and return Douglas-fir to more normal growth rates.

- Most companies manage on ~40 year rotations, so little thinning is done in mature stands with or without SNC.

Federal Lands:

- Much Northwest coast federal land is not intensively managed, allowing SNC to run its course. In stands with several species, SNC slows Douglas-fir and allows other conifers and hardwoods to flourish.

- On actively managed federal lands, the focus is on thinning, with very little regeneration harvesting. BLM and USFS pioneered species mixtures and inter-planting young stands in severe SNC areas near Tillamook and Hebo.

- BLM & USFS do not discriminate against Douglas-fir as a rule; rather they set stand structural and compositional targets according to the plant association of the area, to maintain a forest similar to what existed prior to human alteration.

- No federal agency uses fungicides, sulfur, or fertilizer to reduce SNC effects.

4. What affect would longer rotations have on stand structure, increase in fiber production, wood quality, and harvest output over longer time-frames?

(All points based on Radosevich response)

- Longer rotationsproduce larger/older trees, more wood of usually higher quality and provide attributes of big trees to forest structure and biodiversity.

- Young trees sometimes grow faster than older bigger ones, but not fast enough to make up for large tree size losses that occur even during several back-to-back short rotations.

- Projections based on theory suggest that if rotation age is cut by half timber production could fall by as much as four-fold. There is empirical evidence to support this.

- Rotation length probably has the largest effect of any silvicultural practice on wood quality because young logs have a higher proportion of juvenile wood and sapwood.

- Juvenile wood tends to be weaker; to shrink, swell, and warp more; to have shorter tracheids; to have lower wood density and pulp yield; to be more uniform across the growth ring; and to have wider growth rings and more frequent knots.

5. Are ODF's inventory of standing timber by species and age class based on accurate and ground-proofed surveys?

(All points based on Overhulser's response)

- In May 2002, ODF began inventorying 1000 stands/year out of 9000 total until all stands <8” dbh and 50% of stands >8” dbh have new stand level inventory (SLI). At that time inventorying will be reduced to a maintenance level of ~400/year.

- By May 2004, ~31% of ODF stands and 40% of acres will have new SLI. By May 2005, approximately 43% of stands and 56% of acres will have new SLI.

- The SLI system is designed to support a technique called “double sampling”. Rather than inventorying every stand, a portion of stands are measured and data from those stands is used to expand to similar stands that have not been measured.

- For several more years, some districts have chosen to continue using previous OSCUR (**O**wnership, **S**oils, forest **C**over, land **U**se, operation **R**ating) inventory to represent non-measured stands instead of an expansion from the new SLI.

- All stands in OSCUR inventory were measured earlier but in a variety of formats. Average time since OSCUR inventory was done on any stand is ~15 years. ~2/3 of stands were inventoried by installing plots or recording planting records, 1/3 of stands data was from walk-through observations.

- In some districts, 15 years of OSCUR inventory projected growth still gives a reasonable estimate of stand condition. On other districts original OSCUR data is insufficient for planning purposes.

D. Monitoring

1. What are possible approaches for monitoring the effectiveness of SAH Strategies?

(All points based on Larsen, except as noted)

- Monitoring approach should match that implemented under the Oregon Plan, modified and intensified to suit northwest Oregon forest conditions. (Moore)

- Monitoring effectiveness of SAHs should be based on objective of restoring key watershed processes, i.e. movement of sediment/organic matter through system. (Moore)

- Link monitoring to watershed conditions that support these processes - large conifers in riparian and upslope areas, nutrient dynamics, channel characteristics. (Moore)

- A key issue is whether changes/trends could be attributed to *natural* differences, or *management* differences between SAH and non-SAH watersheds.

- The extent to which indicators of habitat forming processes and salmon productivity reflect trajectories of underlying processes is a subject of ongoing technical discussion.

- Convene a technical workgroup to identify and evaluate natural differences between SAH and non-SAH systems, and extent to which these differences might affect potential differences in response between SAH and non-SAH systems.

- Evaluate extent to which past human management might account for SAH and non-SAH system differences that might affect their trajectories. Differential influence of hatcheries might be important here.

- Evaluate "implementation effectiveness": Are SAH and non-SAH systems being managed according to their specified management plans?

- Expected change/trend and necessary components of spatial and temporal variability are unknown for Tillamook/Clatsop systems, so it is necessary to a) evaluate extent to which variability estimated from other systems is relevant, and b) set up a monitoring network by which the variability can be estimated.

- To evaluate expected survival differences for SAH and non-SAH systems, run existing coastal coho survival models using appropriate controlling factors and their expected trajectories as input. Time frames are on the order of decades.

- Clearest estimate of freshwater salmon productivity is to evaluate the number of adults entering the system and the number of smolts exiting the system using traps at watershed outlets, an expensive proposition.

- More ambiguous approach is to monitor adult spawner numbers and numbers of resultant juveniles in SAH and non-SAH systems, and if this changes over time.

2. What is the appropriate time frame for monitoring SAH effectiveness?

(Larsen)

- Without a clear idea of expected magnitude of change, it is not possible to set an appropriate time frame for monitoring SAH effectiveness.

- Habitat and productivity are expected to respond slowly to SAH and non-SAH management actions, so it will be difficult to detect differences in just 10 years.

- Monitoring should measure responses ranging from a few years (protective riparian measures) to 20+ years (needed to evaluate coho population response).

- Big challenge will be to link appropriate time frames for evaluating environmental response to certainty of protective management in SAHs.

D. Costs and benefits, economic and social values of SAHs

1. If clear cut harvests are limited within SAHs and some planned harvests are moved elsewhere within Clatsop and Tillamook State Forests, what are the longer term implications for harvests from those areas and for overall harvest levels, given that SAHs expire in January 2013?

- Preliminary modeling results suggest that SAHs can be implemented without harvest level impacts by shifting harvests to other areas, but with more clearcutting over the first 10 years and achievement of FMP forest structure goals 10 years later than a "no-SAH" strategy. (Sessions/Overhulser)

- Preliminary modeling results suggest that SAHs can be implemented with higher harvests for the first 10 years and achievement of FMP structure goals 10 years sooner, but with more clearcutting over the first 10 years, declining harvests in the second 10 years and lower, but steadily rising harvests thereafter, compared to a "no-SAH" strategy. (Sessions/Overhulser)

- If overall cuts are the same, it may shift the fiscal impact from one county to another and shift it back to the other county later. (Radtke)

- Firms such as logging and milling services that add assessed value to tax bases may locate in one municipality or another to be closer to operations and markets. (Radtke)

- However, economic impacts (e.g. timber worker household income) flow to economic regions, generally defined by labor market areas, and Clatsop and Tillamook counties would be contained within the same region. (Radtke)

2. What are the costs of SAHs to counties and the state in terms of revenue impacts?

- Preliminary modeling results suggest that revenue can be increased over the next 35 years and SAHs can be implemented, but with achievement of FMP forest structure goals 10 years later, compared to a "no-SAH" strategy. (Sessions/Overhulser)

- Preliminary modeling results suggest that revenue can be increased for the next 10 years, FMP structure goals can be achieved 10 years sooner, and SAHs can be implemented, but with declining revenue 10-20 years in the future and lower, but steadily rising revenue thereafter, compared to a "no-SAH" strategy. (Sessions/Overhulser)

- Statutes have changed revenue flow structure. For counties, timber receipts for schools become an offset (revenue neutral) but at the state level may become a substitute for other revenue generating opportunities. (Radtke)

3. What are the benefits of SAHs in terms of market and non-market values?

- SAHs may help support a host of market and non-market, active and passive use, on-site and off-site, non-timber benefits. (Rosenberger)

- *Active use* value is derived from actively using a resource, *on-site* or *off-site* (Rosenberger)

- *On-site* and *off-site* values can be derived from *consumptive* resource use or derived from *non-consumptive* use. (Rosenberger)

- People also may derive value based on *passive* resource uses. All passive use values accrue to people off-site and are non-consumptive. (Rosenberger)

- *Option value* is the passive use value a person places on retaining the option to actively use the resource sometime in the future. (Rosenberger)

- *Bequest value* is the passive use value a person derives from knowing that a resource exists for future generations' active or passive uses. (Rosenberger)

- *Existence value* is the passive use value a person derives from knowing that a resource exists in the future, independent of any current or future use, most often expressed for scarce environmental resources such as endangered species or remnant wild natural landscapes such as old growth forests or wilderness areas. (Rosenberger)

- The marginal market and non-market value of SAHs relative to other management alternatives is an empirical question that would require significant time and funding to answer. However, there are several benefits to consider including:

- On-site recreation; mental, physical and/or spiritual regeneration, some timber harvesting, and collection of non-timber resources. (Rosenberger)

- Off-site hunting, ocean-harvested fish, and other recreation benefits, scenic viewsheds, enhanced property values, and help attract economic growth to nearby areas. (Radtke, Rosenberger)

- Livability and quality of life. (Radtke, Rosenberger)

- Community benefits via recreation and tourism-based or resource extraction-based jobs, and other contributions to the quality of a place to live and/or do business. (Rosenberger)

- Scientific values of SAHs in the form of research areas, educational tools, and evaluation of management outcomes. (Rosenberger)

- Biodiversity and genetic conservation benefits, and non-consumptive animal and plant uses via wildlife viewing and nature photography. (Rosenberger)

- Ecological services such as watershed protection, nutrient recycling and carbon storage. (Rosenberger)

- Scarcity or abundance of other natural areas with similar features and recreation opportunities would affect the overall value of SAHs. (Rosenberger)

- Externalized costs (e.g. lower water quality, biodiversity/habitat loss) may add significantly to good/service production costs, but are often not counted. (Radtke)

4. What are the economic affects of ODF's proposed harvest increases over the long term compared with harvesting on a longer rotation?

- If only financial returns are considered, 35-40 year rotations would be optimal, but business return considerations are generally secondary to other benefits from public lands such as Tillamook/Clatsop State Forests. (Radtke)

- Longer rotations can still provide significant financial returns.

5. Are there alternative forest management prescriptions that could be applied to the SAH areas that will protect key habitats and processes, as well as provide greater timber revenues over a longer time frame than can be obtained by the short term high harvest regime currently in operation?

- Rotation age has been declining, suggesting that from a business standpoint, shorter rotations are preferable. (Haynes)

- Silviculturists often favor a rotation age of ~80 years, the culmination of mean annual increment for Douglas fir. (Haynes)

- Longer rotations, as opposed to shorter ones, produce larger/older trees, more wood of usually higher quality and provide attributes of big trees to forest structure and biodiversity. (Radosevich)

- Young trees sometimes grow faster than older bigger ones, but not fast enough to make up for large tree size losses that occur even during several back-to-back short rotations. (Radosevich)

- Projections based on theory suggest that if rotation age is cut by half, e.g. from 100 to 50 years, timber production could fall by as much as four-fold. There is empirical evidence to support this. (Radosevich)

- At 4% interest (net of inflation), there are positive returns for 40, 80 and 160-year rotations but considering the value of each as a perpetual periodic annuity, and under fully stocked stand conditions, the value of the 40-year rotation is more than 400 times that of the 160-year rotation. (Haynes)

- Externalized costs (e.g. lower water quality, biodiversity/habitat loss) may add significantly to good/service production costs, but are often not counted. (Radtke)

Salmonid Status, Science, Protection, Recovery: Dr. Gordon Reeves

"What are the historic trends and cycles of North Coast salmonids? What factors influence these trends?"

Little is known about the historic (which I assume is pre-European settlement) trends and cycles of salmonids of the North Coast, or any other part of Oregon. Historic numbers of coho salmon for larger systems have been estimated using cannery records (Mullen 1981, Lichatowich 1989). However, it is not possible to discern variation in numbers or survival from these data.

Variation in numbers and survival of Oregon coast salmonids are strongly influenced by conditions in the ocean and freshwater. Ocean conditions for anadromous salmonids in Oregon are variable. Oregon is at the oceanic boundary (Fig. 1) between cool, nutrient-rich currents and warm, nutrient-poor currents. Ocean productivity, which strongly influences ocean survival (Nickelson 1986), depends on the location of this boundary.

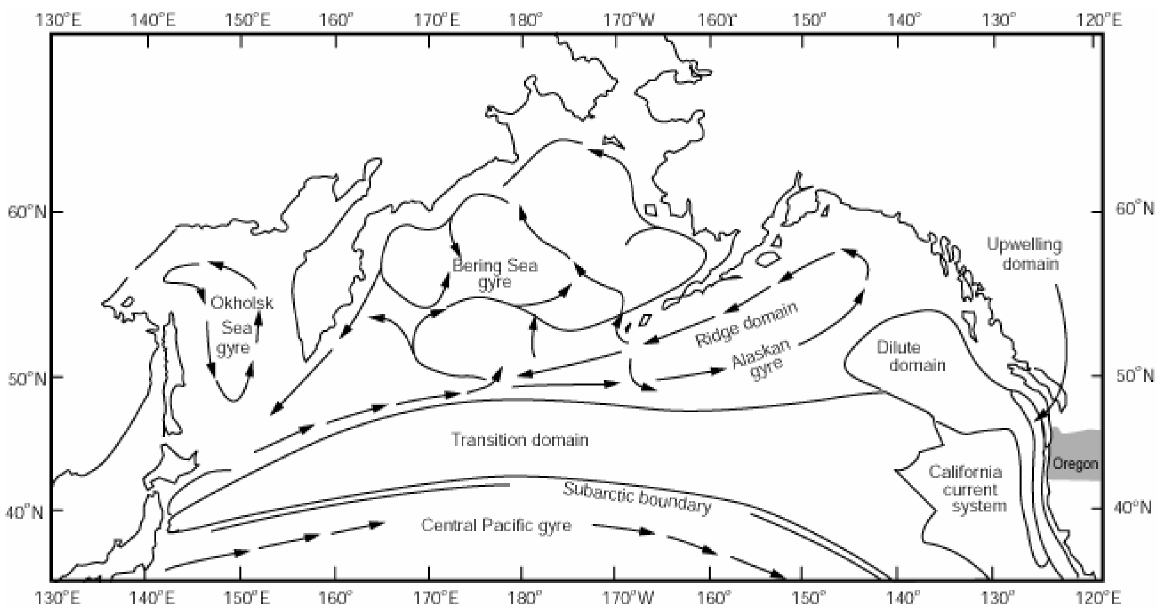


Figure 1. Location of Oregon relative to ocean transition zone between northern cool, nutrient rich currents and southern warm, nutrient, poor currents (from: Fulton and La Brasseur 1985).

During productive years, which are generally associated with a weak winter Aleutian low-pressure system (Hare et al. 1999), nutrient-rich currents move south towards the Oregon Coast. Survival may reach 12% or more during such times (Nickelson and Lawson 1998). The boundary shifts northward during a strong winter Aleutian low-pressure system and ocean productivity off of Oregon declines. Ocean survival during such times may be less than 1%

(Nickelson and Lawson 1998). This pattern of high and reduced ocean productivity generally occurs on a 20-30 year cycle (Mantua et al. 1997). The last extended period of favorable ocean conditions off of Oregon occurred from 1947 to1976 (Miller et al. 1994); less productive conditions occurred from 1925 to 1946 and have been prevalent until the last few years since 1977. This cycle may result in a 10 or more-fold in variation of numbers and survival of anadromous salmonids in Oregon.

Since 2001, the number of salmonids returning to streams in coastal Oregon have increased compared to the previous years. An example of this for coho salmon is shown in Fig. 2.

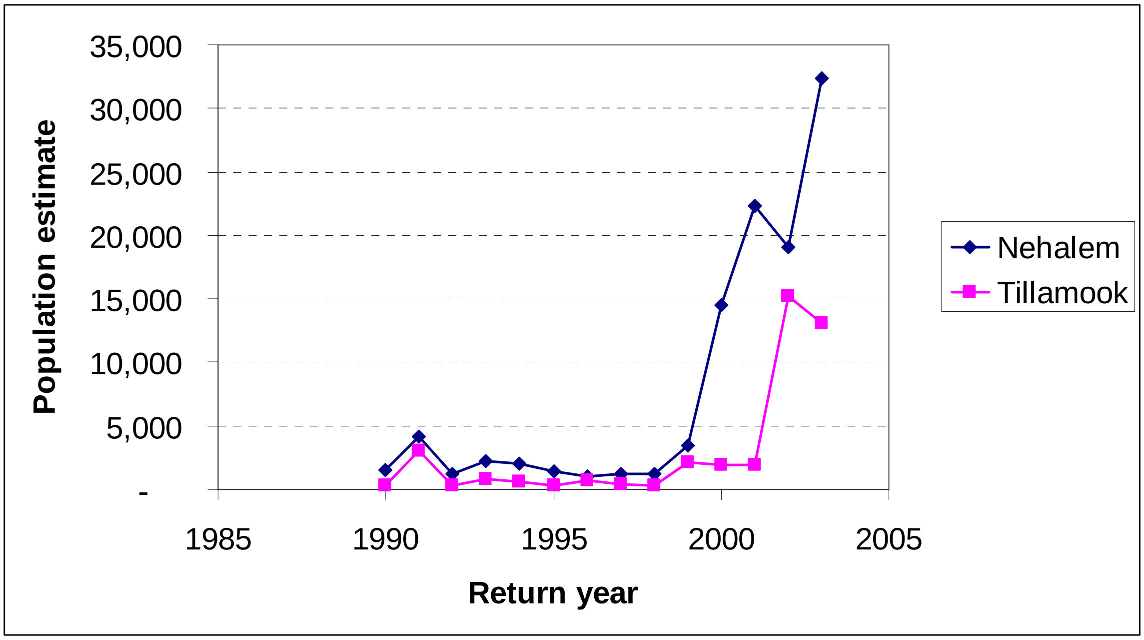


Figure 2. Estimated number of wild coho salmon in the Nehalem and Tillamook Rivers, Oregon since 1990. (Source: T. E. Nickelson, Oregon Dept. of Fish and Wildlife, Corvallis.)

This upswing in numbers is attributed primarily to the presence of favorable ocean conditions. Similar increases were observed in spring chinook salmon returning to the Columbia River during the same time and numbers were expected to be high this year. However, the run appears to be only about one-third of what was predicted. It is not clear whether the pattern of favorable ocean conditions for Oregon coast salmonids will persist for an extended time or whether the pattern of the last few years was simply an anomaly.

(Note: Lawson et al. (draft) estimated that the historical abundance in the Nehalem and Tillamook basins during years of favorable historical conditions were about 200,000 in each system. Lichatowich (1989) estimated the numbers to be 240,000 for the Nehalem and and 292,500 for the Tillamook.)

The scarcity of larger, complex estuaries probably also influenced the numbers and survival of anadromous salmonids in coastal Oregon. Estuaries are sites of early marine growth, an important determinant of ocean survival (Pearcy 1992). They may be particularly important during times of low ocean productivity.

The quantity and quality of freshwater habitat influences the numbers and survival of anadromous salmonids in coastal Oregon. The degree of influence varies among species. It is relatively small for species like pink and chum salmon, which spawn low in the river network and spend very little time in freshwater before migrating to the salt water. Species that spend extended periods in freshwater, like coho salmon and steelhead are more influenced.

The amount of habitat directly influences the number of fish that are produced. In all areas of the Oregon coast, the amount of habitat for anadromous salmonids is much less than it was historically (Reeves et al. 2002). Physical habitats in rivers and streams of all sizes have been altered and simplified by past and recent activities. The extent of historical alterations is not generally appreciated. This is especially true for lower portions of the stream network in all systems, including those in the Tillamook area. Historically such areas were the sites of major production of coho salmon. These areas were drained and diked to allow for the establishment of residences and agricultural and other businesses, flood control, and navigation.

Habitat quality also influences fish numbers and survival. Habitat quality consists of two components: (1) the diversity of habitat types, and (2) the complexity of conditions in the habitat. The former is important for providing habitat for a range of species and for the seasonal needs of a given species. The latter provides for protection from predators (Wilzbach 1985) and serves to moderate social interactions among individuals of the same species (Fausch and White 1981) and thus increase the number of individuals in a given area (Lonzarich and Quinn 1995, Cederholm et al. 1997). Decreases in habitat complexity can directly influence the number and survival of salmonids. For example, the number of chum salmon in Carnation Creek, B.C. decreased when the amount of fine sediments increased following logging. This reduced the quality of spawning gravels and ultimately the survival of developing eggs (Scrivener and Brownlee 1989). Steelhead and cutthroat trout numbers in Carnation Creek declined also (Hartman 1988). The reason for this was the filling in of off-channel habitat.

It is difficult to determine if ocean conditions or freshwater habitat is or was most important for the persistence of salmonids populations in the Oregon Coast, and the North Coast specifically. Designing studies to ascertain which factor is most important is virtually impossible; the problem is just too complex for us to deal with given our current level of understanding. However, I believe that a strong argument can be made that the freshwater environment is relatively more important in coastal Oregon. First, the combination of highly variable ocean conditions and scarcity of well-developed estuaries in coastal Oregon make marine survival problematic. Second, freshwater habitat conditions can potentially buffer the effects of variable ocean conditions.

Nickelson and Lawson (1998) used models to examine the relation between ocean conditions, habitat conditions, and viability of coho salmon populations in coastal Oregon. They found that the better the condition of the freshwater habitat the lower the rate of extinction of the population under variable ocean conditions. Lawson (1993) argued that continued survival of populations through subsequent episodes of low ocean survival is dependent on increased freshwater survival. Third, a key factor that influences marine survival is the size of fish at ocean entry (e.g., Ricker 1962, Bilton et al. 1982); the larger the fish the better the survival. Therefore to maximize the potential for survival anadromous salmonids in coastal Oregon, a fish needs to be as large as possible when entering the ocean. Thus, anadromous salmonid populations in coastal

Oregon are relatively more dependent on the freshwater habitat for their long-term survival and persistence. In more northerly areas (i.e., B.C. and Alaska) where ocean conditions are frequently more favorable and estuaries more abundant, the relative importance of freshwater habitat is likely less than it is in Oregon.

"How should the FMP define 'properly functioning aquatic habitats'?"

Our understanding of what constitutes "properly functioning aquatic habitats" for anadromous salmon and trout is continually evolving. The primary focus of properly functioning habitats has been, and in many cases still is, on relatively small spatial scales, such as habitat units (Bisson et al. 1982, Nickelson 1992) and reaches (Murphy and Koski 1989). Numeric standards for individual components (e.g., number of pools, pieces of wood, etc.) have been developed based on conditions in "unmanaged" or "minimally disturbed" areas. These standards are then used to define properly functioning.

The necessity to recover the freshwater habitats of anadromous salmonids with low or declining population numbers is changing this approach, however. A variety of sources, including interested publics, interest groups, scientific review and evaluations teams (e.g., National Research Council 1996, IMST 1999), regulatory agencies, and policy- and decision-makers, are calling for development of policies and practices that integrate management of habitat for at-risk salmon and trout across a suite of spatial scales- habitat, watershed or ecosystem, and landscape. I believe that instead of referring to properly functioning aquatic habitats that we should be defining properly functioning aquatic conditions (PFCs) for all the scales of interest.

Defining PFCs for each scale is tremendously challenging. Aquatic scientists have only limited experience at the watershed/ecosystem scales and are just beginning to work at the landscape. Consequently, responsible agencies are struggling to develop appropriate and applicable definitions of standards for PFCs.

A key to defining PFCs is to be able to identify and delineate the unit of interest and to recognize that they are different entities with their own properties and management requirements. However, often this has not been done. For this paper, I define the various spatial units in the following ways. Habitats include individual units, such as a pool or riffle, and reaches, which is a collection of habitat units in a uniform geomorphic setting (e.g., low gradient, wide valley floor or high gradient, narrow valley floor). Habitat units range in size from 10 feet to 100 feet or more. Reaches may be several hundred to a thousand or more feet. Ecosystems are vague entities with boundaries that shift in space and time (Carahar et al. 1999). I consider the spatial scale of the ecosystem to be a watershed that is a 6^{th} of 7^{th} code hydrologic unit (HUC), which is consistent with the definition of Hunter (1996). A landscape is a mosaic or collection of ecosystems (Hunter 1996) that occupy a relatively large area ($2.5X10^5$ –$1.5X10^7$ acres; Concannon 1999). Multiple watersheds that are contiguous are considered a landscape.

I believe that properly functioning condition of any spatial scales implies that the scale is operating within or near its range of natural variability (RNV). RNV is the range of conditions that a particular spatial scale experiences naturally over an extended time period, several decades to centuries. It is often expressed for individual components of the scale, such as number of pieces of large wood or number of pools at the habitat scale or for ecological states at the watershed scale. The usual manner for establishing the RNV for a parameter is to measure the parameter in a number of pristine systems (i.e., systems having little of no history of impact from human activities) that are at different points in time from a major disturbance. RNV is represented by the range or statistical distribution of these values. This is well established for terrestrial systems, such as early-, mid-, and late-successional (e.g., Wimberly et al. 2000) but not nearly well or widely recognized for aquatic ecosystems. Studies examining these variations in aquatic systems are scarce. Reeves et al. (1995) describe the RNV of ecological states of aquatic ecosystems in the sandstones of the central Oregon coast. (See more detailed description of this later). May (2001) did this for headwater streams in the same region.

We may not be able to use estimates of RNVs from natural systems in many circumstances. Many areas have been extensively altered by human activities and as a result key ecological processes are likely to be compromised or eliminated. This makes the expression of RNV impossible. In such situations, RNVs need to be established that encompass the range of conditions that need to be expressed through time to support the organisms or goals for the area. RNVs can be established using empirical evidence or through the use of models that compare natural and managed systems.

Spatial scale is an important element of RNV that is seldom recognized when RNVs are discussed or developed. RNV is inversely related to spatial scale (Wimberly et al. 2000). The smaller the spatial scale, the larger the RNV and, conversely, the larger the scale the smaller the RNV. Hierarchy theory provides the rationale for this relation and is an appropriate framework for considering resource issues at and between different spatial scales (Overton 1977). Each level within the hierarchy of scale has unique properties and behaviors that are expressed over time. The properties of lower levels of organization are "averaged, filtered, and smoothed" as they are aggregated at higher levels of organization (O'Neill et al. 1986). Consequently, the range and variability in the properties and conditions of the system are relatively wide at lower levels of organization compared to higher levels (Wimberly et al. 2000).

Wimberly et al. (2000) illustrated this for various successional stages of vegetation in the Oregon Coast Range. They estimated (based on model of fire frequency and intensity and vegetation response over 3000 years) that at the scale of late successional reserves (~16,000 acres) the range in the amount of old-growth was from 0 to 100%. For an area of ~130,000 acres, or roughly the size of a national forest, the RNV for old-growth was from approximately 10 to 75%. The RNV for the Coast Range (~1,000,000 acres) was 30-55%.

The following can be used to help further explain the reason for the relation between RNV and spatial scale. Assume that a person is suspended in a balloon above a given area in the Oregon Coast Range for several decades to centuries and is able to observe the changes in the age of trees, similar to what Wimberly et al. (2000) did with their model. There is a very high likelihood that a site will be disturbed at some point in time by wildfire, a windstorm, or other infrequent disturbance event. Immediately following the event there will be few or no older trees; most will have been killed by the event. Assuming that the next large disturbance event will not occur for some time, new trees will grow and eventually the entire area will be covered with old trees. The RNV for old-growth is 0 to 100% at this scale.

A different pattern would be observed if the balloon was suspended at a higher altitude and a larger area was observed. The large, infrequent disturbance events generally affect relatively small portions of the landscape at any one time. It is, therefore, very unlikely that the entire area being observed would be affected by a disturbance event at the same time. The asynchronous nature of the disturbance events results in a series of patches of vegetation of different ages. This narrows the RNV because of the reduced likelihood of finding the extreme condition of the entire area either having no old-growth or it being all old-growth at any point in time. The RNV is further reduced at larger spatial scales because disturbance events are even more desynchronized.

The following is an illustration of the concept of the RNV for different scales for aquatic systems in the central Oregon Coast. Reeves et al. (1995) examined three watersheds that were at different points of time from the last major wildfire and catastrophic hillslope failure. The values presented for various parameters could be used to describe the RNV at the site or reach scale, which varied widely. For example, the amount of gravel observed varied from 10% in the system that was the longest in time away from the disturbance (>300 years) to 70% in the most recently disturbed (80-100 years) among the systems. Overall watershed conditions for fish ranged from poor in the most recently (i.e., large amounts of sediment, small amounts of wood, and few pools) and least recently i.e., little or not gravel, large amounts of wood, and few pools) disturbed to very good (intermediate amounts of sediment and wood and many pools) in the system that was an intermediate time since the last major disturbance (160-180 years). Reeves (unpublished data) reported that at the scale of the central Oregon coast, on average 60% of the watersheds were in "good" condition for fish at any point in time prior to extensive human activity. This estimate was based on the work of Benda (1994) and Reeves et al. (1995) and represents the average RNV value for the larger area.

Understanding the relation between different spatial scales is imperative to successfully assess the effects of management policies and activities in aquatic systems in the future. Failure to articulate or recognize this relation contributes to the often intense and divisive debate about management policies and practices and impedes development of viable options for managing aquatic ecosystems. Shifting the focus to landscape levels will require recognition of hierarchy theory principles and the relation among levels of organization if future management and assessment policies are to be successful.

Focusing policies for and management of aquatic ecosystems at the landscape scale will present challenges to policymakers, managers, and regulators. One major task will be to understand how the condition of aquatic ecosystems varies through time at all spatial scales and the ecological, social, and economic implications of this variation. Currently, the natural range of the condition of aquatic ecosystems is assumed to be small and to generally be good with regards to habitat. This condition is expected to be relatively constant through time and to be present on all systems at the same time. Assuming that this expectation can simply be applied higher spatial levels is responsible for the current situation.

Establishing and developing management programs for PFCs needs to address the dynamics of individual ecosystems, the external factors that influence ecosystems that comprise the landscape, and the dynamics of the aggregate of ecosystems. Obviously, understanding the dynamics of an individual ecosystem is demanding. Understanding the dynamics of the aggregate of ecosystems is much more challenging (Concannon et al. 1999). Although a dynamic perspective of aquatic ecosystems is not widely held in the scientific community, the number of proponents is growing steadily (Minshall et al. 1989, Reeves et al. 1995, Benda et al. 1998). To establish a dynamic landscape perspective, the RNV must be characterized at different spatial scales.

Applying the concepts of RNV and PFCs to aquatic systems requires having a dynamic rather than a static view of aquatic systems. However, a dynamic perspective is not widely done at present. One of the main reasons is that the primary foundations for understanding aquatic systems, such as the River Continuum Concept (Vannote et al. 1980) and classification systems (e.g., Rosgen 1994) do not recognize changes over time.

In contrast, the foundation and principles for managing terrestrial systems and biota at the ecosystem and landscape levels are much more developed than they are for aquatic systems and readily recognize time and change. Major paradigms of ecosystem management include (Lugo et al. 1999):

- Ecosystems are not steady state but are constantly changing through time.
- Ecosystems should be managed from the perspective of resilience, as opposed to stability.
- Disturbance is an integral part of any ecosystem and is required to maintain ecosystems.

Ecologists (Holling 1973, White and Pickett 1985) and managers recognize the dynamic nature of terrestrial ecosystems and how the associated biota and physical characteristics change through time. They are also aware that the range of conditions that an ecosystem experiences is determined to a large extent by the disturbances it encounters (e.g., wildfire, hurricane, timber harvest). Resilience is the ability of the ecosystem to recover to pre-disturbance conditions following a disturbance (Lugo et al. 1999). This does not imply that the return to pre-disturbance condition is immediate or even in a short time. It may take extended time for this to happen depending on the system. Reduced resilience results in a decrease in the diversity of conditions of a particular ecological state or the loss of a particular state, or both (Lugo et al. 1999). Biological consequences of reduced resilience may include extirpation of some species, increases in species favored by available habitats, and an invasion of exotic species (Levin 1974, Harrison and Quinn 1989, Hansen and Urban 1992).

The key to maintaining aquatic systems at all levels of organization within some desired or accepted RNV is making management-related disturbance resemble natural disturbances as closely as possible. Yount and Niemi (1990) modified the definition of Bender et al. (1984) and referred to a disturbance regime that maintains the resiliency of an ecosystem as a "pulse" disturbance. A pulse disturbance occurs infrequently, and there is sufficient time between disturbances to enable the ecosystem to recover to pre-disturbance conditions. A pulse disturbance allows an ecosystem to remain within its normal bounds and to exhibit the range of states and conditions that it does naturally. A "press" disturbance, on the other hand, reduces resiliency of an ecosystem. A press disturbance is a frequent or continuous impact that does not allow time for recovery to pre-disturbance conditions.

The legacy or the material remaining after a disturbance also influences ecosystem resiliency (Reeves et al. 1995). These materials, which include wood and sediment, influence the potential future response of the system. Systems with standing trees and downed wood following a wildfire will have more complex and diverse conditions than those without. In aquatic systems, those that have wood and sediment introduced from a disturbance will form more complex habitat than only when sediment is delivered.

The less management actions resemble the disturbance regime under which the ecosystem evolved, the less resilient the ecosystem will be. The obvious challenge is make management actions resemble the natural disturbance processes and regime as closely as possible. Management actions should be more pulse-like and less like a press to achieve PFCs.

Properly functioning conditions at the landscape scale entail maintaining a variety of ecological states in some desired spatial and temporal distribution. To do this, landscape management should consider the:

- development of a variety of conditions or states in individual ecosystems within the landscape at any point in time
- pattern resulting from the range of ecological conditions that are present (Gosz et al. 1999)

The other challenge to developing PFCs at the landscape scale is to then determine

Focusing on the landscape requires an understanding that conditions in aquatic systems vary over time at each spatial scale. It also requires that appropriate goals and objectives be established for the landscape. In the case of aquatic ecosystems and watershed, this will require identifying what is the appropriate fraction of the watershed that should be in "good" condition at any point in time and how each ecological condition moves across the landscape over time. Also, it requires the articulation of policies that recognize the dynamic nature of aquatic ecosystems and describe practices that allow the systems to express a range of desired conditions over time.

In summary, there is no single value of properly functioning conditions. PFCs need to be developed for each spatial scale and then the appropriate policies and practices established to meet them. It will require that aquatic systems be viewed as dynamic entities that will change through time in response to periodic disturbances. Management practices and programs need to resemble natural disturbances as closely as possible in order to increase the likelihood of developing conditions at all spatial scales that will support viable populations of salmon and trout. The movement to ecosystem and landscape management for aquatic systems requires articulation of principles and a conceptual basis to the guide the development of policies and practices. However, there is little in the scientific literature to help with this. This requires the development of well designed large scale experiments to evaluate the effects of proposed management policies and to generate the knowledge to establish and refine PFCs.

"What is the scientific basis for the SAH Strategy?"

The Salmon Anchor Habitat (SAH) approach appears to have been developed using some of the primary tenants of conservation biology. One premise of conservation biology is that remaining best habitats for species or multiple species of concern should be given high levels of protection in the short term (McGurrin and Forsgren 1997). My impression is that this is the rationale for the selection of the watersheds in the SAH approach. These areas are often where the species' abundances are greatest or habitats are in better shape. Their protection thus benefits multiple species and has a high cost:benefit ratio for potential biological and ecological attributes (Frissell 1996). These areas may also be cores from which other areas can be recolonized as conditions improve in the future. Loss of these areas will likely reduce the likelihood of recovery of the species.

The second premise is "to do no harm" and to "retain the pieces". This means preventing initial degradation of habitat and ecological processes that create and maintain habitat, which is more prudent and economical than restoration (Toth et al. 1997). Repairing damage can be costly and is not always successful; some impact simply cannot be repaired or reversed. Key ecological process may be very difficult or impossible to recover once they are lost. It appears that proposed special management directions and activities of the SAH approach are designed to meet this premise. However, it is not clear how well these directions and activities will meet this premise.

Literature Cited (Reeves)

Benda, L.E. 1994. Stochastic geomorphology in a humid landscape. Ph.D. disseration. University of Washington, Seattle, Washington.

Benda, L.E., D.J. Miller, T. Dunne, G.H. Reeves, and J.K. Agee. 1998. Dynamic landscape systems. Pages 261-288. *in* R.J. Naiman and R.E. Bilby, editors. *River ecology and management: lessons from the Pacific Coastal ecoregion.* Springer, New York.

Bender, E.A. and others. 1984. Perturbation experiments in community ecology: theory and practice. Ecology 65:1-13.

Bilton, H.T., D.F. Alderdice,a nd J.T. Schnute. 1982. Influence of time and size of release of juvenile coho salmon (Oncorhynchus kisutch) on returns at maturity. Canadian Journal of Fisheries and Aquatic Sciences 39:426-447.

Bisson, P.A. and others. 1982. A system for naming habitat types in small streams, with examples of habitat utilization by salmonids during low stream flow. Pages 62-73. *in* N.B.Armantrout, editor. Acquisition and utilization of aquatic habitat inventory information. Western Division, American Fisheries Society, Portland, OR.

Carahar, D.L. and others. 1999. Scales and ecosystem analysis. Pages 343-352. *in* R.C. Szaro and others, editors. Ecological stewardship: a common reference for ecosystem management, Vol. II. Elsevier Science, Ltd., Oxford, U.K.

Cederholm, C.J. and others. 1999. Response of juvenile coho salmon and steelhead to placement large woody debris in coastal Washington streams. North American Journal of Fisheries Management 17:947-963.

Concannon, J.A. and others. 1999. Describing landscape diversity: a fundamental tool for landscape management. Pages 195-218. *in* R.C. Szaro and others, editors. *Ecological stewardship: a common reference for ecosystem management, Vol. II*. Elsevier Science, Ltd., Oxford, U.K.

Fausch, K.D. and R.J. White.1981. Competition between brook trout (*Salvelinus fontinalis*) and brown trout (*Salmo trutta*) for position in a Michigan stream. Canadian Journal of Fisheries and Aquatic Sciences 38:1220-1227.

Frissell, C.A. 1996. A new strategy for watershed protection, restoration, and recovery of wild native fish in the Pacific Northwest. Pages 1-25. *in Healing the Watershed*, Second Edition. The Pacific Rivers Council, Eugene, OR.

Gosz, J.R. and others. 1999. An ecosystem approach for understanding landscape diversity. Pages 157-194. *in* R.C. Szaro and others, editors. *Ecological stewardship: a common reference for ecosystem management, Vol. II*. Elsevier Science, Ltd., Oxford, U.K.

Hansen, A.J. and D.L. Urban. 1992. Avian response to landscape patterns: the role of species life histories. Landscape Ecology 7:163-180.

Hare, S.R. and others. 1999. Inverse production regimes: Alaska and west coast Pacific salmon. Fisheries 24(1):6-14.

Harrison, S. and J.F.Quinn. 1989. Correlated environments and the persistence of metapopulations. Oikos 56: 293-298.

Hartman, G.F. 1988. Preliminary comments on results of studies of trout biology and logging impacts in Carnation Creek. pp. 175-180. *in* T.W. Chamberlain, editor. Proceedings of the Workshop Applying 15 years of Carnation Creek Results. Carnation Creek Steering Committee, Nanaimo, B.C.

Holling, C.S. 1973. Resilience and stability of ecological systems. Annual Review of Ecological Systems 4: 1-23.

Hunter, M.L. 1996. *Fundamentals of Conservation Biology*. Blackwell Science, Cambridge, MA.

Lawson, P.W. 1993. Cycles in ocean productivity, trends in habitat quality, and the restoration of salmon runs in Oregon. Fisheries 18(8):6-10.

Lawson, P.W. and others. Draft. Identification of historical populations of coho salmon (*Oncorhynchus kisutch*) in the Oregon Coast evolutionarily significant unit. Comanagers draft ONCC-TRT. NOAA/NMFS/NWFSC. Newport, OR. 123 p.

Levin, S. 1974. Dispersion and population interactions. American Naturalist 108: 207-228.

Lichatowich, J.A. 1989. Habitat alteration and changes in abundance of coho (*Oncorhynchus kisutch*) and chinook salmon (*O. tshawytscha*) in Oregon's streams. Pages 92-99. in C.D. Levings and others, editors. Proceedings of the national workshop on effects of habitat alteration on salmonid stocks. Canadian Special Publication of Fisheries and Aquatic Sciences 105.

Lonzarich, D.G. and T.P. Quinn. 1995. Experimental evidence for effect of depth and structure on the distribution, growth, and survival of stream fishes. Canadian Journal of Zoology 73:2223-2230.

Lugo, A.E. and others. 1999. Ecosystem processes and functioning. Pages 219-254. *in* R.C. Szaro and others, editors. *Ecological stewardship: A common reference for ecosystem management, Vol. II*. Elsevier Science, Ltd., Oxford, U.K.

May, C. 2001. Spatial and temporal dynamics of sediment and wood in headwater streams in the central Oregon Coast Range. Ph.D. dissertation. Oregon State University, Corvallis, Oregon.

McGurrin, J. and H. Forsgren 1997. What works, what doesn't, and why. Pages 459-471. *in* J.E. Williams and others, editors. *Watershed Restoration: Principles and Practices.* American Fisheries Society, Bethesda, MD.

Miller, A.J. and others. 1994. The 1976-77 climate shift in the Pacific Ocean. Oceanography 7:21-26.

Minshall, G.W. and others. 1989. Wildfires and Yellowstone's stream ecosystems. BioScience 39: 707-715.

Mullen, R.E.1981. Estimates of historical abundance of coho salmon *Oncorhynchus kisutch* (Walbaum) in Oregon coastal streams and in the Oregon Production Index area. Oregon Dept. of Fish and Wildlife, Fish Division. Information Report 81-5.

Murphy, M.L. and K.V.Koski. 1989. Input and depletion of woody debris in Alaska streams and implications for streamside management. North American Journal of Fisheries Management 9:427-436.

Nickelson, T.E. and others. 1992. Seasonal changes in habitat use by juvenile coho salmon (Oncorhynchus kisutch) in Oregon coastal streams. Canadian Journal of Fisheries and Aquatic Sciences 49: 783-789.

Nickelson, T.E. 1986. Influences of upwelling, ocean temperature, and smolt abundance on marine survival of coho salmon (*Oncorhynchus kisutch*) in the Oregon production area. Canadian Journal of Fisheries and Aquatic Sciences 43:527-535.

Nickelson, T.E. and P.W. Lawson 1998. Population viability of coho salmon (*O. kisutch*) in Oregon coastal basins: application of a habitat-based life history model. Canadian Journal of Fisheries and Aquatic Sciences 55:2383-2392.

O'Neill, R.V., D.L. DeAngelis, J.B. Waide, and T.F.H. Allen. 1986. A hierarchical concept of ecosystems. Monographs in Population Biology 23. Princeton University Press, Princeton, New Jersey.

Overton, W.S. 1977. A strategy for model construction. Pages 50-73. *in* C.A.S. Hall and J.W. Day, editors. *Ecosystem modeling in theory and practice: an introduction with case histories.* John Wiley and Sons, New York.

Pearcy, W.G. 1992. *Ocean Ecology of North Pacific Salmonids*. University of Washington Press, Seattle.

Reeves, G.H., K.M. Burnett, and S.V. Gregory. 2002. Fish and aquatic ecosystems in the Oregon Coast Range. Pages 68-98. *in* S.D.Hobbs and others, editors. *Forest and stream management in the Oregon Coast Range*. OSU Press, Corvallis, Oregon.

Reeves, G.H., L.E. Benda, K.M. Burnett, P.A. Bisson, and J.R. Sedell. 1995. A disturburnce-based ecosystem approach to maintaining and restoring freshwater habitats of evolutionarily significant units of anadromous salmonids in the Pacific Northwest. *in* J. Nielsen, editor. Evolution in the aquatic ecosystem: defining unique units in population conservation. American Fisheries Society Symposium 17. Bethesda, Maryland.

Ricker, W.E. 1962. Comparison of ocean growth and mortality of sockeye salmon during the last two years. Journal of the Fisheries Research Board of Canada 19:531-560.

Scrivener, J.C. and M.J. Brownlee. 1989. Effects of timber harvesting on gravel quality and incubation survival of chum salmon (*Oncorhynchus keta*) and coho salmon (*O. kistuch*) in Carnation Creek, British Columbia. Canadian Journal of Fisheries and Aquatic Sciences 46: 681-696.

Toth, L.A. and others. 1997. Headwater restoration and reestablishment of natural flow regimes: Kissimmee River of Florida. Pages 425-444. *in* J.E. Williams and others, editors. *Watershed Restoration: Principles and Practices.* American Fisheries Society, Bethesda, MD.

White, P.S. and S.T.A. Pickett. 1985. Natural disturbance and patch dynamics: an introduction. Pages 3-13. in P.S. White and S.T.A. Pickett, editors. *The ecology of natural disturbance and patch dynamics*. Academic Press, Orlando, FL.

Wilzbach, M.A. 1985. Relative roles of food abundance and cover determining habitat distribution of stream dwelling cutthroat trout (*Salmo clarkii*). Canadian Journal of Fisheries and Aquatic Sciences 42:1668-1672.

Wimberly, M.C., T.A. Spies, C.J. Long, and C. Whitlock. 2000. Simulating historical variability in the Oregon Coast Range. Conservation Biology 14: 167-180.

Yount, J.D. and G.J. Niemi. 1990. Recovery of lotic communities and ecosystems from disturbance – a narrative review of case studies. Environmental Management 14: 547-570.

SALMON ANCHOR HABITAT WORK GROUP AND CONFERENCE, EXPERT RESPONSE

Salmonid Status, Science, Protection, Recovery: Dr. Charley Dewberry

(Dr. Dewberry's responses are in narrative form, followed by addressing specific questions posed by the SAH Work Group.)

1. What are historic trends & cycles of North Coast salmonid populations? What factors influence these trends?

2. How should the FMP define "properly functioning aquatic habitats?"

3. What is the scientific basis for the SAH Strategy?

4. How does the SAH Strategy compare to state and federal aquatic and riparian strategies, and FPA rules?

5. Does the SAH strategy help or limit ODF in achieving the desired results of the FMP? Why?

6. To what extent does SAH Strategy effectiveness depend on other land ownerships in SAH watersheds?

7. Why focus on "healthy" stocks?

8. What alternatives to the SAH strategy may be available?

9. Are there alternatives to the metapopulation theory?

Why a Salmon Anchor Habitat Strategy (SAH)?

<u>Historical Context</u>
In 1884, a cannery was started in Tillamook Bay, Oregon. See Table 1 below for the average number of cases of salmon packed from 1893-1919:

Table 1. Number of cases of Salmon Packed in Tillamook canneries.

Date: Year	Chinook	Coho	Chum
1893-1902	1,515	5,643	3,072
1903-1912	2,502	4,921	4,104
1913-1919	4,700	4,307	5,313

(Data from Cobb 1930.)

During this period of over 25 years, no

systematic trends are apparent in the table. The average number of cases of chinook and chum increased, while the number of coho decreased by about 25%. In a few years there are no reported cases of salmon canned for a particular species of salmon. In one year, 1900, there are no reported numbers at all, so the period reflects an average of 9 years instead of 10 years. No chinook and coho salmon were canned in Tillamook after 1922, according to Cobb.

We can convert this information into an estimate of the salmon populations in the Tillamook basin. First there are about 65 pounds of chinook in a case of packed salmon. There are about 70 pounds of coho and chum per case of packed salmon. We will assume that an average chinook weighs 20 pounds and a coho and chum salmon 10 pounds. Making this conversion results in the following number of fish:

Table 2. The estimated number of salmon canned in Tillamook canneries.

Date-Year	Chinook	Coho	Chum
1893-1902	5,303	39,501	21,504
1903-1912	8,757	34,447	28,728
1913-1919	16,450	30,149	37,191

This table estimates the number of fish that were annually canned in Tillamook. This estimate, of course, does not include the number of fish that spawned. The cannery information suggests the possibility of over-fishing but it is not severe because the fishery was sustained for over 25 years. It appears that chinook and coho numbers declined rapidly in the early 1920's suggesting something changed. The number of chum harvested increased during the period. This scenario follows a general picture of over-fishing. As the more desirable species decline, less desirable species are targeted. We know that at about 50% harvest, wild fish begin to show signs of over-fishing, so we will assume that the cannery records represent about 50% of the annual salmon run in the Tillamook. Therefore, the estimated annual run size of chinook, coho and chum salmon for the Tillamook basin between 1893 and 1919 are as follows:

Table 3. Estimated annual run size of Tillamook salmon.

Date-Year	Chinook	Coho	Chum
1893-1902	10,606	79,002	43,008
1903-1912	17,514	68,894	57,456
1913-1919	32,900	60,298	74,382

Let's compare those estimates with the current estimates for the salmon in the Tillamook Bay.

Table 4. Recent estimated run sizes for Pacific Salmon in Tillamook Bay (ODFW).

Date-Year	Chinook	Coho	Chum
1990-1999	?	882	?
2000-2001	?	1933	?
2002-2003	?	14,195	?

The chinook estimated run sizes are not far off from the historical estimates. I was unable to get the exact numbers from ODFW but the run is considered healthy. Coho numbers are significantly reduced from their historical estimates. Chum numbers are certainly less but they are currently not adequately estimated. These results are not unique to the Tillamook. They reflect regional trends (see pp 91-222 in Stouder et al. 1997).

I will address coho only for the remainder of my written comments. Coho are the salmonid most reduced and have been the issue of an ESA listing. The recent population estimates for coho salmon in Tillamook Bay show a significant increase starting in 2000 and 2001 and accelerating in 2002 and 2003 (Table 4, ODFW).

Are these results the fruits of restoration efforts of the last decade or of something else? I believe that these results are largely the result of regional changes since every basin up and down the Oregon and Washington coasts show a similar trend. The major change has been attributed mostly to a change in ocean conditions that created a positive change in survival of salmonids in the ocean. A major change in ocean conditions was reported after the El Nino event of 1997-98 (There were some changes in ocean variables starting in 1994 but the big changes came after the 1997-8 El Nino event). A more detailed explanation of this is found in the written answer provided by Gordie Reeves.

Lets turn now to the ocean condition from the late nineteenth century to the present. Investigators have found that there have been alternating periods of good ocean conditions and poor ocean conditions during the last century.

Table 5. Salmon and ocean cycles from the 1880's to the present.

Date-year	Precipitation	Temperature	Ocean conditions
1896-1914	Wet	Cool	Good
1915-1946	Dry	Warm	Poor
1947-1975	Wet	Cool	Good
1976-1998	Dry	Warm	Poor
1998-present	Wet	Cool	Good

From Mantua et al .1996 and Taylor and Southards 1997.

Analysis of Tillamook salmon information in light of the ocean condition information.
From 1883 to 1914, the Tillamook salmon catch reflects a time of good ocean conditions for salmonids. The annual coho run was approximately 75,000 fish. From 1998 to the present, when ocean conditions returned to good ocean conditions for salmonids, the average coho return has been 6,880 fish. Current coho numbers under good ocean condition are only 9% of those during good ocean conditions around 1900. The major cause of the decline is likely habitat degradation, since we are comparing coho production under similar ocean conditions and there has been only incidental catch of coho in the ocean since the mid-1990's.

The story is not so clear under poor ocean conditions. In 1915 the ocean conditions became poor, yet the catch of coho did not decline during these years; the coho salmon catch averaged over 75,000 coho from 1915 to 1919. However, after 1919 the cannery only harvested coho salmon for two years and these were not high production years. It is highly likely that while the catch was sustainable under good ocean conditions, when the ocean conditions changed, the catch was no longer sustainable and the cannery could no longer economically pack coho as the populations of coho crashed from over-fishing. Therefore, our estimates of coho numbers from 1915 to 1919 are likely to too high after 1915. The percent catch may have exceeded 60-70% of the coho in that year class.

During 1976 ocean conditions also changed from good to poor. The harvest of coho in 1977 collapsed from those the year before. In 1976, a record 3.7 million coho were harvested from along the Oregon Coast; in 1977 the catch was under 1.5 million coho and only about 50% of the fish were wild coho. After 1994 the total number of coho (wild and hatchery) in the Oregon Production Index area, most of the Oregon Coast including the Tillamook, never exceeded 500,000 fish. As we have seen the Tillamook number of coho spawning has averaged less than 1,000 fish annually.

The historical production under poor ocean conditions is less clear. Available information suggests that estimates from cannery records over-estimated the run. By the 1920's fishermen moved from netting salmon in the rivers to troll harvest in the ocean. It became difficult to assign fish caught to a particular river.

So what can we conclude? During good ocean conditions it appears that coho production in the ocean is only about 10% of what it was at the turn of the century. The most likely cause is habitat degradation or predation or both. There has only been incidental catch of coho in the ocean since the mid-1990's and the comparison was made during similar ocean conditions. The picture of coho production during years of poor ocean conditions is less clear; however it is likely that the 1990's have been the lowest numbers recorded for at least hundreds of years. Numbers any lower would have likely eliminated coho entirely from the Tillamook basin. There is no evidence that coho populations were ever eliminated from the Tillamook basin in the past. These conclusions are similar to those derived by others, for example Pete Lawson (1993).

Analysis of fishery management

Over the last 100 years salmonid numbers, once corrected for varying ocean conditions, have steadily declined. There is no evidence that the management strategies and techniques employed over the last century have successfully halted the decline in salmonid production. It was not due to a lack of understanding of the situation. In 1875, Spencer Baird outlined three major threats to salmon: excess fishing, dams, and destruction of salmon habitat (Baird 1875). However, fishery managers largely chose to focus on hatcheries as the primary management tool (Lichatowich 1999). They assumed that artificial propagation could maintain or enhance fishery production no matter how many were caught (Lichatowich 1999) or how much habitat was destroyed.

Harvest restrictions were enacted but these were of little value as the political pressure kept them from being effective. In 1878 a one-day restriction a week was enacted and in 1891 an annual season was set from April 1 to November 15. These are minimal restrictions. The fisheries managers faced a tough situation. They believed that adequate regulations would never be enacted because of the political situation. The political opponents to restrictions were too powerful. Given this situation the fishery managers may have believed that they had few other options.

Habitat restoration and enhancement received little attention until after WWII. The first major in-channel efforts were stream cleaning after the 1964 floods when many large migratory stream channels were blocked by miles of short pieces of wood. It was appropriate to remove many of these jams. However, once it was started, it appears no one asked when it should stop.

The basic strategy of stream habitat management was largely established in the 1930's by the CCC working in Midwest trout streams. The focus was on engineering site-specific habitat features, especially on using logs to create pools and cover. Structures were placed about 30-40 feet apart in small streams to create pools. The method was to identify streams with the fewest pools and reaches with the least cover. The idea was that wood placed to create pools and provide cover in these situations would provide the greatest benefit. This strategy has been marginal at best at restoring in-stream habitat. Salmon numbers have continued to decline.

Predators (including seals, sea lions, fish and birds) have been a focus of many people to explain the declines in salmon. Clearly, predators do eat salmon. There is no question about that. Some salmon even eat other salmon at certain life stages. However, evidence is clearly lacking in the argument that salmon populations are primarily controlled by predators. First, why the rebound of the last few years? Clearly ocean conditions have a large impact on the populations of salmon. Second, why are some runs, like coho in the lakes basins along the coast, healthy? If predators are the primary problem why are they not focusing on the lakes basin coho? Chinook runs are pretty healthy. Why do predators not focus on chinook?

I believe that one of the main reason for the fishery management failure is that the major findings of stream ecology during the last 40 years have not made their way their way into the management decision-making process in any significant way.

Summary of the last 100 years of management:
There are no success stories. In particular, coho continue to decline. The focus of fishery management has largely been on hatcheries. The assumption is that artificial propagation could maintain or enhance abundance, no matter how poor the habitat or how any were caught. Stream management of salmonids largely consisted of engineered in-stream work combined with riparian regulations (Forest Practices Act and Wild and Scenic Corridors). These strategies have not been successful. This is in agreement with the conclusions of the IMST (1999).

Towards a New Paradigm for Fishery Management

By the late 1980's, a number of individuals and organizations began to search for a new strategy for fisheries management. Explicitly or implicitly, the major findings of stream ecology began to enter emerge as crucial elements of the management strategy. These include:

- The major linkage between a streams and its valley. Headwater streams form an intimate linkage between the terrestrial and aquatic portion of the landscape. The stream habitat may be viewed as an integration of conditions on the uplands.
- The linkage between headwater streams and downstream reaches. Downstream reaches cannot be restored without first having naturally functioning headwater streams.
- The historical dimension of streams. Current conditions and the trajectory of the stream system cannot be understood without a historical understanding.

I will outline my experience with this process of constructing a new paradigm. It occurred at the same time as the development of FEMAT. I was not a part of FEMAT. (Gordie can address that). There were two major efforts that focused my thinking. First, I was the project manager of an effort to write a restoration vision for the rivers of North America. My first step was to bring together over 25 of the leading stream ecologists in the U.S. and write a white paper for the U.S. Congress. We held a series of meetings in Eugene, Oregon in the early 1990's. This process culminated in the publication of Entering The Watershed published by Island Press.

The second effort was to begin to focus on Knowles Creek, near my home. I had begun to work on it while I worked at the PNW regional lab (FSL) for Fred Everest and Jim Sedell. Knowles was a typical Coast Range stream with mixed ownership and mixed forest management ranging from old-growth to land managed on a less than 50 year clear-cut rotation. Two questions focused my interest:

1) Was coho production evenly distributed throughout the basin or was it located in a portion of the basin? And did coho production vary from year to year?

2) What were the natural processes that built stream fish habitat in Knowles Creek? (How did the stream function prior to European settlement ?)

From 1992 to the present, I have snorkeled the Knowles Creek basin and estimated juvenile coho production. The annual number of coho has varied from a low of 2,490 (1995) to a high of over 75,000 (2003). Production in a portion of the basin has been relatively high every year. In fact during low production years over 85% of the coho production were in less than 20% of the basin (Dewberry et al. 1998). It is this finding that led me to conduct the surveys on the North Coast to determine if the same pattern as observed to Knowles Creek. I found a similar pattern in the Tillamook basin. In 1999 when I conducted the first snorkel surveys, coho were found in only a few areas within the basin.

"How should the FMP define "properly functioning aquatic habitats?"

How did the Knowles Creek basin function prior to European settlement? This question focused my efforts to develop a new restoration strategy. If I did not know how the creek functioned and how salmon habitat was built, how could I possibly restore the stream?

Salmon habitat in the Knowles Creek basin is formed as water, sediment, and organic matter move from the ridge tops down the hill slopes and into stream channels. Most of the material movement is brought down the hillsides by debris torrents or flows, i.e. masses of rocks, soil, boulders and vegetation that move down hill slopes during major storms. What largely determines whether the debris flows build salmon habitat or not is the size of the wood that either comes down in it or gets knocked down by the flows as they move down slope. In a healthy system, there is enough LARGE (twice the wetted stream channel width and a meter in diameter) wood to keep the temporary jam in place during the storm.

The riparian zone also provides large trees and down logs that form key pieces that dissipate the energy of the debris flow. When debris flows enter healthy salmon streams they do not move far. When a debris flow enters a salmon stream during a major storm and it does not have large boulders and logs in the debris flow the stream flow rapidly cuts through the temporary dam releasing a wall of water, small wood, and boulders that scours the channel until it dissipates. The effect is the same as a splash dam. Without the large key riparian pieces to dissipate the energy, the wall of water destroys miles of salmon habitat (Dewberry 1996).

A prerequisite of properly functioning aquatic habitat is that shallow and deep-seated debris flows (and earthflows) have large trees and large downed wood in them to reduce the risk of dam-break floods. (Dam break floods occur when debris flows stop and create temporary dams in salmon bearing streams. If the deposit does not have large key pieces of wood the floodwaters cut rapidly through the deposit and send a wall of water and small debris down the stream channel scouring sediment and incorporating existing large wood into the mass. The effect is the same as a splash-dam). This was the major destructive feature observed in Knowles Creek during the 1996 storm (Dewberry et al. 1998).

Tillamook Forest Management Plan and Salmon Anchor Habitat

The Tillamook-Clatsop Forest Management Plan is a significant step toward accomplishing the goals that have been set before the Oregon Department of Forestry. The implementation of a SAH strategy is considered by ODF "…critical to short-term survival of these populations by providing a higher short-term level of protection to existing key habitat areas." (FMP 4-81.)

The following elements comprise this higher level of protection: wider no-harvest zone near fish bearing streams, additional protection for debris torrent fans, higher tree retention adjacent to streams, additional ground-based equipment restrictions near aquatic areas, and greater precautions in high landslide hazard areas. These are all positive steps; however, in practice it is unclear how much additional protection these actions actually provide. First, when looking at particular sites within Salmon Anchor Habitats, it was acknowledged by ODF personnel that the management prescriptions outside SAH would have had the same actions taken in a SAH basin. For example, greater precautions are taken on high-risk slopes in SAH basins but the same greater precautions are also taken in non-SAH basins. There is no clear standard that is higher in SAH basins.

Secondly, it is not clear that salmon are a high priority within SAH basins. At the same time the FMP was put in place, the Board of Forestry directed ODF to treat for Swiss needle cast. As part of the Swiss needle cast Treatment 10-25% of each SAH would clear-cut the first 10 years and the same prescription would be continued the second 10 years. That means that in some SAH, 50% of the basin would be clear-cut in 20 years. This is a rate comparable to a 40-year clear-cut rotation found on industrial timber lands.

This is incongruous. How are SAHs affording salmon greater protection? In the case of the Little North Fork Wilson, this incongruity was acknowledged and at a later time the percent clear-cut was dropped to 16% for the first 10 years. This still means that it is likely that 32% of this key SAH will be logged in 20 years. It is difficult to see how this is meeting the goal of minimizing the risks to salmon in key habitat. In fact, at this point is hard to see how SNC treatment is compatible with the FMP itself on the west side of the forest.

Third, I have not seen the master maps that show what areas are going to be the large blocks of older stands in 20,50 and 100 years. These need to be overlain over salmon anchor habitat in order to be able to evaluate the likely success of the SAH strategy. One key question is how many acres will be clear-cut now (SNC or for other reasons) and then placed in stands identified as older stands in the next rotation? This affords salmon little protection in the short-run, the objective that ODF identified as primary in SAHs.

The reason that this is critical for salmon is that, in general, the salmon habitat is at is lowest level of health ever right now. Streams have the lowest amount of large wood in them that they probably have ever had. The streams have been living off the wood that came in after the fires (minus of course what was salvaged from hillslopes and stream channels- or cleared during stream cleaning). There has been little input since that time. We are just entering the time when large wood will begin to be significant and be recruited from the uplands. It is critical to the recovery of salmon habitat that when landslides, deep-seated flows, and debris flows enter stream channels that they have big wood in them since the majority of large wood will enter the streams from debris flows and deep-seated mass erosion events. We should be particularly careful in SAH because if we log them only to discover a mistake, it will take a minimum of 75 years to grow the trees to get back to where we are now.

As a result of these three issues it is not clear to me that the SAH strategy in practice in the Tillamook-Clatsop State Forest is indeed a SAH strategy.

"Does the SAH strategy help or limit ODF in achieving the desired results of the FMP?"

As configured, the current version of the SAH does not limit the harvest goals in any significant way. Up to 25% of SAH watershed will be clear-cut in the first 10 years. This is a rate comparable to private industrial logging (i.e. 40 year rotation). As far as the other goals established the legislature it is somewhat unclear how the SAH strategy will meet the goal. At this point SNC treatment appears to be the highest priority within the forest. As currently practiced it would appear that the ODF SAH strategy will not lead to the forest meeting its goals for salmon.

"To what extent does SAH Strategy effectiveness depend on other land ownerships in SAH watersheds?"

As a practical matter given the SNC treatments, the cutting rates on west side forest SAH will be comparable to the 40-year rotations on private industrial lands. Therefore, there is probably no practical difference as a result of ownership.

"Why focus on healthy stocks?"

As articulated above, we have yet to show restoration is a possibility. Fishery management during the first 100 years has not been successful, it largely focused on poor runs and maintaining them with hatchery fish. We have never restored a significant run by design in a coastal basin. At this point protection is our best chance of success, especially with regards to coho salmon. Given that we have yet to figure out what restoration would entail, real restoration would likely be cost prohibitive and take decades to a century to accomplish.

"What alternatives to a SAH strategy may be available?"

A SAH strategy assumes that all parts of a watershed are not equally valuable for salmon production, therefore it is efficient and effective because it focuses on where the fish are now and what is critical to them now. A non-SAH strategy assumes that all portions of the basin are equal for salmon. The result to achieve the same degree of attention is that higher levels of restriction are necessary on all of the watershed instead of just a portion of it to accomplish the same level of benefit. Strategies built on current forest practices and in-stream work are not likely to be successful. This conclusion is similar to that arrived at by the IMST (1999).

"Are there alternatives to the metapopulation theory?"

First, what is metapopulation theory? The easiest way to understand what metapopulation theory is to contrast it with the classical concept of population. According to the classical definition, a population is a group of individuals that share the same environment. All individuals in a population interact equally with all other individuals. The population is closed to migration. A metapopulation is a population consisting of many local populations.

A metapopulation study typically assumes that an environment consists of discreet patches of suitable habitat surrounded by uniformly unsuitable habitat. The focus of a metapopulation study is often a balance between local extinction and recolonization. (Hanski 1999, pp. 1-20.) If the question is, is the classical definition of a population a preferred alternative to the metapopulation perspective with regards to salmon the answer is clearly no. Salmon are characterized by migration patterns and local populations are separated from other population groups (e.g. in different tributaries). The metapopulation theory is really an approach. It can be applied at a variety of scales.

There is really not one definition of a metapopulation theory nor scale that it applies to. Metapopulation theory is slightly different than a landscape approach. So, a landscape approach might be considered to be an alternative to a metapopulation approach but this is splitting hairs.

"What is the scientific basis for the SAH Strategy?"

(My initial comments are for the general concept of the Salmon Anchor Concept. Then I move to discuss the ODF SAH concept.)
During the first 100 years of salmon management from approximately 1870-1970, salmonid numbers, runs, and life-histories in the Pacific Northwest declined significantly (e.g. Lichitowich 1999). Management of salmon during this period emphasized hatchery development, some limited regulations with a small amount of habitat enhancement. There is little or no evidence that the management strategies of this period had any positive effects. The number of salmonids continued to decline in the Pacific Northwest.

Beginning in the 1970's more emphasis began to be placed on habitat restoration. In the late 1970's when the role of large wood was recognized, the majority of habitat restoration dollars in the region was spent on placing large wood structures in stream reaches with little or no large wood present. The strategy was to spend time and effort improving the worst habitats, i.e. the stream reaches with the least wood. Again the salmon numbers continued to decline through the 1980's. It soon became clear that these new fishery management strategies were also not stopping the decline. **Working on the worst areas was not stopping salmon decline.**

By the late 1980's, it was clear to many people that a new approach to the management of streams and fish was needed. A new management paradigm was developed, "Protecting the best". The thinking was that protecting the remaining small portion of high quality habitat in the region was the cornerstone of management. Two of the most important publications touting this approach were *FEMAT 1993*, and *Doppelt et al. 1993*.

The second most important development was the development of the Hankin-Reeves (1988) whole-basin snorkel method. For the first time a "snap shot" of the abundance and distribution of juvenile salmonids could be constructed for a basin. In many basins, "hot spots" of fish production were found. These hot spots suggested that all parts of a river system are not equal for fish.

One place where the abundance and distribution of juvenile salmonids has been investigated annually since 1992 is Knowles Creek, Siuslaw basin. The Knowles Creek project was initiated as a partnership among the Pacific Rivers Council, Champion Timber Company, and the US Forest Service. The goal was to develop a new restoration strategy, based on protecting the best habitats (Entering the Watershed) and test the effectiveness of the restoration activities. The major relevant finding of the Knowles Creek work over the last decade is that in years with low salmon production, over 85% of the coho production in the Knowles Creek basin occurs in the same 15-19% of the basin (SAH) (Dewberry et al. 1998). (Recently I sumitted a paper to the Canadian Journal of Fisheries and Aquatic Science reporting the existence of SAH for over a decade in Knowles Creek).

The basis for my expansion of the Knowles Creek work from the Siuslaw to the Tillamook was to examine if the SAH was an isolated phenomenon or a more widespread characteristic of the Pacific Northwest. During 1999 and 2000, portions of the Tillamook State Forest were snorkeled to determine if the same pattern observed in the Knowles Creek basin was also observed in the Tillamook basin. The major focus of the endeavor was coho salmon, because they were listed and their numbers were very low on the North Coast. The population estimate for adult coho salmon in the Tillamook basin was approximately 2000 coho in both years (ODFW). We found a similar pattern to the pattern that we found in Knowles Creek. The majority of the coho salmon were found in less than 15% of the basin. This suggested the same pattern that had been observed in Knowles Creek. (I also have submitted a paper to Conservation Biology based on surveys from the Nooksack River, WA, Siuslaw Basin, OR and Napa River CA. In all cases the same pattern was observed).

In summary, available evidence suggests that the SAH concept is a regional concept. Conversely, I am aware of no evidence that currently suggests that all parts of a river system are equal for salmonids at the basin or watershed scale.

ODF Tillamook/Clatsop SAH Concept:

First, the new Forest Management Plan for the Tillamook and Clatsop Forests (based on structure-based management) is a bold positive step toward reaching the numerous management objectives. The Oregon Department of Forestry should rightfully be proud of this plan. In addition, ODF realized in a number of cases that the management plan did not meet certain goals (owls, murrelets, and salmon) and that additional strategies would have to be devised. This is also commendable. But I have two concerns about whether the SAH concept can meet it objectives: One, the practical on-the-ground management within anchor habitats is little different from the management outside anchor habitats. There are additional management constraints that are important, like keeping ground-based equipment out of the channel network; however, the basic management of anchor habitats is essentially the same as non-SAH streams. For instance, high-risk slopes are off limits in both cases. No additional restrictions on slopes are afforded salmon anchor habitats. **Restrictions should also be placed on moderate slopes which can deliver sediment directly to fish-bearing streams in salmon anchor habitats.** The decision is currently left to geotechnical specialists.

My biggest concern is that management for Swiss Needle Cast trumps management for salmon anchor habitat. During the next 10 years, 25% of four of the salmon anchor habitat basins will be clear-cut harvested. This is a rate comparable to harvest on private industrial timber lands

(40-year rotations). This rate of harvest is incompatible with the stated goals for the salmon anchor habitat. It is difficult to understand how this rate of harvest is compatible with minimizing the risk of additional mass erosion events in these basins. In the case of the Little North Fork Wilson, which might be the most important salmon anchor habitat in the Tillamook basin, the proposed 25% clear cut harvest was reduced to 16%.

This is a step in the right direction. ODF acknowledged that the 25% level posed too great a risk in this basin; however, 16% is still too high for a 10-year period. It is also not clear what the cut in the second 10-year period would be. If the rate remained the same, 50% of some SAH basins would have been clear-cut in a 20-year period. This level of harvest is not compatible with maintaining high quality salmon habitat. Then there is the issue of the third and fourth 10-year period. Clearly, that rate of harvest could not be sustained, but it is not clear what would limit total harvest in a 40-year period in a SAH basin.

It is also not clear how the Swiss Needle Cast Treatment fits within the forest management itself, unless the Swiss Needle Cast basins become the intensive young stands for the next few decades. In this scenario, the forest outside of Swiss Needle Cast would be managed for the majority of the older forest stands while those inside would be clear-cut and for the next few decades managed as primarily young stands. What seems incongruous to me is that some of these intensely harvested basins that will be maintained for the next few decades primarily as intensive young stands and simultaneously as SAH, while the stands outside SAH basins will be on average managed for older stands. This does not make sense. Does not this defeat the purpose of a SAH?

References Cited (Dewberry)

Baird, S. 1875. The salmon fisheries of Oregon. Oregonian (March 3). Portland.

Cobb, J.N. Cobb. 1930. Pacific Salmon Fisheries. U.S. Department of Commerce. Bureau of Fisheries Document #1092. Washington, D.C.

Dewberry, T.C. 1996. *Can We Diagnose the Health of Ecosystems?* Northwest Science and Photography, Florence OR.

Dewberry, T.C., L. Hood, and P. Burns. 1998. After the flood: the effects of the storm of 1996 on a creek restoration project in Oregon. Restoration and Management Notes 16(2):174-182.

Doppelt, B., and three other authors. 1993. Entering the Watershed: A New approach to save America's River Ecosystems. Island Press, Washington, D.C.

Forest Ecosystem Management Assessment Team. 1993. Forest ecosystem management: An ecological, economic, and social assessment. Report of the Forest Ecosystem Management Assessment Team. USDA Forest Service, Portland, Oregon, USA.

Hankin, D.G. and G.H. Reeves. 1988. Estimating total fish abundance and total habitat area in small streams based on visual estimation methods. Canadian Journal of Fisheries and Aquatic Sciences 45:834-44

Hanski, I. 1999. Metapopulation Ecology. Oxford University Press. Oxford.

Independent Multidisciplinary Science Team (IMST.) 1999. Recommendations to Oregon Department of Forestry and Oregon Department of Fisheries and Wildlife.

Lawson, P. 1993. Cycles of ocean productivity, trends in habitat quality, and the restoration of salmon runs in Oregon. Fisheries 18(8): 6-10.

Lichatowich, J. 1999. Salmon Without Rivers. Island Press, Washington, D.C. 317pp.

Mantua and four other authors. 1996. A Pacific interdecadal climate oscillation with impacts on salmon production. Bulletin of the American Meterological Society, 78: 1069-1079.

Stouder, D.J., P.A. Bisson, R.J. Naiman (eds). 1997. Pacific Salmon and their Ecosystems: Status and Future Options. Chapman and Hall, New York, New York.

Taylor, G. and C. Southards. 1997. Long-term climate trends and salmon populations. Oregon Climate Service web-site.

SALMON ANCHOR HABITAT WORK GROUP AND CONFERENCE, EXPERT RESPONSE

Regulatory and Legal Assurances and Considerations, Policy Questions: Ian Whitlock (State Perspectives)

"How does the SAH strategy relate or respond to Executive Order 99-01 to seek approval of a Habitat Conservation Plan?"

Paragraph 3(e) of Executive Order 99-01 states that the [Oregon] Department of Forestry will present an HCP to NMFS (NOAA Fisheries) under Section 10 of the Endangered Species Act. ESA Section 10 (a)(1)(B) allows federal authorities to authorize "incidental take" of listed species through a Incidental Take Permit (ITP) which is based on a Habitat Conservation Plan (HCP). Although the ESA establishes criteria for issuing incidental take permits, it does not dictate the contents of HCPs. Instead, HCPs are typically developed through an iterative process in which the applicant crafts conservation strategies with the goal of obtaining federal approval and surviving judicial challenge. (In the present case, challenges are possible under both federal and state law.)

The HCP for the Northwest State Forests has undergone many changes and refinements over several years, resulting from discussions with federal agencies, stakeholder groups, and the scientific community. The SAH concept is part of the Forest Management Plan (FMP) for the Northwest State Forests, which is in turn an important aspect of the state's proposal for obtaining an ITP. (The SAH concept is not at this time being considered as an HCP strategy.) The SAH concept is not dictated by law. To the extent that it describes a conservation strategy supportive of the HCP/ITP effort, it is consistent with Executive Order 99-01.

"What would be the benefits and/or costs of continuing the SAHs if the coho is delisted?"

The benefits of maintaining the SAH Strategy even in the absence of an ESA listing follow from the HCP/ITP process discussed in response to the first question. One could argue that a "conservative" strategy is more likely to win federal approval, and to survive judicial review. In addition, the status of coho salmon is in flux. It is typical for multi-species HCPs to cover not only presently listed species, but candidates for listing too.

<u>Follow-up question</u>: "*Ian Whitlock states, 'The SAH concept is not dictated by law.' When the Oregon Fish & Wildlife Commission adopts Basin Management Plans for fish management, those plans are adopted as Oregon Administrative Rule. Anchor habitats for salmonids are identified in the FMP as a strategy that will be implemented, at least for the initial implementation period (Chapter 4, pages 81-84). The FMP was adopted by the [Oregon] Board of Forestry. Is the FMP adopted similarly as Oregon Administrative Rule? If so, then are SAHs required by law? If not, then the question is moot.*"

Mr. Whitlock's response:
The points about the role of [Northwestern Oregon] FMP adoption are good, and arise from my having been too succinct. I had interpreted the question as trying to get at whether ODF was

required, in the first instance, to pursue the SAH concept in its current form (whatever that is). My answer means that there isn't a statute that I'm aware of that required the agency to pursue the SAH concept. The FMPs are adopted as rules, and thus have the force of law unless and until modified by the Board [of Forestry], or repealed by operation of some higher law.

SALMON ANCHOR HABITAT WORK GROUP AND CONFERENCE, EXPERT RESPONSE

Regulatory and Legal Assurances and Considerations, Policy Questions: NOAA Fisheries (Federal Perspectives)

"To what degree would the salmon anchor habitat (SAH) strategy elevate the stature of the Oregon Plan and the Northwest Oregon Forest Management Plan (FMP) in the eyes of NOAA Fisheries regarding "Federal assurances" for the Oregon Plan and a Habitat Conservation Plan (HCP)?"

Introduction

The National Marine Fisheries Service (NOAA Fisheries) is required to implement all provisions of the Endangered Species Act (ESA). The ESA includes provisions both to prevent further damage to listed species, by prohibiting unauthorized take, and to promote recovery of listed species, through development of recovery plans. NOAA Fisheries' Northwest Region is actively engaged in recovery efforts for threatened salmon and steelhead and the development of ESA recovery plans. State and local governments, tribes, and others throughout the Northwest have also stepped forward and assumed leadership roles in saving these species. NOAA Fisheries is working with jurisdictions and entities to implement the ESA by providing Federal ESA assurances for actions covered under ESA regulatory options. This response describes the ESA assurances implemented by NOAA Fisheries and how NOAA Fisheries may consider a salmon anchor habitat (SAH) strategy in relation to ESA assurances for the Oregon Plan and a habitat conservation plan (HCP).

NOAA Fisheries uses regulatory assurances and incentives to promote actions and policies to recover salmon and steelhead. For example, in the Columbia Basin, NOAA Fisheries is working with local sub-basin planning entities to develop ESA-related incentives and assurances to encourage broad participation in sub-basin planning and seeks to match the regulatory assurance options with actions in a sub-basin plan.

Regulatory Mechanisms for ESA Assurances

NOAA Fisheries can provide ESA assurances through one or a combination of ESA regulatory options or "tools" under ESA sections 4(d), 7, and 10. The need for regulatory assurance depends on the action and the desire of the jurisdiction or entity carrying out the action. NOAA Fisheries uses the following ESA regulatory tools to provide ESA assurances:

A. Section 7: Under section 7 of the ESA, Federal agencies must consult with NOAA Fisheries when they fund, permit, or carry out activities that may affect ESA-listed species. NOAA Fisheries' review ensures that the Federal action will not jeopardize the continued existence of the species. The resulting ESA assurance is that incidental or direct take is allowed under stated conditions. A section 7 consultation will permit take that is incidental to an otherwise lawful Federal action. No public review is required. Consultation may be reinitiated as conditions change, or if permitted take is exceeded.

B. Section 4(d): Under NOAA Fisheries' July 2000 4(d) rule[1] (65 FR 42422), 13 "limits" or programs were identified that minimize impacts on threatened salmon and steelhead enough so that additional Federal protections are not needed to conserve the listed species. A program can be approved as qualifying under one of the existing 4(d) limits after review by NOAA Fisheries and the public. In this case, the ESA assurance is that ESA take prohibitions will not be applied to activities approved under one of the 13 limits in the 4(d) rule.

C. Section 10: There are two parts of section 10 where ESA assurances apply: section 10(a)(1)(A) and section 10(a)(1)(B). Under section 10(a)(1)(A), NOAA Fisheries can permit activities for scientific purposes, or to enhance the propagation or survival of the listed species. Section 10(a)(1)(B) is available to non-Federal parties. An "incidental take permit" is issued by NOAA Fisheries based on a comprehensive habitat conservation plan (HCP), which identifies impacts and how they will be avoided, minimized, and mitigated. HCPs must comply with the National Environmental Policy Act, undergo public review, and include monitoring for compliance. Additional criteria for HCPs can be found at 50 CFR 222.307. The ESA assurance for a section 10(a)(1)(B) permit is that incidental take is permitted for all covered species. Non-Federal entities may then proceed with activities that otherwise would result in illegal take. "No surprises" assurances are provided by the government, whereby landowners are assured that, for as long as they implement the terms and conditions of the HCP, the government will not require commitment of additional resources or additional restrictions on natural resources beyond those agreed to in the HCP.

<u>Examples of ESA Regulatory Assurances</u>

NOAA Fisheries is actively engaged in numerous negotiations with Federal, state, and local jurisdictions regarding programs that may result in ESA assurances if the programs are approved through one of the ESA regulatory mechanisms described above. NOAA Fisheries regularly carries out section 7 consultations with Federal agencies throughout the Pacific Northwest. For example, in 2001 the Corps of Engineers consulted with NOAA Fisheries regarding its Standard Local Operating Procedures for Endangered Species (SLOPES) covering 10 types of permit actions in Oregon and Washington. The section 7 consultation on SLOPES has resulted in approximately 400 projects being authorized using this process.

Section 4(d): Numerous State and county programs have been approved as being consistent with different limits under the July 2000 4(d) rule. In Oregon, Marion Counties' routine road maintenance program was approved under limit 10, and the Oregon Department of Fish and Wildlife's fishery management and evaluation plans have been approved under limit 4.

Section 10: A section 10(a)(1)(B) incidental take permit was issued to the City of Seattle for the Cedar River HCP. The city developed a multi-species HCP with NOAA Fisheries and the U.S. Fish and Wildlife Service to ensure the ability of the City to meet drinking water needs of its metropolitan area, to restore salmon runs to 12 miles of human-blocked habitat, to improve

[1] At the same time NOAA Fisheries adopted a 4(d) rule for Tribal Resource Management (Tribal Plan) which allows American Indian tribes to quality for a limit on the take prohibitions in cases where the Secretary of Commerce has determined that implementing the Tribal Plan would not appreciably reduce the likelihood that listed species would survive and recover (65 FR 42481). This response focuses on the 4(d) rule for salmon and steelhead.

watershed conditions by upgrading and closing old logging roads, and to supplement the introduced sockeye salmon fishery for tribal and non-tribal fishing opportunities in Lake Washington.

<u>NOAA Fisheries Supports the Concept of SAHs</u>

An important distinction between the aquatic and terrestrial elements of the landscape strategies in the state of Oregon's Forest Management Plan (FMP) is the distribution of habitats across the landscape and the time and processes that create them. Theoretically, terrestrial habitats, the focus of structure-based management, can be managed as mosaics of forest stand structures that move gradually across the landscape. In contrast, aquatic habitats are largely fixed in space as a network of stream channels and associated water bodies. Thus, while the terrestrial habitats provided through structure-based management can be described in traditional forestry terms (stand age, species, acreage, etc.), the aquatic analog must be described as the stream network and entire watersheds that support them.

A watershed is a logical unit for analysis of potential effects of land management (particularly for actions that are large in scope or scale). Healthy salmonid populations use habitats throughout watersheds (Naiman et al. 1992), and riverine conditions reflect biological, geological and hydrological processes operating at the watershed level (Nehlsen et al. 1997, Bisson et al. 1997). A watershed perspective is needed to identify refugia or highly productive habitat patches, and to assess connectivity between these areas and between fish population segments (Sedell et al. 1990, Naiman et al. 1992, Li et al. 1995, Bisson et al. 1997). For these reasons, habitat conservation and restoration strategies are most likely to be effective if carried out at the scale of the watershed (Reeves and Sedell 1992, Botkin et al. 1995, National Research Council 1996, Nehlsen et al. 1997), or at the scale of composites of multiple watersheds in a species' range (Reeves et al. 1995, Frissell and Bayles 1996).

The overall concept of identification and priority conservation of high quality habitat and areas important to fish is firmly grounded in principles of conservation biology. Conservation of anadromous fish at the landscape scale requires an assessment of habitat quality and distribution in relation to historic, current and potential fish use, protection of areas of high quality habitat while other habitat areas are improving to a functional condition, and an effort to ensure that sufficient high-quality habitat remains available through space and time for the fish to survive natural and human-induced disturbances (Reeves and Sedell 1992, Frissell 1993, Frissell et al. 1993, Li et al. 1995, National Research Council 1996).

In the northern Oregon Coast area, there is little Federal forest land with key watersheds managed under the Northwest Forest Plan to help conserve anadromous fish. Several papers have identified watersheds that are priorities for protection and restoration in the northern Oregon coast area as fundamental elements of proposals to conserve and recover salmonids (e.g. Huntington et al. 1997, Nehlsen et al. 1997). Oregon's Independent Multidisciplinary Science Team (1999) supported landscape-scale planning of forest practices, and recommended enhanced protection for Core Areas, which are areas of high spawning concentrations identified for the Oregon Plan for Salmon and Watersheds. Based on the above information, the identification and management of SAHs offers an opportunity to provide needed landscape-scale conservation and restoration of fish habitat that complements the structure-based management approach for terrestrial species in the FMP. NOAA Fisheries supported the concept of salmonid emphasis areas (similar to SAHs) in negotiations on the draft HCP as an essential element of the HCP at the watershed scale (July, 2000, memo to ODF on salmonid emphasis areas).

The state of Oregon has several options under which SAHs could be recognized through the ESA. One option may be to consider SAHs within the context of a larger landscape scale conservation plan or strategy. In this case, activities which enhance survival (such as habitat restoration) within SAHs may be covered under a 10(a)(1)(A) permit. One of the most appropriate mechanisms for coverage of activities in SAHs under the ESA is probably issuance of an incidental take permit under section 10 of the ESA. This permit would be issued upon completion of an HCP that would be negotiated between NOAA Fisheries and non-federal partners. Under the ESA and related federal regulations, an HCP must describe in detail[2]:

- Impacts from the proposed taking of covered species;
- measures the applicant will take to monitor, minimize and mitigate such impacts;
- the funding that will be made to undertake such measures;
- procedures to deal with unforeseen circumstances;
- alternative actions the applicant considered that would not result in take, and reasons why such alternatives are not being used; and
- additional measures NOAA Fisheries or USFWS may require as necessary or appropriate for purposes of the plan.

[2]Habitat Conservation Planning Handbook, U.S. Fish and Wildlife Service and National Marine Fisheries Service, November, 1996.

NOAA Fisheries must meet criteria in section 10(a)(2)(B) of the ESA prior to issuing an incidental take permit for an HCP. In addition to overlapping several of the requirements listed above, the issuance criteria include:

The taking will be incidental to otherwise lawful activities,

- the taking will not appreciably reduce the likelihood of survival and recovery of the species in the wild, and
- assurances that the HCP will be implemented.

NOAA Fisheries has not reviewed in detail the current SAH proposal, but is open to discussing how SAHs would fit into any future negotiations about an HCP or other ESA regulatory mechanisms. SAHs could be an important conservation strategy, but they likely would be only one part of an overall HCP for forest management. It also may be possible to cover SAH activities through a section 4(d) limit. Finally, SAHs may also have a role in salmon recovery planning and SAHs could be incorporated as an important landscape scale conservation strategy in a recovery plan for Oregon coast coho salmon.

"What, if any, level of increased regulatory certainty can Oregon expect from our Federal partners if the SAH is implemented?"

In response to this question, NOAA Fisheries can only address its authority under the ESA and cannot represent other Federal agencies, e.g., the U.S. Fish and Wildlife Service or the Environmental Protection Agency. Regarding coverage from potential liability under the ESA, the state of Oregon can expect increased ESA-related regulatory certainty if NOAA Fisheries qualifies a state program under one of the ESA regulatory mechanisms in sections 7, 4(d), and 10.

As described in No. 1 above, NOAA Fisheries has several options for authorizing regulatory assurances through the existing regulatory mechanisms available under the ESA. These ESA regulatory mechanisms include:

(1) Issuing section 7 incidental or direct take permits for Federal activities, Federally permitted and funded activities;

(2) Approving programs as consistent with the criteria for limits in the July 2000 4(d) rule; and

(3) Issuing section 10 incidental take permits for non-Federal actions based on a comprehensive HCP.

Depending on how SAHs are identified and managed, SAHs could make an important contribution to conservation of Oregon coast coho, and could increase the likelihood of ESA assurances should the state decide to pursue them through an HCP or another regulatory mechanism. If the Oregon Department of Forestry, or any other entity, seeks ESA assurances from NOAA Fisheries for a program that contains an SAH strategy, NOAA Fisheries will conduct scientific and regulatory evaluations of the SAH strategy in the context of the overall program for which ESA assurances are being sought. Without a specific program to review, however, NOAA Fisheries cannot anticipate what level of increased regulatory certainty Oregon can expect.

SAHs also could contribute significantly to recovery planning for Oregon coast coho through the Oregon plan and the ESA. Participation in recovery planning is voluntary and does not remove the burden to avoid unauthorized take of listed species under section 9 of the ESA. However, effective implementation of an approved recovery plan could speed de-listing of species listed under the ESA. In conclusion, NOAA Fisheries is always available to discuss ideas or proposals regarding SAH with the state of Oregon and other entities in order to promote salmon conservation and recovery.

<u>Follow-up points and questions to NOAA Fisheries:</u>
"Question 1 'to what degree would the salmon anchor habitat strategy elevate the stature of the Oregon Plan and the Northwest Oregon FMP in the eyes of NMFS regarding 'fedeal assurances' for the Oregon Plan and a HCP?'

NMFS took five pages to not answer the question. It provided points about the ESA and Sections 4 and 10, but failed to answer the question. It did say, on page 4 of its response that IMST 'supported landscape-level planning of forest practices, and recommended enhanced protection for core areas,' but we already knew that. I remarked at first SAH committee meeting that pages 9 and 19 of IMST 1999 bootstrapped 'concept' to science without going through the scientific method. IMST and NMFS 1999 took this 'concept' to each point they commented on to say that from a 'landscape level' conceptual view, those points failed to achieve what they wanted.

Also at page 4, NMFS says it 'supported the concept of salmonid emphasis areas similar to SAHs in negotiations on the draft HCP as an essential element of the HCP at the watershed scale.' Alright, if Oregon goes forward with HCP planning and negotiation, then SAHs could become part of the discussion. However, since the FMP is in fact the HCP, why throw away SAH as a part of the negotiations? If NMFS gets SAH for free, Oregon no longer has it as a negotiating tool to get an HCP.

In the next paragraph, 'In this case, activities which enhance survival (such as habitat restoration) within SAHs may be covered under a 10(a)(1)(a) permit.' Permits of that category are for scientific research or 'to enhance the propagation or survival of the affected species.' Is this a reference to permit propagation rather than species propagation?

Finally, at page 5, NMFS acknowledges that it 'has not reviewed in detail the current SAH proposal, but is open to discussing how SAHs would fit into any future negotiations about an HCP or other ESA regulatory mechanisms.'

It appears that asking question 1 of NMFS was a waste of time for both NMFS and the SAH committee. NMFS hasn't "reviewed in detail" the SAH proposal to the detail sufficient to respond and, back to my previous point about possibly keeping SAH as an HCP negotiating tool, 'is open to discussing how SAH's would fit into any future negotiations about an HCP.'

Question 2 to NMFS elicited the same answer as Question 1. In generosity to NMFS, the questions had a probability of receiving a recitation of the ESA and relevant CFR."

NOAA Fisheries' response to follow-up questions:

NOAA Fisheries is pleased to participate in the upcoming Salmon Anchor Habitat (SAH) conference. In responding to our two questions about ESA assurances, we first wanted to clarify and define what NOAA Fisheries means by the term "ESA assurances." We have learned that in many cases, there is a misunderstanding about the definition and application of this term. After defining ESA assurances, we provided examples to illustrate how ESA assurances can be used in different circumstances. Finally, we described NOAA Fisheries' support for establishing SAH and expressed our willingness to discuss this issue as it applies to forest management and habitat conservation plans in the future with representatives of the Oregon Department of Forestry (ODF).

Due to the time constraints of the conference comment deadline, however, staff were not able to conduct a full review and evaluation of a specific SAH proposal. A thorough analysis of ODF's SAH proposal would require meeting with ODF staff to define the purpose, goals, scope, and content of the review. NOAA Fisheries staff would need the most up-to-date SAH proposal, and would need to discuss the data and other background information used to develop the proposal with biologists from ODF and the Oregon Department of Fish and Wildlife. Finally, NOAA Fisheries management would need to reassign staff that are currently working on other projects to conduct the review. Therefore, an appropriate review could not have taken place within the limited amount of time we had to prepare our responses to the SAH work group's questions.

One of the main points NOAA Fisheries' attempted to make in its response is that it supports the designation and appropriate management of SAH regardless of whether there is a Habitat Conservation Plan being developed or evaluated. In fact, SAH will most likely be an important element of any future Endangered Species Act recovery plan for Oregon Coast coho salmon.

References Cited (NOAA Fisheries)

Bisson, P.A., G.H. Reeves, R.E. Bilby and R.J. Naiman. 1997. Watershed management and Pacific salmon: desired future conditions. P. 447-474 in: Stouder, D.J., P.A. Bisson, and R.J. Naiman, eds. Pacific salmon and their ecosystems: Status and future options. Chapman and Hall, New York.

Botkin, D., K. Cummins, T. Dunne, H. Regier, M. Sobel, and L. Talbot. 1995. Status and future of salmon of western Oregon and northern California: findings and options. Report #8. The Center for the Study of the Environment, Santa Barbara, California.

Frissell, C.A. 1993. A new strategy for watershed restoration and recovery of Pacific salmon in the Pacific Northwest. Report prepared for the Pacific Rivers Council, Eugene, OR.

Frissell, C.A., W.J. Liss, and D. Bayles. 1993. An integrated biophysical strategy for ecological restoration of large watersheds. P. 449-45 in: D.E. Potts, ed. Changing Roles in Water Resources Management and Policy, June 1993. American Water Resources Association Technical Publication Series TPS-93-2. Bethesda, MD.

Frissell, C. A. and D. Bayles. 1996. Ecosystem management and the conservation of aquatic biodiversity and ecological integrity. Water Resources Bulletin 32(2):229-240.

Huntington, C.W. and C.A. Frissell. 1997. Aquatic conservation and salmon recovery in the North Coast Basin of Oregon: A crucial role for the Tillamook and Clatsop State Forests. Report prepared for Oregon Trout, Portland, Oregon. 39 p. plus appendix.

IMST (Independent Multidisciplinary Science Team). 1999. Recovery of wild salmonids in western Oegon forests: Oregon forest practices act rules and the measures in the Oregon Plan for Salmon and Watersheds. Technical Report 1999-1 to the Oregon Plan for Salmon and Watersheds, Governor's Natural Resources Office, Salem, Oregon.

Li, H.W. and 12 others. 1995. Safe havens: Refuges and evolutionarily significant units. Amer. Fish. Soc. Special Symposium 17:371-380.

Naiman, R.J., T.J. Beechie, L.E. Benda, D.R. Berg, P.A. Bison, L.H. MacDonald, M.D.

O'Connor, P.L. Olson, and E.A. Steel. 1992. Fundamental elements of ecologically healthy watersheds in the Pacific Northwest coastal ecoregion. P. 127-188 in: R.S. Naiman, ed. Watershed Management: Balancing Sustainability and Environmental Change. Springer-Verlag, N.Y.

National Research Council. 1996. Upstream – Salmon and Society in the Pacific Northwest. National Academy Press, Washington, D.C.

Nehlsen, W. 1997. Prioritizing watersheds in Oregon for salmon restoration. Restoration Ecology 5(4S):25-43.

Reeves, G.H. and J.R. Sedell. 1992. An ecosystem approach to the conservation and management of freshwater habitat for anadromous salmonids in the Pacific Northwest. Proceedings of the 57th North American Wildlife and Natural Resources Conference: 408-415.

Reeves, G. H., L. E. Benda, K. M. Burnett, P. A. Bisson, and J. R. Sedell. 1995. A disturbance-based approach to maintaining and restoring freshwater habitats of evolutionarily significant units of anadromous salmonids in the Pacific Northwest. American Fisheries Society Symposium 17:334-349.

Sedell, J. R., G. H. Reeves, F. R. Hauer, and C. P. Hawkins. 1990. Role of refugia in recovery from disturbances: Modern fragmented and disconnected river systems. Environmental Management 14(5):711-724.

Regulatory and Legal Assurances and Considerations, Policy Questions: Dr. Jon Souder (State Forest Legal Background)

"How have courts defined legal relationships between forest trust counties and the state in relation to management of state forest lands?"

The Oregon Supreme Court clearly defined the legal relationship between the State and the counties in *Tillamook County* v. *State*:

> "We deem it unnecessary to describe the relationship in contract or trust terms. Rather, we look to the statutes to determine what flows from them."[3]

Thus, it's clear that the Supreme Court did not feel that there was a contract or trust relationship, but rather that the statutes under which lands were transferred to the state defined the relationship. As enumerated in the report to the Board of Forestry that Teresa Rice and I wrote,[4] what are now called Chapter 530 Forest Board Lands came to be owned by the state through three statutes, beginning in 1931,[5] 1939,[6] and largely ending in 1941.[7] Thus, the terms and conditions of each individual parcel that came into State ownership are subject to the provisions of a specific statute. These terms and conditions can be divided into three areas: (1) transfer of ownership; (2) division of the proceeds of their management; and (3) land exchanges or sale.

Transfer of Ownership. While the vast majority of State Forest lands that are administered under Chapter 530 fell into County ownership through tax defaults, the statutory history shows that a wide range of different owners could transfer lands into State ownership.[8] For other owners, county court or board of commissioners had to approve the transfer.[9] While the counties were authorized by statute to hold and manage their tax-defaulted lands, they would have had to pay property taxes and other assessments on them.[10] By transferring ownership under one of the three statues, the counties were able to relieve themselves of these obligations while at the same time gaining a greater assurance that the lands would be managed and they would receive a portion of the proceeds from this management.

---

3 302 Or at 416.

4 Rice, T. A. and J.A. Souder, "Managing Oregon's Chapter 530 Lands: Report to the Oregon Board of Forestry" (July, 1997).

5 Oregon Laws 1931, Ch. 92.

6 Oregon Laws 1939, Ch. 477.

7 Oregon Laws 1941, Ch. 236.

8 "Lands may be acquired by conveyance of title by or from any county, municipality, state or federal agency, or by exchange of lands with any county, municipality, federal agency or any person, firm, corporation or association." Oregon Laws 1939, Ch. 478, §2.

9 Id.

10 Landman, C. 1995. "Oregon Board of Forestry Lands: An Historical Overview of the Establishment of State Forest Lands." Oregon Department of Justice, Salem, OR.

The exact statutory language used to describe the relationship between the counties and the State when making land transfers under the statutes varies over time, but is substantially similar. In all three statutes, the State required that the counties provide clear title to the lands. The 1931 law states that "before accepting conveyance of such lands the state board of forestry shall have the title to said lands examined and shall not accept title from the grantor or donor, unless a good and merchantable title, free and clear of all taxes, liens or encumbrances, is show to be vested in said grantor or donor."[11] Forest lands that were foreclosed for taxes were specifically included.[12]

On the State's side, the 1931 law said, "such lands shall be conveyed to and become and be the property of the state of Oregon and shall be administered and managed by the state board of forestry… ."[13] Similar language is repeated in the 1939 Act, with one difference being that the State could accept the lands by making adjustments for "accrued delinquent fire patrol liens on tax foreclosed lands now or hereafter owned by any county… ."[14] It is clear in the 1939 statute that the counties where conveying the title to the lands transferred. The 1941 Act loosened up the requirements for clear title, stating only that the attorney general would be authorized by the county to institute of quiet title suit.[15] Again, it is clear that the county was deeding the land to the state.

Division of Proceeds. Conveyance of title not only relieved the counties of their tax liabilities to the state, it also provided them with a potential source of future revenues. The statutes under which these lands were transferred to the State provide only that the county is entitled to a portion of the revenues received from their management. While the exact calculation of the revenue division varied among the three laws, and was changed with subsequent amendments in 1948 and 1969, the 1941 statute, under which most of the land was transferred, lays out the basic framework:

> "The county court or board of county commissioners of any county hereby is authorized and empowered, in its discretion, to convey to the state for state forests any lands heretofore or hereafter acquired by such county through foreclosure of tax liens, or otherwise, which are within the classification of lands authorized to be acquired under the terms of this act, if the board [of Forestry] deems such lands necessary or desirable for acquisition, <u>in consideration of the payment to such county of the percentage of revenue derived from such lands as provided in section 9 of this act</u>."[16]

Past practice has been that changes to the revenue division formula in subsequent statutes were also retroactively applied to Forest Board lands transferred to the State under previous authorities. Counties have concurred with this practice, generally because it has been favorable

---

11 Oregon Laws, 1931, Ch. 93, §2.

12 Id., §4.

13 Id., §3.

14 Oregon Laws, 1939, Ch. 478, §2.

15 Oregon Laws, 1941, Ch. 236, §2.

16 Oregon Laws 1941, Ch. 236, §3 (emphasis added).

towards them, either by increasing the proportion of revenues they receive or because it has allowed the lands to be reforested faster. In the *Tillamook* case, the Oregon Supreme Court determined that the counties' claim that the State could not unilaterally change the distribution formula was not "justiciable".[17] Therefore, the Court made no determination as to whether there is a legal obligation on part of the State to obtain concurrence of the counties with any change in revenue distribution.[18]

In *County of Tillamook* v. *State Board of Forestry*, the Oregon Supreme Court stated that the counties have a "protected, recognizable interest" in a portion of the proceeds from Chapter 530 lands located within their county. The Oregon Supreme Court opinion in *Tillamook County* v. *State* suggests that the state cannot take any actions with regard to this type of forest land that would totally deprive a county of its right to revenue. It implies that some reduction in revenue may be acceptable, or that a substitute form of compensation to the county that would "protect" the county's "right to revenues" might be sufficient.[19] Neither the statute, case law or other materials reviewed suggest that the Board has an obligation to produce a certain *level* of revenue, or that revenues must be produced from every acre.[20]

Land Sales and Exchanges. It was clear from the beginning in 1931 that the state was authorized to exchange Chapter 530 lands for other public lands to block them for better management and protection, but was not authorized to sell them.[21] The 1939 Act is silent with respect to sales and exchanges. However, the 1941 Act provides for exchanges of equal value within the same county when the purposes of the Act can be furthered. Prior to making exchanges under the 1941 Act, a hearing must be held in the county, and descriptions of the exchange must be published in a local newspaper.[22] Inter-county exchanges are permitted with the approval of both counties. Our 1997 report to the Board of Forestry, we said "what *Tillamook* says is that the state cannot *exchange* Chapter 530 lands into uses that do not have the potential to provide revenues to the counties."[23]

---

17 302 Or at 412.

18 Id., at 412-13

19 Id., at 417, n.8.

20 OAR 629-035-0010(4).

21 Oregon Laws 1931, Ch. 93, §3

22 Oregon Laws 1941, Ch. 236, 4.

23 Rice and Souder, *supra* note 2, at 37 (emphasis in original).

References Cited (Souder)

Rice, T. A. and J. A. Souder. Managing Oregon's Chapter 530 Lands: Report to the Oregon Board of Forestry. July, 1997.

Rice, T. A. and J. A. Souder. 1998. "Pulp Friction and the Management of Oregon's State Forests." J. of Environmental Law and Litigation 13: 209-273.

SALMON ANCHOR HABITAT WORK GROUP AND CONFERENCE, EXPERT RESPONSE

Silvicultural Issues and Strategies: Alan Kanaskie (Swiss needle cast)

<u>Background: Swiss Needle Cast effects on trees and stands:</u> Swiss needle cast (SNC) is a native foliage disease that affects only Douglas-fir. It is caused by the fungus *Phaeocryptopus gaeumanni*. The pathogen infects needles, impairs their physiological function, and ultimately causes them to drop prematurely form the tree. This loss of foliage results in reduced photosynthesis, slower tree growth, and occasionally tree death.

Healthy Douglas-fir in the Coast range of Oregon typically retains foliage for four or more years before they are shed. At any given time a healthy tree will have four or more annual cohorts of needles. Trees damaged by Swiss needle cast may retain only one cohort of needles, giving the tree crown a very sparse, yellow appearance. Disease severity typically is classified based on mean foliage retention in April-May as follows: severe = retention of one annual cohort; moderate = two cohorts, and; light = 3 or more cohorts.

A tree that retains only one annual cohort of needles because of SNC will grow approximately 50 percent less volume per year than a healthy tree. Most of this reduction in growth occurs in stem diameter, but height growth also is reduced.

Trees with very sparse crowns allow abnormal amounts of light to penetrate the canopy, which often results in profuse growth of understory plant species that normally would have been shaded out by the Douglas-fir canopy. The canopy of stands damaged by Swiss needle cast is most sparse (transparent) from March through May, and most dense (with new foliage) from August to October.

When SNC is severe, trees grow slowly, increasing the amount of time it takes for stands to reach merchantable size. The slower growth also delays time to canopy closure. The reduced leaf area resulting from SNC reduces competition among trees and permits higher stand densities to exist before inter-tree competition slows diameter growth, which has implications for thinning.

"What are the potential Swiss needle cast treatment alternatives?"

Silvicultural treatment alternatives for Swiss Needle cast depend on the age and characteristics of the stand. For the purposed of this discussion, stands are divided into three age classes: establishment (0 to 10 years old), young stands (10 to 30 years old), and mature (>30 years old). Characteristics such as stand density, species composition, location (distance form the coast, aspect, and elevation), Swiss needle cast severity, and seed source all affect choice of treatment alternatives. Similarly, the desired future condition or objectives for managing the stands will heavily influence the choice of treatment alternatives.

The overarching strategy is to return the coastal region of western Oregon to a forest of diverse species and age classes that closely mimic the natural forests of this area prior to human intervention. The rationale behind this is that SNC apparently was not a significant problem in these coastal forests until after substantial harvesting and establishment of plantations occurred in the latter half of the 20th century. Given that much of the northern coast range is occupied by Douglas-fir stands of various ages and seed sources, there are two basic stand management strategies to address SNC: 1) replace pure Douglas-fir stands with mixed species stands that may include Douglas-fir, and; 2) do something to the existing Douglas-fir to mitigate the effects of Swiss needle cast.

The silvicultural tools for doing this include planting species other than Douglas-fir, planting Douglas-fir with genetic tolerance to SNC, conserving established Douglas-fir trees that appear to grow well despite SNC, pre-commercial thinning, commercial thinning, clearcutting or other regeneration harvest, application of fungicides or sulfur, and doing nothing. Which tool or tools to use depends mostly on the current and expected severity of damage from Swiss needle cast, stand age, and stand density.

Options for stands in the establishment phase (age 0-10 years):
The ideal time to establish a mixture of tree species and to plant genetically tolerant Douglas-fir is following a clear-cut or partial cut regeneration harvest. In areas with severe Swiss needle cast, plant a mixture of conifers and/ or hardwoods, keeping the proportion of Douglas-fir at 20 percent or less. For all species use seedlings grown from local seed sources. Douglas-fir seedlings should be grown from seed of genetically tolerant trees or from local trees that show evidence of SNC tolerance.

Salmon Anchor Habitats occur on a wide range of sites with varying plant associations, SNC risk, and topography. Species mixtures should be tailored to the specific environment of the management area. In areas with moderate SNC damage, species mixtures are appropriate but the proportion of Douglas-fir can increase to 50 percent. Where SNC damage is light, factors other than SNC should dictate the planting mixture, but SNC-tolerant Douglas-fir should be used if available.

If a plantation has already been established, it may be inter-planted with species other than Douglas-fir. Shade tolerant species such as hemlock, spruce, and cedar can do well in this situation, but vegetation control and treatments to reduce animal damage may be required. Inter-planting generally is most successful and most cost-effective if it is done within a few years of the previous planting. By age 10, inter-planting van be very difficult and expensive.

In a few instances where SNC damage was extreme, landowners have chosen to destroy existing young Douglas-fir plantations and replace them with mix-species stands or western hemlock stands. This is a very costly treatment and is rarely practiced in stands of this age.

Aerial applications of fungicides such as chlorothalonil or sulfur would reduce the impacts if SNC on stand growth, but they generally are not applied to stands of this age because the economics are not attractive. Fertilization likely would improve tree and stand growth somewhat, but growth ultimately will be limited by SNC if disease is severe.

Alternatives for young stands, age 11 to 30 years:
One of the most difficult challenges in the northern Coast range is how to manage established Douglas-fir stands that are being damaged severely by SNC. When SNC is severe, Douglas-fir occupies the site but grows very little wood volume. Often stands in this age are too dense to plant other species beneath the Douglas-fir, and they have too little volume to justify an early regeneration (clear-cut) harvest. The existing volume per acre also may be too low for an economically viable thinning operation, and projected growth may suggest an unreasonable amount of time until enough volume is present for a commercial sale. Stands such as this also show little promise of developing other desirable attributes in a reasonable amount of time.

Early clear-cut harvest is an option to replace the poorly growing Douglas-fir stand with a stand better suited to the situation. This option makes the most sense when the stand is essentially pure Douglas-fir and SNC damage is severe. Unfortunately the low per-acre volume may not allow for a commercially viable operation. In this case, some landowners have chosen to cut the stand at a loss (rehabilitation) in order to get a more productive and desirable stand established. If species other than Douglas-fir account for 50 percent or more of the stems per acre, the stand could be managed without clearcutting. If the existing stand was planted with an off-site seed source that is highly susceptible to SNC, clearcutting is recommended to allow establishment of stand with long-term vitality.

Pre-commercial thinning. Observations of stands with severe SNC damage suggested that thinning made SNC worse. Indeed, when some young stands were thinned, the residual crop trees did appear alarmingly yellow and sparsely foliated. Recent research on paired plots has shown that pre-commercial thinning does not make SNC more severe. The sickly appearance of residual trees after thinning is partly due to our ability to see them more clearly in the absence of trees removed. The current recommendation is to pre-commercially thin stands as early as possible so that the crop trees retain deep crowns. A tree with a deep vertical crown will have more leaf area than a tree with a shorter live crown, and will grow better under a given level of SNC because it has more foliage. This is not to say that thinning severely damaged stands is recommended; thinning will help trees grow better in the face of SNC, but the growth response to thinning will be inversely related to the severity of SNC damage. Pure stands of Douglas-fir with severe SNC might best be treated a regeneration harvest.

Pre-commercial thinning also offers the opportunity to manipulate the composition of the stand. Thinners can select (for crop trees) Douglas-fir that appear tolerant to SNC, and they can favor species other than Douglas-fir in order to shift the stand toward a species mixture that is best suited to the particular site and risk of SNC damage. In mixed species stands, it often is not necessary to cut the Douglas-fir because SNC puts them at a competitive disadvantage compared to other species.

Commercial thinning. Observations by foresters in the areas with the most severe Swiss needle cast suggested that stands did not respond positively to thinning and in some case seemed to look worse as a result of thinning. An ongoing research project between the ODF State Forests program and Oregon State University has shown that although stands do often look sickly following commercial thinning, individual trees do respond (increase their diameter growth) to thinning. However, the degree of response is related to the severity of SNC damage, i.e., severely damaged trees show negligible increase in diameter after thinning, while moderately damaged trees will show a moderate increase in diameter growth. There is no evidence that the usual thinning intensities make SNC worse. Stand level response, i.e., how trees are growing on a pre-acre basis suggests that thinning for the purpose of increasing stand volume growth and tree size may not be appropriate in severely damage stands and in some moderately damaged stands. As with pre-commercial thinning, there may be some value in using thinning as a tool to shift species composition and to select the best-performing Douglas-fir. Unfortunately, thinning young stands with even moderate SNC damage may not be commercially viable because of the low per-acre volume available to remove.

Thinning decisions are extremely complex because of the interactions between stand density, live crown ratio, SNC severity, and stand volume, and must be made on a stand-by-stand basis. Broad general prescriptions based on the geographic location of stands relative to areas with SNC damage rarely will provide for optimum management of the resource. Thinning often is necessary to create or maintain future stand management options, even though the short term response to thinning may not be attractive. Stands that remain un-thinned suffer the compounding effects of foliage loss from SNC and receding crowns from tree competition, which combine to slow growth and destabilize the stands as density increases.

<u>Chemical treatments</u> Young stands of age 15 to 30 years with severe SNC often are the best candidates for treatments to accelerate volume growth and shorten the time until the stand achieves a size and per-acre volume that allows for commercially viable clearcutting or thinning. The fungicide chlorothalonil (Bravo, Daconil) applied in May-June for several years can increase volume growth of stands by as much as 60 percent. But the cost ($150/acre/year) and environmental concerns have worked against its widespread use. Aerial application of liquid or powdered sulfur shows promise, and has been applied operationally by some private companies. An ongoing study soon will provide information about the cost and effectiveness of sulfur for reducing damage from SNC and improving Douglas-fir volume growth.

<u>Fertilization.</u> Much work has been done on fertilization of Douglas-fir in areas with Swiss needle cast. There is no question that certain fertilizer mixtures can dramatically improve the growth of Douglas-fir, even in areas with SNC. There is little evidence that fertilization *per se* controls Swiss needle cast. In fact, there is some evidence that nitrogen fertilization can exacerbate SNC on some sites. If fertilization could move the stand to a merchantable size quickly, then it may be an economically viable and profitable treatment. Cost-effectiveness of such treatments needs to be determined before they are widely used operationally

<u>Do nothing.</u> If plantations are not managed, stand density and SNC will work together to decrease wind firmness and eventually destabilize the stands. Because SNC does not usually kill trees, Douglas-fir will continue to occupy the sites, but will produce much less wood volume per acre than either a mixed species stand or a healthy Douglas-fir stand. The "do nothing" alternative might be appropriate in a few cases, such as low stand density and an abundance of tree species other than Douglas-fir. In most cases, allowing severely damaged pure stands of Douglas-fir to remain on the landscape likely will not meet most management objectives.

Alternatives for stands more than 30 years old:
When Douglas-fir stands reach an age of 30 years, stand density and species composition generally dictate the silvicultural options available to meet management objectives. Stands of this age usually are treated by thinning or regeneration harvest (clear-cut or partial cut).

<u>Clear-cut / regeneration harvest</u> often is chosen for stands with severe SNC damage. A high proportion of Douglas-fir, high stand density, and low live crown ratio further support the clear-cut option, because response to thinning will be poor in terms of tree and stand volume growth. A suspect seed source for the plantation, which is the case for many plantations established after the Tillamook Burn, argues for regeneration harvest because the trees may be poorly suited to the sites for reasons other than Swiss needle cast, and therefore and pose a long-term risk of damage from other agents. Some stands may not allow commercially viable thinning, but will provide a viable clear-cut harvest. The decision to thin or clear-cut is complex and should be made on a stand by stands basis, rather than a simple set of rules based on SNC severity and/or geographic location.

Regeneration harvests are not necessarily clearest, and clear-cuts do not necessarily remove all large trees on the site. Regeneration harvests that leave numerous large trees on the site while allowing enough light to promote growth of understory seedlings have been used with good results in area with moderate to severe SNC damage. Shade tolerant species such as hemlock, cedar, and true fir grow well in these situations and are not affected by SNC.

<u>Commercial thinning</u>. On public lands in the northern Coast range, commercial thinning is the most widely used option for stands over 30 years old. Thinning does not make SNC worse, and stands will respond to the thinning by increasing volume growth. However, the degree of volume growth response is directly related to SNC severity (more severe damage = less growth response). When SNC is severe and stand density is high, trees have very small effective live crowns and likely will respond poorly or not at all to thinning. Regeneration harvest might be the best option for these stands. If stands have moderate to light SNC and are not yet overly dense, commercial thinning makes sense.

Stand with poor needle retention (less than 2 annual cohorts) will not be the best candidates for thinning unless thinning guidelines are modified (if improving stand volume production is the objective). Stands with severe to moderate SNC damage can carry a higher stocking level than healthy stands because of the decreased foliage area resulting from SNC. Consequently, if stands are thinned under the usual thinning regimes, they may be thinned too heavily and the residual stands may not use the available growing space efficiently. The current recommendation is to thin stands with severe to moderate SNC more lightly than usual, i.e., leave the stands at a slightly higher density that normally is prescribed. This allows for more efficient use of available growing space after thinning. In some cases thinning might be the best treatment biologically for the stands, but the economics of the sale make preclude it.

Commercial thinning can benefit the stand by allowing trees to maintain deep live crowns, by selecting Douglas-fir fir that grow best, and by shifting the species composition to whatever is best suited to the site. Stands with light SNC damage can be thinned normally, and moderately damaged stands may be thinned lightly, where economically feasible, favoring species other than

Douglas-fir. Commercial thinning might not be the best long-term option if the stand was established from an inappropriate seed source.

Fungicide, sulfur, or nutrient applications might have a place in managing stands over 30 years old, but the cost effectiveness has not been worked out (see discussion for young stands).

Uneven-age silviculture. Uneven age silviculture can be applied to forests with SNC damage. This system typically involves managing several age classes of trees of various species. Severe SNC damage likely would prevent Douglas-fir being a fully functional component in such as system, but the increased abundance of other species may provide long term benefits to the SNC situation.

"How are various landowners (federal, state, private) dealing with Swiss needle cast?"

State Lands. The long-term strategy on State Forests is to actively manage stands in areas with SNC damage to reduce the amount and proportion of Douglas-fir and to increase the amount of other native species not affected by SNC. The resulting stands reflect species composition appropriate to the ecological zone, and include species such as western hemlock, western red cedar, true firs, Sitka spruce, and red alder. Douglas-fir used for planting is genetically well adapted to the site and from parents that exhibit SNC tolerance.

Decisions are made on a stand-by-stand basis. Needle cast severity, location, aspect, stand density, tree size, species composition, seed source, abundance of competing vegetation, ecological/vegetation zone, and management objectives are all considered when selecting a silvicultural option. Decisions for specific stands and the larger landscape consider environmental, social, and economic factors.

Severely damaged Douglas-fir stands are targeted for regeneration harvest and reforestation - in general, districts attempt to "take the worst first", though other resource and operational considerations will also influence stand selection for treatment. Some moderately damaged stands are clear-cut because of poor live crown ratios, poor height to diameter ratios, and high stand density which would preclude commercial thinning as a viable option. Clear-cut harvests include a range of techniques ranging from the traditional clear-cut to harvests that leave 30 or more mature trees per acre.

Regeneration of desired tree species generally is accomplished by planting. Non-susceptible species and mixes appropriate to the ecological zone are emphasized. The proportion of Douglas-fir in the stand is governed primarily by the severity of SNC damage and the geographic location of the stand. Generally stands closer to the coast experience more severe damage than those stands located farther inland. In areas with severe SNC damage the percentage of Douglas-fir does not exceed 20 percent; in moderately damaged areas the percent of Douglas-fir does not exceed 50 percent. Douglas-fir planting stock is genetically well adapted to the site and from parents that exhibit SNC tolerance. ODF obtains and deploys seed with tolerance to Swiss Needle Cast in the coastal zone, and has established a seed orchard to produce genetically superior seed.

Most Douglas-fir stands less than 12 years old and within about 18 miles of the coast have been inter-planted or re-planted with non-susceptible species. Young stands with moderate to light SNC damage are pre-commercially thinned. Pre-commercial thinning of stands with severe SNC damage is done only as necessary to improve spacing of species other than Douglas-fir.

Beyond the age of 25 years, stands with light damage are thinned normally, and moderately damaged stands are thinned lightly, favoring species other than Douglas-fir, when economically feasible. Moderately damaged stands that have maintained good live crown ratios, good height to diameter ratios, and exhibit other attributes of good stand condition, usually are chosen for thinning over stands without these attributes. In areas of severe SNC damage, stands are thinned only if they have a significant component of species other than Douglas-fir.

ODF supports and participates in research on Swiss needle cast and related topics. The State Forest program actively participates in the Swiss Needle Cast Cooperative (SNCC) and directly funds cooperative research on a variety of topics related to SNC management. The State Forests program also funds and participates in cooperative aerial surveys and other forest health monitoring projects related to SNC.

Private lands: In areas with severe SNC, industrial managers are replacing Douglas-fir stands with stands of mixed species or of single species other than Douglas-fir that are well suited to the specific site. In some case this includes a proportion of Douglas-fir in the mixture, usually not more than 50 percent. Some companies have taken the extreme measure of destroying established non-merchantable Douglas-fir stands and replacing them with mixed species or hemlock stands. This practice is not common because of the high cost. The most common treatment of Douglas-fir stands less than 10 years old has been to interplant the stands with species other than Douglas-fir, usually hemlock, cedar or Sitka spruce. This may be done with or without chemical or mechanical control of competing vegetation. It can be a challenging operation when SNC is severe because of the abundant competing vegetation that often develops as a result of the increased light transmission to the forest floor.

In young stands, commercial thinning or early clear-cut harvest is common. When SNC is severe and Douglas-fir growth has practically shut down because of SNC, stands may be clearcut at age 25 to 35 years. This alternative allows replacing the stands with more suitable tree species. If SNC is moderate or light, thinning is an option, but most timber companies in the area of major SNC impacts tend toward clearcutting. Some companies have made aerial applications of sulfur to reduce SNC damage and return Douglas-fir to more normal growth rates. This approach allows the stand to reach a merchantable size in a reasonable amount of time. The stand may then be harvested and replaced with one more suited to the site and SNC conditions. Because most companies manage on rotations of approximately 40 years, little thinning is done in mature stands with or without SNC

Federal lands. Much federal land along the Northwest coast is not available for intensive management. In these areas Swiss needle cast is allowed to run its course. When stands contain several tree species, SNC will slow the Douglas-fir and allow other conifer and hardwood species to flourish. In stands that are essentially pure Douglas-fir and SNC is severe, Douglas-fir typically languishes for decades, and may or may not die. In some areas near Hebo and Beaver, where SNC is most severe, significant numbers of mature Douglas-fir have died from the prolonged effect of Swiss needle cast.

On federal lands that are actively managed, the focus is on thinning, with very little regeneration harvesting. The NW forest plan directs most of the federal lands towards an old-growth condition with a mixture of species. The Bureau of Land Management (BLM) and USFS actively manage stands along the north coast to mitigate the unwanted effects of Swiss needle cast. They have pioneered species mixtures and inter-planting young stands in areas with severe SNC damage near Tillamook and Hebo. As with other agencies and private companies, they collect seed from parent trees with demonstrated tolerance to SNC (seed orchards and progeny test sites) and from local apparently tolerant wild trees. Genetically tolerant Douglas-fir material has been incorporated into the federal seed orchard program. Federal foresters pay very close attention seed source (the use of off-site seed likely has contributed to the current SNC situation). During thinning they save apparently tolerant Douglas-fir as leave-trees, and they attempt to shift the stand species composition toward the most appropriate mixture for the site. Neither BLM nor the USFS discriminate against Douglas-fir as a rule. Rather, they set stand structural and compositional targets according to the ecology (plant association) of the specific area, with the goal of maintaining a forest similar to what existed prior to human alteration. No federal agency uses fungicides, sulfur, or nutrient amendments to reduce the effects of SNC.

Many silvicultural tools are available for managing stands with SNC. The challenge lies is in selecting the most suitable treatment for a given combination of stand characteristics, disease severity, and economic, ecological, and social constraints. With intelligent active management, stands with significant damage from SNC can, in the long-term, provide many of the values expected from these highly productive Coast range forests. Lack of management, especially in areas with severe damage, likely will delay considerably the realization of these same values.

References Cited (Kanaskie)

Hansen, E.M., Stone, J.K., Capitano, B.R., Rosso, P., Sutton, W., Winton, L., Kanaskie, A., McWilliams, M., 2000. Incidence and impact of Swiss needle cast in forest plantations of Douglas-fir in coastal Oregon. Plant. Dis. 84, 773-778.

Kanaskie, A.; Maguire, D.; Mainwaring, D. 2002. Influence of Pre-commercial thinning on Swiss needle cast severity and tree growth in North Coastal Oregon. Pages 25-27 In: Swiss Needle Cast Cooperative Annual Report 2002. Oregon State University College of Forestry, Corvallis, OR. 86 p.

Kanaskie, A.; Maguire, D.; McWilliams, M.; Christian, R. 2002. Pre-commercial thinning of Douglas-fir stands with varying intensity of Swiss needle cast in the Coast Range of Oregon, Status report on trends in disease severity, November 2002. Pages 20-24 In: Swiss Needle Cast Cooperative Annual Report 2002. Oregon State University, College of Forestry, Corvallis, OR. 86 p.

Kanaskie, A.; McWilliams, M.; Overhulser, D. 2002. Swiss needle cast aerial survey 2002. 2002. Pages 7-10 In: Swiss Needle Cast Cooperative Annual Report 2002. Oregon State University College of Forestry, Corvallis, OR. 86 p.

Maguire, Douglas A.; Kanaskie, Alan; Voelker, William; Johnson, Randy;, Johnson, Greg. 2002. Growth of young Douglas-fir plantations across a gradient in Swiss Needle Cast severity. West. J. Appl. For. 17, 86-95.

Maguire, Douglas .A ;, Kanaskie, Alan. 2002. The Ratio of Live Crown Length to Sapwood Area as a measure of Crown Sparseness. For. Sci. 48, 93-100.

Mainwaring, Doug; Maguire, Douglas A.; Kanaskie, Alan. (In Press). Response of Douglas-fir to fungicidal suppression of *Phaeocryptopus gaeumannii*: volume growth, branch elongation, and foliage dynamics. Forest Ecology and Management.

Mainwaring, Doug; Maguire, Douglas A.; Kanaskie, Alan; Brandt, Jeff. (In Press). Interactive Effects of Swiss needle cast and commercial thinning on Douglas-fir growth and development on state forests. Forest Ecology and Management.

Oregon Department of Forestry. 2003. Strategic Plan for Managing State Forests in Northwest Oregon Affected by Swiss Needle Cast. Internal report 3-2-1-205. 10 p.

SALMON ANCHOR HABITAT WORK GROUP AND CONFERENCE, EXPERT RESPONSES

Silvicultural Issues and Strategies: Pamela Overhulser (State Forest Inventories)

"Is ODF's inventory of standing timber by species and age class based on accurate and ground-proofed surveys?"

In May 2002 ODF embarked on a stand level inventory (SLI) project that is providing new inventory for use in forest management planning. For the next 5 to 6 years ODF is administering annual contracts to inventory 1000 stands per year from a total of 9000 ODF stands. That rate per year will be inventoried until all of the stands that are less than 8 inches average diameter breast height (DBH) and 50% of the stands over 8 inches DBH have new SLI inventory. At that time the amount of stands inventoried will be reduced to approximately 400 per year which is considered a maintenance level. ODF has completed the first and second year contracts; the third year contract began in May 2004 and will be completed May 2005.

By May 2004 approximately 31% of stands and 40% of acres will have new SLI across ODF ownership. By May 2005 approximately 43% of the stands and 56% of the acres will have new SLI. A larger % of acres than stands were accomplished in the first few years of the contracts because the largest stands were a first priority for selection for SLI.

For each stand in the SLI project, 16 to 24 plots are taken to measure trees, snags, non-tree vegetation, and down wood. The tree measurements include tree species, status live or dead, and DBH on every tree in the plot with a subsample of age, height, crown ratio, and crown class. Data collected on non-tree vegetation is species, % of plot covered and average height. Down wood data collected are tree species, diameter, length, decay class, and wildlife excavation code.

The stands that have not had new SLI are represented in one of two ways, either using the new SLI system or the previous OSCUR inventory. The inventory system is designed to support a technique call "double sampling". Rather than inventorying every stand on State Forest Land, a portion of the stands is measured and the data from those stands is used to expand to similar stands that have not been measured.

For several more years some districts have chosen to continue to use the previous ODF "OSCUR" inventory to represent the non-measured stands instead of an expansion from the new SLI. All stands in OSCUR inventory were measured at some earlier time but in a variety of formats. However, the average years since OSCUR inventory was done on any stand is about 15 years. About two-thirds of the stands were inventoried by installing plots or recording planting records, a third of the stands data was from walk-through observations. The OSCUR inventory did not measure non-tree vegetation or down wood. In some districts 15 years of projected growth of OSCUR inventory still gives a reasonable estimate of stand condition. On other districts the original OSCUR data is insufficient for planning purposes.

SALMON ANCHOR HABITAT WORK GROUP AND CONFERENCE, EXPERT RESPONSE

Silvicultural Issues and Strategies: Dr. Steven Radosevich (Longer Rotations)

"What affect would longer rotations have on stand structure increased fiber production, wood quality and harvest output over longer timeframes?"

The use of longer timber harvest rotations, as opposed to shorter ones, should have all the advantages to stand structure for biological diversity and wood production and quality that older/larger trees provide in forests. The reason for this fact is based in both theory and empirical evidence; i.e. larger/older trees produce more wood of usually higher quality and provide the attributes of big trees to forest structure.

Theory—compound interest rule of plant growth. Several textbooks have been written that encompass the subject of plant growth (Harper, 1977; Lambers et al, 1998) with the basic tenant that big plants produce more biomass over time than smaller ones. This concept has been explored experimentally for many kinds of plants, ranging from herbs to trees, and always with the same result. The concept also holds for stands as well individual plants. The compound interest rule takes the form of the following equation:

$$R = 1/W * \Delta W/\Delta t$$

where R is the growth of a plant relative to its size; W is the biomass or size of the plant, and $\Delta W/\Delta t$ is the change in plant weight or size over time. This equation is often interpreted by using a financial analogy, i.e. as if the forest were a bank account. In this analogy, the size of the trees in the forest (1/W) represents the principal in the bank account, and their growth rate ($\Delta W/\Delta t$) is the interest which is compounded annually. A large principal "invested", even at a low interest rate, will always yield (R) more than a small principal invested at much higher rates because there is so much more principal on which to collect returns. Young trees sometimes have higher growth rates than older bigger ones, but it's not fast enough to make up for the large loss of principal (tree size) that occurs during short rotations; even if several rotations are made back-to-back. Projections based only on the theory suggest that if a harvest rotation is cut by half, for example from 100 years to 50 years, timber production could fall by as much as four-fold.

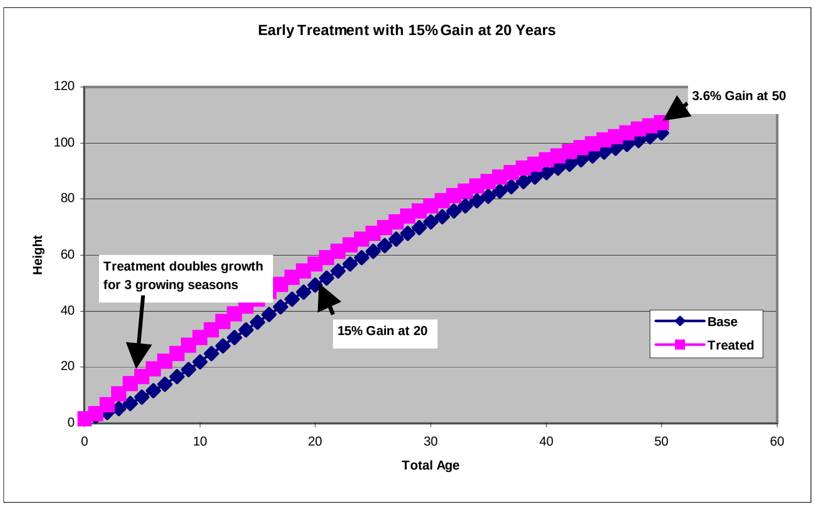
Empirical evidence

Brown tract—an example. The Brown family bought 272.3 acres of cut-over forest land in Yamhill county, Oregon in 1964. Net volume at that time was 1,939,000 board feet, comprised of trees from 4 to 10 inches dbh. The land was entered and selectively harvested fourteen times between1964 and 1985, which resulted in 4,303,990 board feet of timber being removed and sold. There was still 2,185,000 board feet of timber remaining after the final harvest in 1985 (Individual Tree Selection Management, Portland Oregon).

If the Brown tract had been clearcut and replanted for short rotation plantation forestry, only a maximum of 1,939,000 board feet of timber could have been harvested by the owners. They would also have grown a stand of newly planted trees to about twenty years of age by 1985. These newly planted trees, even under the best silvicultural management, could not produce 4,303,900 board feet of timber over the intervening twenty years. In fact, it is unlikely that the new plantation could even approach the 2,185,000 board feet of timber remaining on the Brown Tract after the fourteen selective harvests.

Willamette Industries Study. Dr. Greg Johnson, then of Willamette Industries Inc., conducted a study to compare Douglas-fir growth performance under optimal versus normal growing conditions, and to then project any growth advantage over different timeframes. The time periods were from 10 to 50 years after planting. All the trees studied were located on permanent plots, and data from stocktype studies, nursery bed density experiments, and first generation progeny tests were compared to trees planted under normal regeneration conditions following the clearcut. In all, 55,000 observations were compared (Figure 1, below).

Dr. Johnson found that after three growing seasons the growth of seedling trees intensively



managed was twice that of trees that were not. However after twenty years only a 15 percent gain in size was realized by the intensively managed trees, and after fifty years the gain was only 3.6 percent. If this study had been extended to 70 years, the now recognized normal rotation time for coast range forests, it is likely that no yield gain at all would have been realized.

This study raises serious questions about the value of (1) intensive plantation regeneration practices on tree yield, and (2) whether two or more short rotations can recover the yield lost from not growing trees of longer times.

Extrapolation of short-term research and operational results to long-term yield forcasts (Marshal and Turnblom, 2004). The stand level growth model DFSIM (Curtis et al. 1981) provided the earliest information on the growth of Douglas-fir plantations in western Oregon and Washington. However, plantation data available at that time was limited and this need for better information led to the establishment of the Stand Management Cooperative (SMC) at the University of Washington. In the early 1990s, the SMC began collecting growth data from throughout the region and developed a tree-level growth model, the SMC version of ORGANON (Hann et al. 2003). The SMC database now provides information on yields from managed plantations (Table 1).

These growth and yield projections compare Douglas-fir stands planted at different densities (trees /acre) over time intervals that range from 50 to 35 years. Yield declines from short rotations can be somewhat compensated by planting higher densities of trees. None-the-less, short rotation declines in tree yield ranged from 7 to 27 percent.

Table 1. Percent of predicted maximum MAI in total stem cubic foot per acre and merchantable (6-inch top diameter) cubic foot per acre at different rotation ages for a site 130 plantation with three target planting densities projected with the SMC version of ORGANON.

Target Planting Density	Total Stem Volume				Merchantable Volume			
	50 years	45 years	40 years	35 years	50 years	45 years	40 years	35 years
	%	%	%	%	%	%	%	%
302	93.7	87.5	78.5	66.6	90.1	82.4	71.6	57.5
435	98.4	95.7	89.9	79.8	93.9	88.8	80.0	66.5
680	99.6	98.6	96.6	93.3	96.2	92.5	86.6	77.4

Harvesting at rotation ages less than culmination (now considered to be 70-80 years in the Coast Ranges of Oregon and Washington) will probably reduce timber production even more than projected in Table 1 (above).

Producing wood of specific quality for designated end uses (Gartner et al. 2004). Intensively managed forest plantations will almost certainly have shorter rotations than plantations that are managed less-intensively. Rotation length probably has the largest effect of any silvicultural practice on softwood wood quality because, compared to old logs, young logs will have a higher proportion of juvenile wood and sapwood. The transition from juvenile to mature wood is related to log age (that is, the number of growth rings outward from the pith at any point), not to radial growth rate.

Therefore, even if intensive plantation management (IPM) can produce the same-sized log as less intensive management, the IPM-grown logs will be younger and thus have different qualities. For most applications, the effects of juvenile wood are negative. In softwoods, juvenile wood (as compared to mature wood) tends to be weaker; to shrink, swell, and warp more; to have shorter tracheids; to have lower wood density and pulp yield; to be more uniform across the growth ring; and to have wider growth rings and more frequent knots. The higher sapwood proportion also will decrease overall extractive content and increase treatability, moisture content, rate of drying, and possibly gluability.

Literature Cited (Radosevich)

Curtis, R. O., G. W. Clendenen, and D. J. DeMars. 1981. A new stand simulator for coast Douglas-fir: DFSIM user's guide. General Technical Report. PNW –28. Pacific Northwest Forest and Range Experiment Station, USDA Forest Service, Portland, OR. 79p.

Gartner, B., D. Newton, R. McKinley. 2004. Producing wood of specific quality for designated end uses. Proceeding: Intensive Plantation Forestry in the Pacific Northwest, p 32-34.

Harper, J. L. 1977. Population Biology of Plants. Academic Press, London. 892p.

Hann, D.W. D.D. Marshall and M.L. Hanus. 2003. Equations for predicting height-to-crown-base, 5-year diameter growth, 5-year height growth, 5-year mortality rate, and maximum size-density trajectory for Douglas-fir and western hemlock in the coastal region of the Pacific Northwest. Research Contribution 40, Forest Research Laboratory, Oregon State University, Corvallis. 83p.

Individual Tree Selection Management. 204 American Bank Bldg. 621 SW Morrison. Portland Oregon.

Johnson, G. Personal Communication. Weyerhaeuser Corporation. P.O. Box 907 Albany, Or.

Lambers, H., H Poorter and M.. Van Vuuren. 1998. Inherent variation in plant growth. Backhuys Publsihers, Leiden. 591p.

Marshal, D. D. and E. C. Turnblom, 2004. Extrapolation of short-term research and operational results to long-term yield forecasts. Proceeding: Intensive Plantation Forestry in the Pacific Northwest, p 53 -56.

SALMON ANCHOR HABITAT WORK GROUP AND CONFERENCE, EXPERT RESPONSE

Monitoring: Dr. Phil Larsen and Kelly Moore

Note: The first part of this response was provided by Dr. Phil Larsen of the US EPA Western Ecology Division in Corvallis. The second part was provided by Kelly Moore, Oregon Watershed Enhancement Board Monitoring Advisor.

"What are possible approaches for monitoring the effectiveness of SAH Strategies?"

"What is the appropriate time frame for monitoring SAH effectiveness?"

Phil Larsen:

Possible approaches for monitoring effectiveness: First, we assume that effectiveness consists of two parts: 1) maintenance and improvement of key habitat forming processes (such as supply and transport of water, sediment, wood, nutrients) and 2) improvement of wild salmonid productivity within these SAHs, compared with areas not subject to SAH management.

The premise to be evaluated is whether changes/trends in habitat and wild salmon productivity in stream networks and watersheds subject to SAH differ from those not subject to SAH.

Issue 1: Under ideal, experimental design, circumstances, stream networks and watersheds would be randomly assigned to SAH treatment. However, for numerous reasons, SAH treated systems were selected with other criteria in mind. Therefore, a key issue is whether there are natural differences between the two sets of stream networks/watersheds. The key question here is whether changes/trends could be attributed to natural differences between the two groups.

Issue 2: Both habitat forming processes and salmon productivity are difficult/expensive to assess. As a result, it is usual to identify indicators that reflect the habitat forming processes and salmon productivity. The extent to which the indicators and their trajectories reflect the trajectories of the underlying processes is a subject of ongoing technical discussion.

Issue 3: No one has a good estimate of the expected magnitude of change associated with the two different management actions. However, habitat and productivity are expected to change slowly in response to the kinds of management actions anticipated under the two scenarios. As a result, it will be especially difficult to detect differences in trajectories between SAH managed systems and those not managed under SAH, particularly in the 10 year time frame anticipated. Without a clear idea of expected magnitude of change, it is not possible to set an "appropriate time frame for monitoring SAH effectiveness".

Recommendations for Landscape level evaluation and monitoring:

1) Conduct a thorough evaluation of the natural differences between the SAH treated systems compared with those not SAH treated. Convene a technical workgroup to identify the primary natural factors likely to be different between the two groups. Evaluate the extent to which these

natural differences might affect the potential differences in response of SAH treated systems compares with those not SAH treated.

2) Evaluate the extent to which historical factors might account for differences between the two types of systems: have the two types of systems been treated differently by human management in the past in a way that might affect their trajectories (the differential influence of hatcheries might be important here)? 3) Evaluate the "implementation effectiveness" for the two types of systems: Are the two groups of systems being managed according to their specified management plans?

As a component to the landscape level monitoring, classify the landscape into areas of high mass wasting potential (i.e., landslides); identify areas where mass wasting has occurred; also identify both natural and un-natural (i.e., road crossings/culverts) fish passage barriers. Identify areas of human disturbance, e.g. road networks (and road failures), mines (both gravel and other) any logging activity, areas of active restoration (bank stabilization), habitat addition (wood placement) and other habitat structures.

Habitat level evaluation and monitoring:
With respect to habitat, we assume that maintenance and improvement of key habitat forming processes is not amenable to direct, practical measurement, and that key channel and riparian indicators reflecting these processes would be selected for monitoring. Change (trend) in these habitat indicators in a favorable direction would imply that the habitat forming processes are on a favorable trajectory. Key habitat and riparian indicators are amenable to monitoring over time to evaluate change and trend. Whether change and trend are detectable depends on several key factors including magnitude of change/trend expected, survey design, and spatial and temporal variability.

Both expected change/trend and the necessary components of spatial and temporal variability are unknown for the Tillamook/Clatsop systems. As a result some commitment is necessary to a) evaluate the extent to which variability structure estimated from other systems is relevant to the Tillamook/Clatsop systems, and b) set up a monitoring network by which the variability structure can be estimated. The monitoring network can be set up both to estimate the variability structure and to begin monitoring to detect the trajectories. The monitoring network can be set up to meet accepted statistical design requirements that are in use for Oregon's coastal stream networks (ODFW and ODEQ Salmon Plan monitoring).

Salmon productivity evaluation and monitoring:
The key consideration is whether the productivity/survival of wild salmon in the SAH managed systems is improved compared with those not SAH managed. Salmon survival models have been built for coastal coho (and other species?). It would be necessary to run these models using as input the appropriate controlling factors and their expected trajectories based for SAH treated systems and those not SAH treated to evaluate the expected survival differences. Time frames are on the order of decades. The modeling can also be used to inform the selection of habitat indicators for monitoring.

With respect to salmonid productivity, the clearest estimate of the freshwater productivity is to evaluate the number of adults entering the system and the number of smolts exiting the system using traps at the outlets of the watersheds. Unfortunately, this is an expensive proposition as the traps are costly, and monitoring fish moving through the traps is time consuming. A key design question is a determination of how many watersheds of each type of management would be necessary to detect expected differences in productivity due to the different management types.

An alternative, but more ambiguous, approach would be to monitor the numbers of adult spawners in each type of system, and the numbers of resultant juveniles. Do SAH systems routinely draw more adults than those not treated (adjusting for natural differences), and is this changing over time? Do SAH systems produce more juveniles per adult spawner than those not treated? Here again, the variability structure that affects detection of differences for the Tillamook/Clatsop systems is largely unknown, requiring some up front evaluation.

ODFW uses all three approaches (modeling, life cycle watersheds, and network monitoring) across five coastal monitoring areas. Information obtained under these studies could be used to evaluate the sensitivity of various monitoring designs to evaluate differences between the two management types.

Kelly Moore:

Approaches for monitoring effectiveness of SAH Strategies should be derived from the objective of restoring key watershed processes, particularly the movement of sediment and organic matter through the system. Monitoring should be linked to watershed conditions that support these processes - presence of large conifers in riparian and upslope contributing areas, nutrient dynamics, and stream channel characteristics. Intensive monitoring of coho populations is also appropriate. Without going into detail, the monitoring approach should match that implemented under the Oregon Plan for Salmon and Watersheds, modified and intensified to suit the conditions in northwest Oregon forests. This would be a combination of EMAP-based Status and Trend monitoring, intensive monitoring at the watershed scale, and evaluation of specific restoration actions.

Time Frame. It will be a big challenge to link appropriate time frames for evaluating environmental response to certainty of protective management in anchor habitats. Monitoring should be set up to measure responses that may range from just a few years (such as implementation of protective riparian measures) to twenty years or longer (time needed to evaluate coho population response). What are the assurances that the protective measures established for anchor habitats will extend over that time? There is little evidence to suggest that management plans for State Forest Lands have sufficient longevity, and may even change on a biennial basis, either by legislation or initiative processes.

Perceived Costs and Benefits of SAHs, Economic and Social Values: Dr. Hans Radtke

"If clear cut harvests are limited within SAHs and some planned harvests are moved elsewhere within Clatsop and Tillamook State Forests, what are the longer term implications for harvests from those areas and for overall harvest levels, given that SAHs expire in January 2010?"

This is a distributional issue. A small amount of the direct fiscal impact (revenues derived from the timber sales) flows to counties. As long as the overall planned cuts are the same, it may shift the fiscal impact from one county to another and then shift it back to the other county later. There are also indirect fiscal impacts, such as investments from dependent service (for example log cutting) and manufacturing (for example sawmills) firms that add assessed value to tax bases. These firms may locate in one municipality or another to be closer to operations and markets. However, economic impacts (for example, household income from timber workers) flow to economic regions. Regions are generally defined by labor market areas (convenient commuting distance from residence to work) and Clatsop and Tillamook counties would be contained within the same region.

"What are the costs of SAH to counties and the state in terms of revenue impacts?"

Measure 5 and Measure 50 have changed the structure of revenue flows (Radtke and Davis 1997). The distribution shifts of any potential revenues from timber sales are about:

- 5% to county general fund
- 6.5% to special taxing districts
- 39% to schools. Becomes an offset, so neutral at the local level. At the state level, this may become a substitute for other revenue generating opportunities.
- 49% to the state for forestry related services

A more thorough discussion of the fiscal impact is shown in Exhibit 1, below.

Exhibit 1: Excerpt from Radtke, Hans D. and Shannon W. Davis. *Economic Considerations of the Future Use of the Tillamook State Forest With Emphasis on the Trask River Basin.* Prepared for Oregon Trout with funding from Northwest Area Foundation. August 1997.

F. LOCAL FISCAL IMPACTS OF TILLAMOOK FOREST HARVEST - AN EXAMPLE

The State of Oregon has experienced about ten years of significant economic growth. This has changed the reliance of local economics on traditional resource use. Economics that were once heavily dependent on timber harvests are growing with small manufacturing, electronic and service industries. Also changed is the fiscal interdependence of resource use and local government. "Things look different now" for local entities. The effects of Measure 5 and Measure 50 mean that most revenues from timber harvests that used to flow to local schools now are a component of State school support. State timber receipts are subtracted from per enrollment funding of K-12 schools.

The formula for distributing revenues from timber receipts is displayed in Figure 7. These are legal distribution formulas whose actual impacts have been changed dramatically as a result of Measure 5 and Measure 50. The result of these measures is that, even though revenues may be dedicated to local taxing districts, the actual impact on these entities is minimal.

The following is an example of the actual flow of funds for a two million board foot sale of timber in the Tillamook State Forest (Figure 8).

The basic assumptions are:

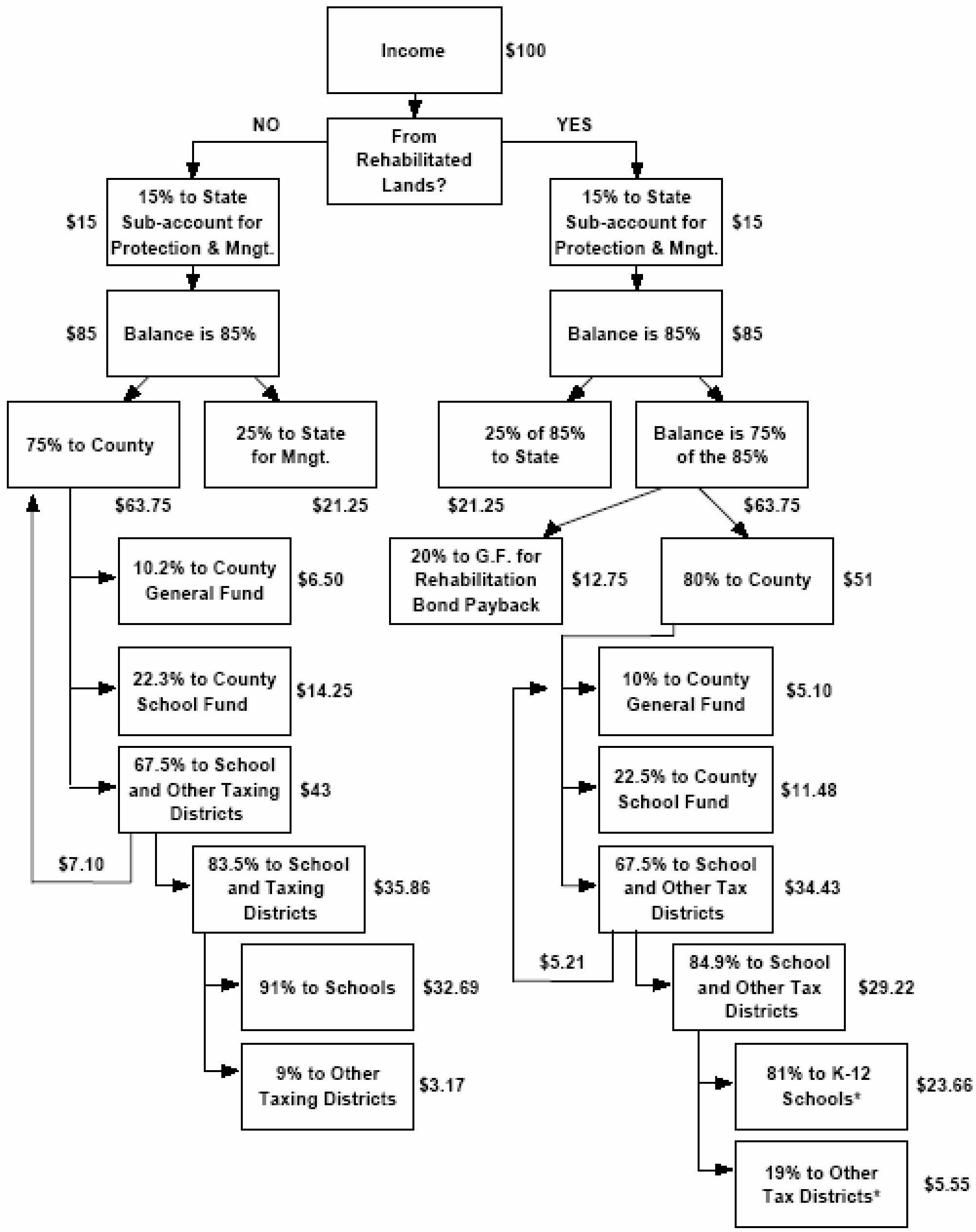
- Involves several individual harvest sites
- Two million board foot sale in Tillamook County
- Bid price is $1,000,000 @ $500 per MBF
- Sale is from State Board of Forestry Rehabilitated Lands

The general distribution of funds are (see Figure 8):

- 49% to State of Oregon = $490,000
  - --- $150,000 to State subaccount for Protection and Management
  - --- $212,500 to ODF for management
  - --- $127,500 for Rehabilitation Bond Payback

- 51% to county = $510,000
  - --- $103,000 to County General Fund
    - ➢ 51,000 via County General Fund
    - ➢ 52,000 via Taxing District Allocation

Figure 7
Distribution of Income from Board of Forestry Lands



* Based on current property tax levies.

Figure 8
Revenue Flows of Tillamook Harvest of a $1 Million Timber Sale

State of Oregon	Tillamook County	Local Schools*	Other Taxing Districts
$490,000	$103,000	$392,390	$14,610
	County budget increases or tax liabilities are reduced, depending on spending priorities	Considered a component for per enrollment statewide K-12 school support	District budgets increase or tax liabilities are reduced, depending on spending priorities

* State of Oregon does not send $392,390 to Tillamook schools.

--- $392,390 to schools
- $114,800 via County School Fund
- $277,590 as School Taxing Districts

--- $14,610 other Taxing Districts

The effects of Measure 5 and Measure 50 are:

◊ Assumptions:

- Annual budget growth is restrained by local decision making on spending priorities
- Decisions to increase overall budgets and super majority votes for bond measures are not successful
- State established a per enrollment school support formula

◊ Financial flows and effects:

- Revenues to schools: State lowers the amount of local school support by $392,390.
- Revenues to counties: $103,000 to County Funds. County property tax levy would be lowered by $103,000, in order for the County budget to stay the same or the County budget is increased and the property tax levy would stay the same, depending on local spending priorities.
- Other Taxing Districts: Same situation as counties.

Forty-nine percent of the timber receipts are returned to the State of Oregon for revenue bond payments and ODF management. Fifty-one percent are returned to local government. The distribution of State timber receipts in Tillamook County in FY 1995-96 is about 12 percent of school budgets, four percent of the County budget, and about two percent of other taxing district budgets.

For schools, Measure 5 means almost all increases in revenues from Board of Forestry Lands are treated as a component of K-12 per enrollment school support.[1] The State reduces its contribution to schools by the same amount of timber receipts. A prorated share of timber receipts can be used for bond payments. Therefore, the harvest revenues in effect become State revenues.

1. Most of the lands in the Tillamook Forest are Board of Forestry Lands. About three percent of the stumpage revenue in 1996 from Tillamook and Clatsop Counties from State managed forests went to the Common School Fund. These funds and future returns from these funds are allocated to schools throughout Oregon.

“What are the benefits of SAHs in terms of market and non-market values?”

Besides timber production, the land/water within the SAH area produces a host of actual and potential benefits. These range from the use of salmon and steelhead that are harvested in the ocean, to use of wildlife that is dependent on the late succession forest, and to attracting economic growth for surrounding regions. The enclosed section from Radtke and Davis (1997) is one attempt to identify and to estimate the extent of some of these benefits (Exhibit 2).

Most economic analysis will be incomplete because not all changes in long range values and external costs will be addressed. Long range value changes are those that can be expected to occur after management plan adjustments are absorbed. If these future changes were included, the revenue or costs streams would be reduced to annual net present values in order for them to be used in the analysis.

Short term value changes are the immediate gains or losses to be expected to occur if the status quo is changed. These types of changes are usually included in an analysis, but the impacts on national, state, and local economies are analyzed only in terms of dollar flows. Economic values can also be nonfinancial (no market information), as well as be financial (market information exists). For example, people (termed nonusers) who do not actually fish for salmonids will still place a value on the existence of the resource. Deriving this value must rely on nonmarket information. Because of lack of budget resources to do a more comprehensive analysis, the values of the nonusers are generally not evaluated. Those values will play a significant role in determining future programs related to the management of the resource and should be a criteria in any policymaking.

Nonmarket values include livability considerations, and livability is becoming more important as Pacific Northwest economies mature. Regional economic growth or decline is predicated upon the comparative advantages of a region's resources. As local economies mature, it is becoming dependent upon high-technology industries; industries that require a highly educated, highly skilled workforce. There is no doubt that one of the competitive advantages is livability relative to other areas. It will not be necessary to pay premium compensation for a degraded environment or for overcrowding. Scenic and productive river basins can play an important role in drawing the major components of economic growth: capital and a highly skilled work force.

All external costs are also not usually evaluated. Prices of products or services sold in the open market often do not reflect all the costs of making the product or providing the service. External costs are passed on to others in society, often in the form of dirty air, polluted water, or less biodiversity. External costs are often difficult to identify and hard to quantify, but they can significantly decrease the value to society of commodity production. Although it would not be easy to allocate these costs to resource management plan strategies, they could make up a significant part of the costs of producing commodity outputs and should be evaluated along with market and nonmarket values. An attempt to calculate the value of protecting estimates that a stream in a watershed not being clear-cut may be worth $32,007 per mile in just natural coho production (Exhibit 3). Other anadromous fish and resident species production would have to be added to just complete the analysis for fisheries impacts, let alone the other above mentioned benefits.

Exhibit 2: Excerpt from Radtke, Hans D. and Shannon W. Davis. *Economic Considerations of the Future Use of the Tillamook State Forest With Emphasis on the Trask River Basin.* Prepared for Oregon Trout with funding from Northwest Area Foundation. August 1997.

3. Economic Contribution of Marine Resources of the Tillamook Watershed

Northwest Oregon state forests provide habitat for rearing salmon (chinook, coho, and chum), steelhead, and cutthroat trout (resident and seagoing). Other marine wildlife also depend on the water quality and quantity of the rivers and estuaries of the Tillamook watershed. The abundance of these marine resources attracts commercial and recreational activities that generate local income. This section discusses the economic contribution of marine resources to local communities.

The Tillamook watershed forests contribute to local economic activities outside forest boundaries as well as generating economic activity within forest boundaries. For example, salmon produced in forest streams may be caught in ocean commercial fishing, an activity clearly outside forest boundaries. These off-forest economic contributions may be as important or even more important than on-forest economic contributions such as recreational fishing in forest streams.

Important economic activities in local communities made possible by Tillamook watershed marine resources include the following activities.

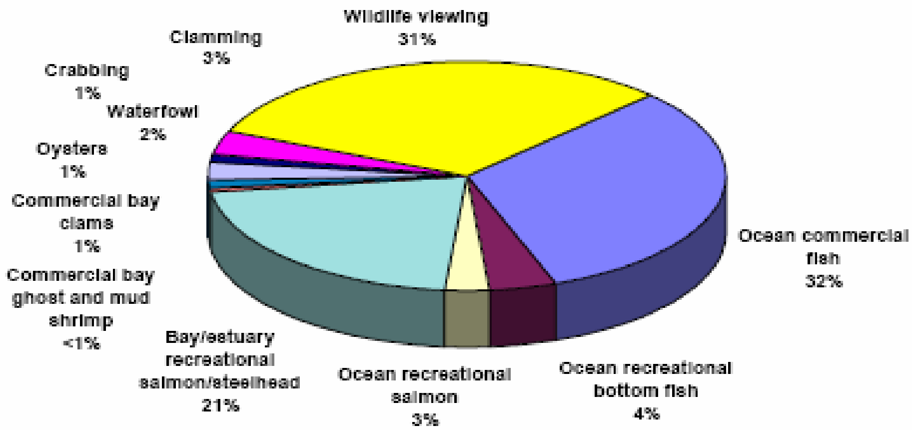
1. Upriver freshwater recreational fishing, crabbing, and clamming.
2. Recreational fishing in the bays and estuaries.
3. Recreational waterfowl hunting.
4. Wildlife viewing.
5. Commercial bay shrimp, clam, and oyster production.
6. Ocean commercial and recreational fishing.
    a. Direct harvest of Tillamook watershed-produced fish.
    b. Recreational and commercial access to hatchery-produced fish resulting from wild coho being the constraining factor in fishing season management.
    c. Ocean access to the commercial chinook fishery. In times of adverse ocean conditions, the freshwater survival through habitat protection and habitat management becomes a critical component of the salmon life cycle.

Tillamook watershed marine resources make a number of contributions to local economies. Estimated economic impacts are expressed in terms of annual personal income. Resource availability and harvest management policies change from year to year. This discussion should therefore only be used to describe in general the local impact of these resources. These direct impacts may only be a small percent of the total economic impact of these resources. This is especially true of wild coho production in the Tillamook watershed. In total, the marine resources of the Tillamook watershed contribute about $15 million per year to the Tillamook Bay communities. Figure 3 summarizes 1994 Tillamook Bay-dependent resource use and the resulting personal income.

Tillamook Bay allows access to ocean fisheries and is also the nursery for some commercially harvested marine species. Commercial fish landed by fishermen from Tillamook Bay generated a total of $4.9 million of personal income for the local economies in 1994 (Radtke and Davis, 1994a). The harvest of Tillamook Bay shrimp and clams generates about $95,000 in personal income per year. Oysters are farmed on state-owned marine lands with lease agreements. In 1994, oyster production from Tillamook Bay generated a total of $161,000 in personal income to the local economy (Radtke and Davis. 1994a).

Recreational ocean fishing dependent on Tillamook Bay also contributed to local economies. Ocean recreational salmon and bottom fishing generated $1.1 million in personal income (see Figure 3). Bay and estuary recreational salmon and steelhead

Figure 3
Tillamook Bay Marine Dependent Resource Use and
Annual Local Economic Contribution in 1994



Uses	Unit	Amount	Local Economic Contribution
Ocean commercial fish landed (pounds)	$1.44	3,403,101	4,900,465
Ocean recreational bottom fish (angler days)	$41.25	15,093	622,586
Ocean recreational salmon (angler days)	$41.25	10,700	441,375
Bay and estuary recreational salmon and steelhead (c	$20.33	160,528	3,263,534
Commercial bay ghost and mud shrimp (pounds)	$1.65	885	1,460
Commercial bay clams (pounds)	$1.65	57,356	94,637
Oysters (pounds)	$1.05	152,932	160,579
Waterfowl (hunter days)	$34.00	10,600	360,400
Crabbing (angler days)	$20.33	9,758	198,380
Clamming (angler days)	$20.33	25,000	508,250
Wildlife viewing (visit days)	$17.00	279,100	4,744,700
Total economic contribution			15,296,367

Notes:
1. The calculations do not differentiate between local and out-of-area visitors.
2. Economic contribution is measured in personal income impact and includes multiplier effects.
3. Multipliers are derived from U.S. Forest Service IMPLAN input-output model for Tillamook County.

Sources: Estimates of recreational activity provided by the Oregon Department of Fish and Wildlife (ODFW) are made without actual surveys of use. Ocean commercial fish landed and ocean recreational fishing days are from ODFW records. Oyster harvests are from Department of Agriculture. The other estimates are from The Research Group (1992) and Radtke and Davis (1994).

fishing generated $3.3 million in personal income. The Tillamook watershed ranked second to the Rogue system in the amount of income generated by recreational fishing in coastal watersheds. Recreational hunting, crabbing, and clamming in the Tillamook Bay generated another $1.1 million.

Wildlife viewing, especially birdwatching, in the Bay attracts an estimated 253,760 annual visitor days. At an estimated $16 in personal income generated per day of wildlife viewing, this generates about $4.1 million in income per year.

The natural resources of the Tillamook watershed produce a range of benefits. Some may be quantified as income generated. Other non-market benefits from these resources may exist in the Tillamook Forest. Such possible benefits are displayed in Table 5.

Table 5
Examples of Regional Economic Impacts (REDs) and
Net Economic Values (NEDs) of Non-Timber Resource Uses

Uses	Regional Personal Income Economic Impacts (REDs) Per Unit Impacts in $	National Economic Benefits (NEDs) Per Unit (value in $)
Ocean Commercial Fishing		
(a) Salmon		
(1) Chinook	3.20 per lb.	2.60 per lb.
(2) Coho	2.40 per lb.	1.50 per lb.
(b) Pink shrimp	0.80 per lb.	0.70 per lb.
(c) Groundfish	0.65 per lb.	0.40 per lb.
(d) Crab	2.50 per lb.	1.40 per lb.
(e) Other	1.00 per lb.	1.00 per lb.
Bay Commercial Seafood Production		
(a) Oysters	35.00 gal.	15.75 gal.
(b) Clams	1.65 per lb.	0.75 per lb.
(c) Shrimp(mud/ghost)	1.65 per lb.	0.75 per lb.
(d) Crab	2.50 per lb.	1.59 per lb.
Ocean Recreational Boating (per day)		
(a) Ocean salmon fishing	37.50 Private Angler per day; 88.27 Charter Boat per day	
(b) Wildlife viewing	17.00 - 25.06 per day	26.00
Steelhead and Salmon Fishing (per day)		
(a) Steelhead fishing	36.33 per day	20.00 - 60.00 per day
(b) Salmon fishing	46.16 per day	35.43 per day
Other Bay and River Recreational Use		
(a) Clamming	11.50 - 20.33 per day	
(b) Crabbing	11.50 - 20.33 per day	26.00 per day
(c) Wildlife viewing	17.00 - 25.06 per day	
(d) Waterfowl hunting	34.00 per day	19.00 per day
Other Non-Market Economic Values		
(a) Riparian areas and wetlands conservation		5.09 to 16.61 per household per year
(b) Increased water flows for habitat and recreation		1.55 to 11.35 per household per year
(c) Municipal and industrial water use due to water quality and habitat improvements		14.20 to 160.19 per household per year
(d) Salmon - preservation value or additional fish		223 per fish per household per year
(e) Dam removal - Olympic Peninsula - restore ecosystem		68.49 per household per year per additional fish
(f) Wilderness - natural habitat protection		59 to 73 per household per year
(g) Wildlife - existence value		
(1) Whooping Crane		11.14 per household per year
(2) Northern Spotted Owl		1.08 to 9.33 per household per year
		49.72 to 86.32 per household per year
Forest Recreational Uses		
(a) Deer hunting	$36.28 per day	$41.00 per day
(b) Elk hunting	$40.25 per day	$41.00 per day
(c) Upland game hunting		$34.00 per day
(d) Wildlife viewing	17.00 - 35.06	$26.00 per day
(e) Gathering forest products		$16.48 per day
(f) Picnicking		$17.26 per day

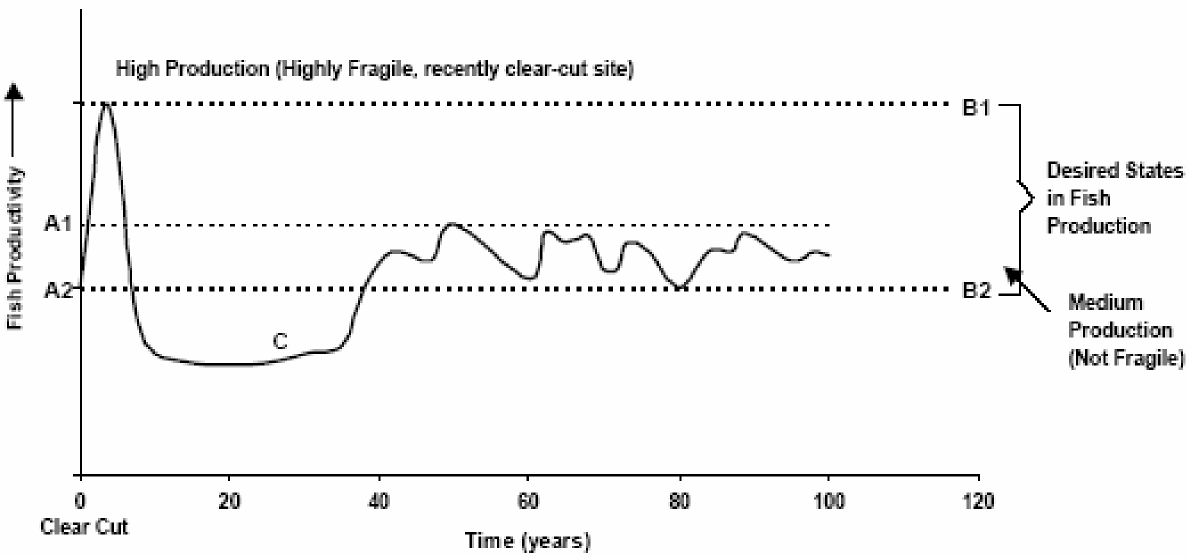
Sources: Estimates of economic impacts and net economic benefits of marine resources come from various publications of the Pacific Fishery Management Council (PFMC), Portland, Oregon. Estimates for recreational uses and other non-market values are from other studies. Citations are available from authors.

Exhibit 3: Excerpt from Radtke, Hans D. and Shannon W. Davis. *Economic Considerations of the Future Use of the Tillamook State Forest With Emphasis on the Trask River Basin.* Prepared for Oregon Trout with funding from Northwest Area Foundation. August 1997.

D. FISH PRODUCTION

In salmon producing watersheds (e.g. coho at 40 spawners per mile of stream), a one percent change in inland survival of smolts will return about $450 annually. A report prepared for the Oregon Department of Forestry (ODF) (popularly called the Botkin report) presented a graphic depiction of expected salmon production in a clear cut timber harvest watershed (Figure 6). Timber harvesting in such watersheds may produce a total economic loss of $32,007 in coho production. (At a six percent interest rate, the stream in the watershed not being clear-cut may be worth $32,007 per mile in natural coho production (Table 8).) Additional returns may occur from increased production of other salmon and trout species. Any improvement that increases fresh water smolt survival generates significant economic returns. Depending on ocean survival conditions, the annual returns to a mile of stream may be as high as $4,500 per year, the capitalized value of one mile of stream for which production may be as high as $50,000 (Table 9).

Figure 6
The Level of Salmon Production in a Stream During Riparian Succession
Over a 100 Year Period Following a Clear Cut to the Stream Edge



Notes: 1. Normal long-term fish production in a mature forest environment is between A1 and A2. Desirable production levels fall within the range of B1 and B2. The portion of the line labeled C is the period of low production between five and 40 years following clear cut.

2. Does not include cumulative effects of timber harvesting, such as effects from upstream landslides.

Source: Botkin et al. 1994.

Table 8
Calculations of Present Value of Salmonid Production of a Forty Year Timber Rotation
(six percent interest rate)

Fish Production Gains		Fish Production Losses	
Year	Discounted Economic Value at 6%	Year	Discounted Economic Value at 6%
1:$0 =	0	6-40:$450 x 0.70 x 154 =	$48,510
2:$450 x 0.94 x 10.3 =	4,357		
3:$900 x 0.89 x 10.3 =	8,253		
4:$450 x 0.84 x 10.3 =	3,893		
5:$0 x 0.79 x 10.3 =	0		
Total Economic Value	$16,503		

Difference Between Fish Production Gains and Losses:

($48,510) + $16,503 = ($32,007)
losses gains present value of net losses

Notes:

1. The following assumptions are made:
   - gains
     - 1st year 0
     - 2nd year 1% gain
     - 3rd year 2% gain
     - 4th year 1% gain
     - 5th year 0
   - losses - from year 6 through 40 at a 1% loss per year
2. Economic returns (or losses) that take place in the future are discounted to the present and compounded for 40 years.

Source: Study.

"What are the economic effects of ODF's proposed harvest increases over the long term compared with harvesting on a longer rotation?"

Business return considerations are generally secondary to other benefits from public resources such as the Tillamook/Clatsop forests. If only financial returns to intensive timber management are considered, the most likely outcome would be 35 to 40 year rotations. The second alternative would be for a timber harvest natural regeneration (low intensive management) at rotations of about 150 to 200 years. The third alternative is a mix of the two. The outcome includes social and political consideration, with some economic input (Exhibit 4).

Exhibit 4: Excerpt from Radtke, Hans D. and Shannon W. Davis. *Economic Considerations of the Future Use of the Tillamook State Forest With Emphasis on the Trask River Basin.* Prepared for Oregon Trout with funding from Northwest Area Foundation. August 1997.

C. TIMBER PRODUCTION

Timber production on a per acre basis in the Tillamook Forest Watersheds may yield production of about 0.50 to 0.65 MBF per year for a net value of about 26 MBF in 50 years and about 54 MBF in 80 years.[1] The annual increase is the greatest between the years of 40 and 65 years (Tables 6a and 6b). However, even in the year 80, the annual volume increase is greater than the average annual production. From a volume production standpoint, timber production is increasing up to and beyond 80 years. Without considering the cost of money and the opportunity cost of revenues, the conclusion may well be made that incremental wood production may well increase in longer rotation periods and that there is no cost in not harvesting (Figure 4).

In economic evaluation of timber production, price forecasts and the discount rate are the overwhelming decision factor. In the past, when substantial annual price increases took place, an extrapolation of the price increases led to annual price growths of up to four percent per year. For the future, such price increases may not be substantiated. Therefore, it is prudent to use existing real prices in analyzing future returns. In analysis of long term projects, the discount rate, at a period of 50 years, becomes the critical factor (Figure 5).

Investment analysis of timber production (with intensive timber production management) shows the importance of time and interest rate assumptions to the final outcome. With an interest rate of up to four percent, the benefit/cost (B/C) ratio is positive at 50 years and 80 years. This drops to a less than one B/C ratio at six percent interest rate. At seven percent over an 80 year time period, the B/C ratio declines to 0.12. This underscores the dilemma facing public agencies attempting to justify timber management for late successional forests (Table 7).

If the decision is to include other than market returns in evaluation of forest management, then economic considerations should be secondary to the non-market considerations.

1 This assumes that the average productivity of the area is represented by Tables 6a and 6b. According to Angle, et al. (1996), the representative soil classes are nine percent in Class I, 56 percent in soil Class II, 32 percent in soil Class III, four percent in Class IV and V for a total land base of 97 percent.

Table 6a
Investment Analysis on Timber Production

Assumptions:

1. Age of harvest: 50 years or 80 years
2. Costs of manual preparation, conversion from grass or recent clear cut:
   a. Site preparation $ 99.00
   b. Plant trees 208.10
   c. Animal protection 144.30
   d. Release-survival 462.00
   Total costs per acre $913.40
   Annual management fee $2.00 per acre
   (No land costs are included)
3. Revenues:
   a. 50 years: $15,982
   b. 80 years $30,509

Source: Study. Compiled from information provided in Table 6b of this section.

Table 6b
Calculation of Forest Trust Timber Values Nonindustrial Plant and Clear-cut

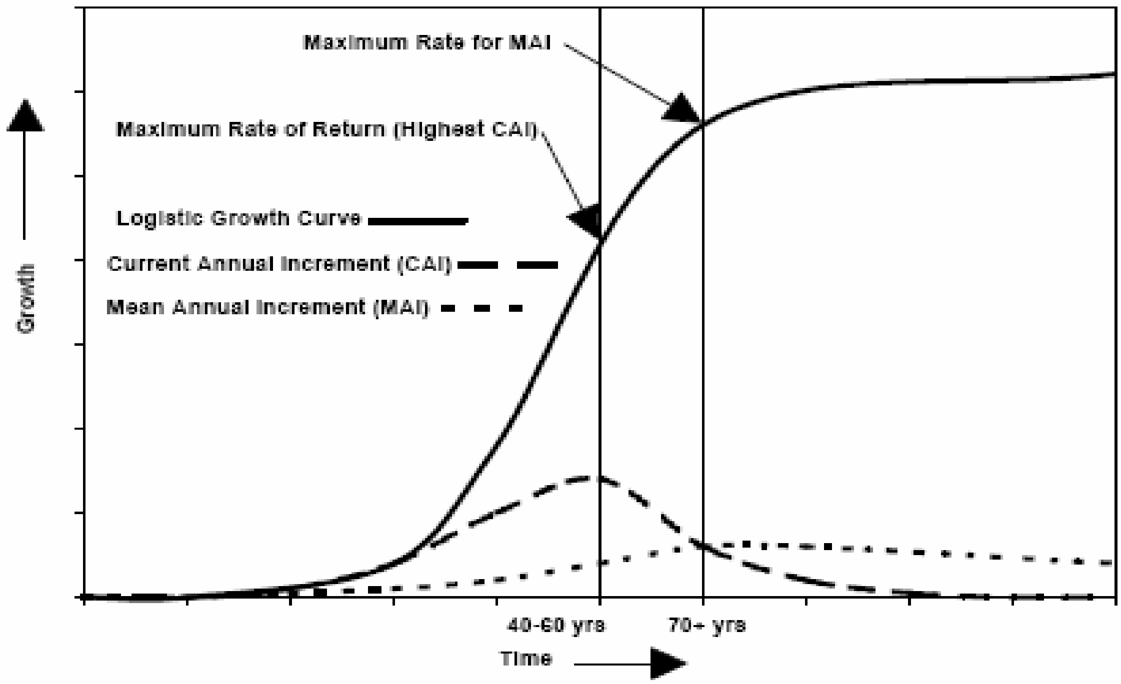
Age	MBF	DBH	% Remaining After Yield Reduction DEFECT	ABILITY	UNSTOCK-ABLE AREA	UNLOGGABLE FPA ETC	FIRE & PEST	CLUMP-INESS	NET VOLUME	ANNUAL VOLUME INCREASE IN MBF	PERCENT INCREASE	AVERAGE ANNUAL PRODUCTION IN MBF
20	0.00	0.00	1.00	0.98	0.99	0.95	0.99	0.96				
25	2.19	7.10	1.00	0.98	0.99	0.95	0.99	0.96	1.92	0.08		
30	6.08	8.40	1.00	0.98	0.99	0.95	0.99	0.96	5.32	0.68	1.77	0.18
35	10.76	9.50	1.00	0.98	0.99	0.95	0.99	0.96	9.37	0.81	0.76	0.27
40	16.44	10.60	0.99	0.98	0.99	0.95	0.99	0.95	14.09	0.94	0.50	0.35
45	23.97	11.50	0.99	0.98	0.99	0.95	0.99	0.95	20.45	1.27	0.45	0.45
50	30.80	12.30	0.98	0.98	0.99	0.95	0.99	0.94	25.86	1.08	0.26	0.52
55	36.37	13.00	0.98	0.98	0.99	0.95	0.99	0.94	30.36	0.90	0.17	0.55
60	43.91	13.70	0.97	0.98	0.99	0.95	0.99	0.93	36.11	1.15	0.19	0.60
65	50.95	14.40	0.97	0.98	0.99	0.95	0.99	0.93	41.68	1.11	0.15	0.64
70	57.55	15.10	0.96	0.98	0.99	0.95	0.99	0.92	46.33	0.93	0.11	0.72
75	64.11	15.70	0.96	0.98	0.99	0.95	0.98	0.92	50.83	0.90	0.10	0.68
80	69.82	16.30	0.95	0.98	0.99	0.95	0.98	0.91	54.46	0.73	0.07	0.68

KINGS S1 105

Age	SM+	GRADE % 2 SAW	3 SAW	VALUE BY GRADE SM+	2 SAW	3 SAW	POND VALUE	LOGGING &HAULING	STUMPAGE VALUE	HARVEST TAX	SEVERANCE TAX	NET VALUE
20	0.00	0.00	0.00	$818.75	$773.75	$683.75	$0	$160	$0	$2.14	6.40%	$0
25	0.00	0.00	1.00	$818.75	$773.75	$683.75	$1,310	$160	$1,004	$2.14	6.40%	$935
30	0.00	0.00	1.00	$818.75	$773.75	$683.75	$3,638	$160	$2,787	$2.14	6.40%	$2,597
35	0.00	0.00	1.00	$818.75	$773.75	$683.75	$6,406	$160	$4,907	$2.14	6.40%	$4,573
40	0.00	0.12	0.88	$818.75	$773.75	$683.75	$9,789	$160	$7,534	$2.14	6.40%	$7,022
45	0.00	0.24	0.76	$818.75	$773.75	$683.75	$14,421	$156	$11,232	$2.14	6.40%	$10,469
50	0.00	0.24	0.76	$818.75	$773.75	$683.75	$18,243	$156	$14,208	$2.14	6.40%	$13,243
55	0.00	0.35	0.65	$818.75	$773.75	$683.75	$21,733	$151	$17,144	$2.14	6.40%	$15,982
60	0.00	0.47	0.53	$818.75	$773.75	$683.75	$26,216	$147	$20,908	$2.14	6.40%	$19,493
65	0.00	0.47	0.53	$818.75	$773.75	$683.75	$30,262	$147	$24,135	$2.14	6.40%	$22,501
70	0.00	0.53	0.47	$818.75	$773.75	$683.75	$33,890	$143	$27,264	$2.14	6.40%	$25,420
75	0.02	0.57	0.41	$818.75	$773.75	$683.75	$37,497	$137	$30,534	$2.14	6.40%	$28,471
80	0.02	0.57	0.41	$818.75	$773.75	$683.75	$40,181	$137	$32,719	$2.14	6.40%	$30,509

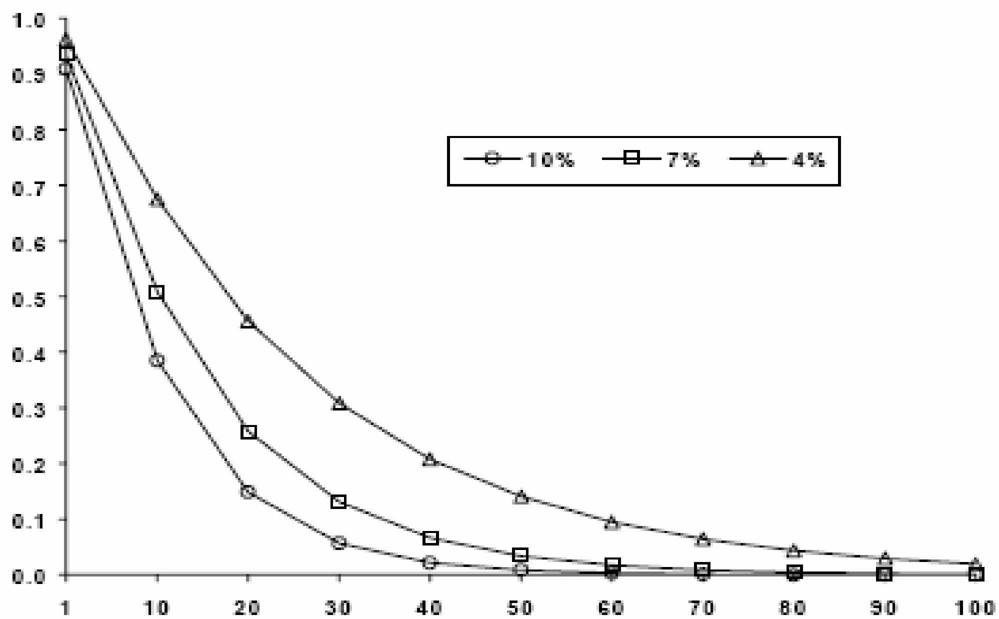
Source: Lettman 1995.

Figure 4
Growth Functions (Curves) Used Commonly in Natural Resources Management



Notes: This figure is a hypothetical homogeneous production function of timber volume.

Figure 5
Present Value of $1 Over 50 Years Using Various Interest Rates



Source: Study.

"Are there alternative forest management prescriptions that could be applied to the SAH areas that will protect key habitats and processes, as well as provide greater timber revenues over a longer time frame than can be obtained by the short term high harvest regime currently in operation?"

These alternatives may be listed as three very different strategies. They may range from a monetary investment program to intensive forestry to forest production that includes ecological diversity protection (Exhibit 5).

Exhibit 5: Excerpt from Radtke, Hans D. and Shannon W. Davis. *Economic Considerations of the Future Use of the Tillamook State Forest With Emphasis on the Trask River Basin.* Prepared for Oregon Trout with funding from Northwest Area Foundation. August 1997.

G. ALTERNATIVE MANAGEMENT CONSIDERATIONS

The State is now deliberating a rule through which the State will define, for purposes of long term management, the "greatest permanent value," as required in statutes for these lands. On private lands, the objective may be to generate the greatest return on investment on strict monetary considerations, without any consideration for damages to fish, wildlife, water quality, etc. that may result from such a program. Or, it may include some intensive forest management with present monetary value considerations. On State forests, other considerations must also be included. These may include a steady flow of timber products to local industries, even revenue flows to local communities, and maximum protection of water quality and natural resource diversity.

This section briefly discusses key considerations of some of these objectives and reviews three management alternatives that include many of these objectives.[1]

1. Alternative 1 - Divestiture and Monetary Investment Program

This assumes an alternate investment strategy will yield a 10 percent return. To meet the minimal Oregon Forestry Practices Act requirements, minimal replanting and stream protection program may cost about $300 per acre for replanting and remove about 10 percent of the land base from harvest. That leaves 324,000 acres to be harvested out of a total of 364,000 acres in the Tillamook State Forest. The assumption is that an average acre at the present contains 17,500 board feet per year.

Table 10
Return From Selling Timber, Selling Land

Land sale @ $300 per acre x 364,000 acres	=	$109,200,000
Less minimal replanting costs @ $300 per acre	=	$109,200,000
Difference	=	0
Timber net present value of 17,500 board feet at $500 MBF is $8,750 per acre x 324,000 acres	=	$2,835,000,000
Annual return at 10 percent return on investment	=	$283,500,000

Investment strategy is to leave three percent in the account for inflation and removes seven percent per year for disbursement.

Annual disbursement is $198,450,000.

1. The Oregon Department of Forestry has prepared a "Structure Based Management Approach." Not enough specifics are described to understand the intrusion into watersheds on a geographic as well as time scale. Such a program may well be part of a forest management plan, if it meets the requirements of water and other resource protection. However, the crucial point is the amount of time and the scale of recurring intervention into a natural watershed.

Although this alternative may yield the largest monetary return, it ignores non-monetary benefits and costs related to such a strategy. This alternative is only presented to address the simple question, "What is the greatest return," if monetary considerations are the only considerations. Such a program would incur consequences that would not be acceptable to the citizens of Oregon and should not be taken seriously, because it doesn't reflect society's values toward public forest land management. Some of the consequences are:

- A 364,000 acre clear-cut in a very short time frame
- Increased flooding and chronic landsliding and siltation
- Destruction of native plant, animal, and fish species habitats
- Water quality problems
- "Boom and bust" in local industries
- Public outrage over violation of public trust

2. Alternative 2 - Intensive Forestry

This options assumes that standing timber is harvested on a 50 year or 80 year rotation basis. On 324,000[1] acres at 500 board feet average growth per year, annual yield is 162,000 MBF on 6,480 acres per year at 25 MBF per acre for a 50 year rotation; 223,000 MBF annually per year on 4,050 acres per year at 55 MBF per acre for an 80 year rotation. The cost of such an intensive management program is $913 plus two year annual per acre management fee. The higher marginal growth rates past 50 years increase the average overall yield for an 80 year rotation.

The cost of intensive forest management is $913 plus a $2 per year recurring management fee. At a seven percent interest rate, the following investment decisions should be considered.

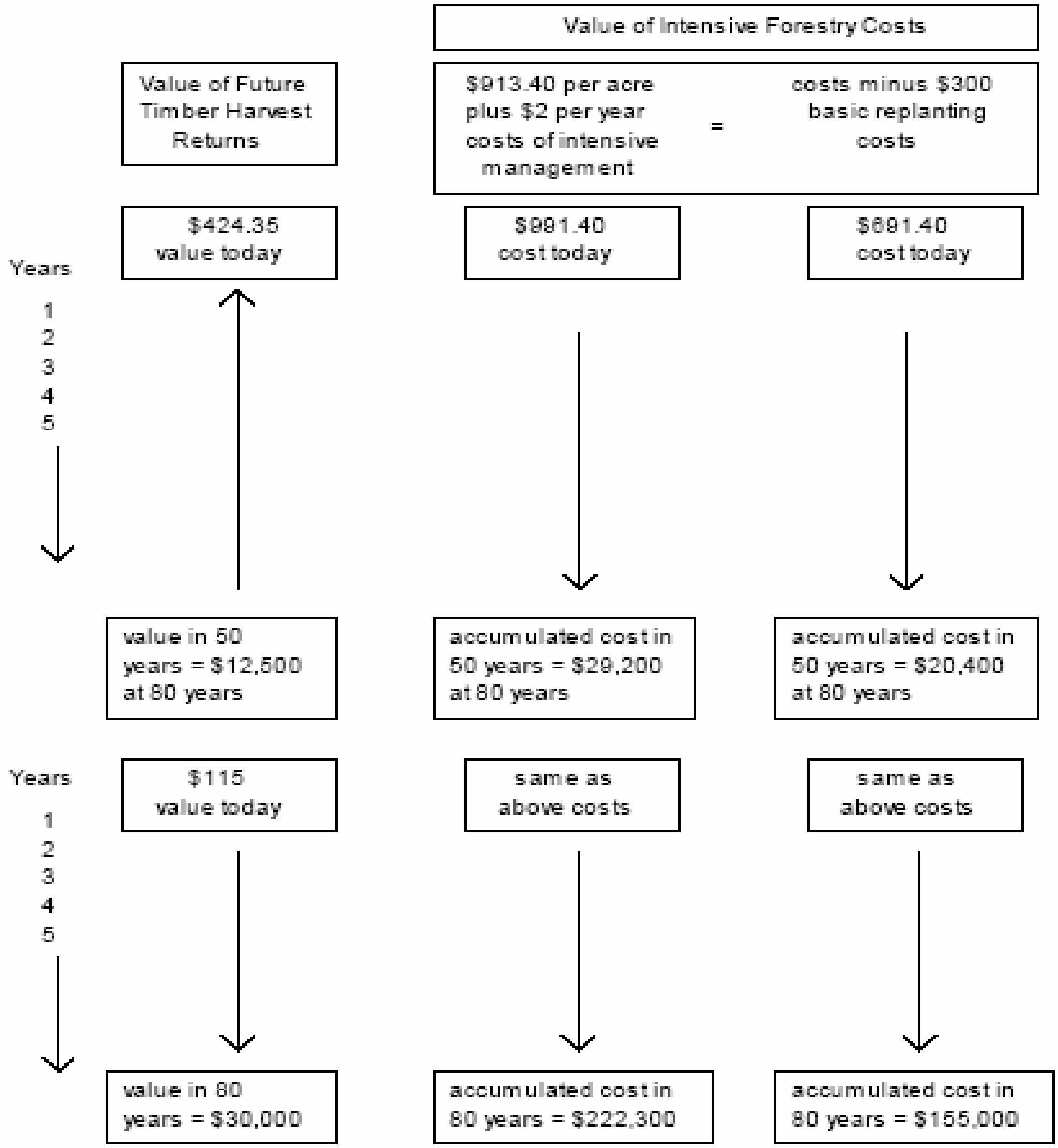
On a per acre basis, the present cost of an intensive forest management program is $991 compared to a value of $424 over a 50 year rotation schedule or to a $115 value on an 80 year rotation schedule (Figure 9). This is because, on a long term investment basis, the opportunity cost of money (i.e. returns from investing in alternatives such as stock market or CD's) becomes the critical decision factor.

To grow trees in the Pacific Northwest to maturity takes a long time. For private business analysis that only considers cost of money and return to monetary investment, rotation periods over 40 years usually cannot be justified unless other factors, such as increasing real timber prices, are included in the analysis.

Reforestation investments are risky because of the long time between reforestation and harvest and the cost of money used in the investment. "Intensive timber management is

1. Timber growing acres minus area for roads, streams, etc.

Figure 9
Future Value and Discounted Present Value of Timber Growing on an Acre of Forest Land and Future Value of Preparation, Planting, and Other Intensive Management Costs, With and Without Consideration of Basic Replanting Costs



Notes: 1. This considers that basic replanting has to be completed under Oregon law. Therefore, only the additional costs of intensive forest management are considered as costs to be included in the investment analysis.

not appropriate everywhere. . . The economic returns from timber management regimes that require low capital investment and maintain species diversity need to be examined."[1] An evaluation of alternative forestry management techniques concluded that ". . . low-cost silviculture is a viable economic option that compares favorably with intensive plantation management."[2]

The returns to intensive forestry management over long periods of time are not favorable on a fiduciary basis and such monetary analysis focuses only on the "economics of timber production and . . . ignored the projection and evaluation of non-timber outputs, which, in many cases, are equally important."[3]

It should be understood that intensive forest management in itself does not generate the Greatest Permanent Value because forest management practices on any specific property over a 40 year period cycle tend to have negative returns. An intensive management objective would take existing assets and provide smaller returns than an investment strategy as outlined in Alternative 1. Under the Intensive Forest Management Alternative, objectives other than generating the Greatest Permanent Value (monetary) are included. These objectives may be job security of State personnel, continuation of existing programs, steady and continuous supply of timber and resulting industry jobs, etc.

The Intensive Forestry Management Alternative may yield 162,000 to 223,000 MBF per year. This would return $8.1 million to $11.2 million (compared to about $3 million at the present) per year to local counties and $73 million to $101 million to the State. (About 45 percent of this would be returned to the Department of Forestry for forestry protection and management programs.) An average of about 24 jobs per MBF are generated in Oregon by State forest sales.[4] A small portion of these jobs are in the coastal economies. Therefore, about 4,000 to 5,000 jobs in Oregon would be directly or indirectly affected by an intensive forestry management program (compared to about 1,500 jobs at the present).

Since an intensive forest management program is not the highest return to the asset (Tillamook State Forest), these jobs should be considered subsidized jobs. Economic development strategies that would consider present economic growth rates in the region and in the State would need to be analyzed in order to justify such a State subsidized job development program.

Special consideration should be given to programs that may stabilize existing economic conditions. In the 1987-1994 period, increased lumber production has supported job gains in Tillamook County.[5] The total jobs that the regional economy in Tillamook

---

1. Haight 1993, p1.
2. Ibid., p16.
3. Ibid., p16.
4. Angle, et al. 1996, p163.
5. Ibid., p98.

County may gain is difficult to project, since there are major changes taking place in the distance that timber is hauled to be processed.[1] If Tillamook County were to log and process 30 percent of timber made available, the lumber and wood products industry in the Tillamook area may realize a gain of about 300 jobs under an intensive management alternative.

3. Alternative 3 - Timber Production, Water Resource and Ecological Diversity Protection

"We believe the northwest Oregon State forests are rich in non-market values, and that these values should play a significant role in determining the future management of the forest."[2]

Non-market values include user values for fish and wildlife as well as preservation values for forest resources. The preservation value is the willingness to pay for the existence of a resource without immediately using it. "Non-market values include livability considerations, and livability is becoming more important as the State's economy matures."[3]

Economic studies have calculated net economic values for consumptive uses, such as fishing and hunting, as well as preservation values, such as the existence value for salmon or the northern spotted owl.[4] One study at Oregon State University estimated the amount that residents in western Oregon would be willing to pay not to view clear cuts from their homes.[5]

Although the direct tradeoffs between timber practices and other forest produced resources are not always calculable, scientists do provide evidence of the negative effects of logging on water quality and therefore water dependent uses.[6,7]

Presently, the Tillamook Basin produces salmon and steelhead that generate about 160,000 annual angler days in the rivers and estuaries of the Basin. Historical

---

1. The "timbershed" is expanding; that is, the remaining lumber mills are larger and are willing to haul timber at greater distances. As the use rates of timber approach 100%, the distance of the haul of raw timber is becoming a smaller component in the total decision making process.
2. Angle, et al. 1996, p7.
3. Ibid., p8.
4. Ibid., pB-3.
5. Johnson, et al. 1994.
6. See for example: Brown and Binkley 1994.
7. Botkin, et al. 1994.

sustained salmon steelhead runs in the Tillamook Basin circa 1900 are estimated to be as follows:[1,2]

- Chinook 181,000
- Coho 98,000
- Steelhead 59,000
- Chum 355,000

At a 50 percent harvest rate, the amount of chinook, coho, and steelhead available annually for the area is 169,000.[3] At a recreational day economic value of $50 per angler day and angler success rate of 50 percent,[4] a total of $8.4 million to $16.9 million may be generated annually by the river and bay fishery if the available fish were taken recreationally.[5] Chum salmon also provide a recreational fishery in the Tillamook Basin. This fishery is presently limited. However, using the same assumptions on success rates and economic value, an additional $17.75 million to $35.5 million may be available, if chum salmon return at historic rates to the Tillamook Basin. In recent years, the Oregon Coast experienced over 300,000 salmon trips when fish were available; therefore, it would be reasonable to expect anglers to be drawn to the Tillamook area when salmon runs recover.[6] The economic value of the Tillamook salmon resource may, therefore, be between $26.2 million and $52.4 million per year. The present value of this stream of benefits received annually (at a seven percent rate) for 100 years is between about $375 million and $750 million (see Table 11). The asset value of other non-market values may be calculated similarly.

The point of this exploration is that the returns from the Tillamook State Forest need not be calculated with one use only at the total expense of other users. A forest management strategy may be developed that includes considerations for several uses of the Forest. Such a strategy would allow timber production on a specified number of annual and total area to produce a sustainable amount of timber. Such a strategy may also minimize the amount of regular and frequent intrusion into selected watersheds and

---

1. Huntington 1997.
2. Some of the streams in this watershed have been and may again be very productive. The Oregon Coho Plan calls for 42 returning spawners per mile of productive stream as a goal. Many streams in the Tillamook Basin have a much higher production potential. For example, estimates circa 1900 salmon production are 571 chum, 291 coho, 158 chinook, and 95 steelhead, according to personal communication with Chuck Huntington, Biologist.
3. This does not mean that 50 percent harvest rate is sustainable. The 50 percent rate used should be viewed as an example, not as a goal.
4. A $100 value per salmon assumes a success rate of 50 percent per angler day or two days per fish caught.
5. For every fall chinook that is caught inland in the Tillamook system, another one is caught in the ocean (mostly north of Oregon). For spring chinook, this rate is about 1 to 5. For coho, before current restrictions on ocean fishing, the ratio was about 1 to 20. If these ratios of catches outside the Tillamook Basin are included, then it may be concluded that the Tillamook Basin, in recent years, has been producing close to the maximum historical rate.
6. The $100 per fish may also be an indicator of non-use existence value.

Table 11
Potential Annual Benefits and Asset Value of Recurring Benefits

Year	At $50 per Fish	At $100 per Fish	Asset Value at 7% at $50 per Fish	Asset Value at 7% at $100 per Fish
1	$26,200,000	$52,400,000		
2	$26,200,000	$52,400,000		
3	$26,200,000	$52,400,000	$375,000,000	$750,000,000
↓	↓	↓		
100	$26,200,000	$52,400,000		

thereby protect water dependent resources. Most importantly, such a strategy need not be irreversible, since trees will continue to grow.

At present, it is estimated that the average acre contains 17,500 board feet and that the forest grows at an average of 500 board feet per acre per year. Therefore, an acre in the Tillamook Forest may contain up to 100,000 board feet over a 200 to 400 year period (Table 12).

This strategy has to be viewed as a long term strategy. It will take 120 years to reach the sustainable timber production level.

A larger acreage would be required earlier in the management period until the forest matures to 100,000 board feet per acre. At a 120 year period, previously harvested acreage in highly productive sites that provide the least probabilities of providing other resource benefits or problems may enter the harvest rotation. In effect, about 168,000 acres may be required to maintain harvests at the present level. The rest, a total of 196,000 acres, may be used to develop a water resource and ecological diversity program. No timber harvests or timber management practices would be required in 196,000 acres, or 54 percent of the forest.

A water resource and ecological diversity protection program may return $30 million per year in revenues. Out of this, approximately 50 percent or $15 million would be returned to the State of Oregon for school financing, another approximately 40 percent or $12 million may be available for ODF management, while 10 percent or $3 million is made available to local government.

The identifiable results of this alternative are:

- Annual Timber Harvest Revenues on 120 Year Rotation
  - 60,000 MBF
  - $30 million timber revenue
  - $3 million annual local distribution

- Potential Annual Fish Benefits
  - $26.2 million to $52.4 million

- Undisturbed Area
  - 196,000 acres

Assuming 168,000 acres are in timber management, there are two options:

- Continue harvesting 1,050 acres at 120 year rotation for a total of 60,000 MBF per year; acres in timber production can be reduced.
- Harvest 1,400 acres, keep all 168,000 acres in timber program and produce 80,000 MBF per year.

Table 12
Board Feet Per Acre Production, Number of Acres Harvested Per Year Required to Produce 60,000 MBF, and Acres Per Decade Harvested

Year	Board Feet Per Acre /1	Acres Harvested Per Year	Total Acres Harvested Per Decade
40	17,500	3,500	57,000
60	27,500	2,200	38,000
80	37,500	1,600	29,000
100	47,500	1,300	23,500
120	57,500	1,050	20,500
140	67,500		168,000
160	77,500		
180	87,500		
200	97,500		
220	100,000		
240	100,000		
260	100,000		
280	100,000		
300	100,000		
320	100,000		
340	100,000		
360	100,000		
380	100,000		
400	100,000		

Notes: 1. Ed Obermeier, Silviculturist at Waldport Ranger District, USFS, estimates that the yield from previously uncut forests that were burned during 1830 to 1850's was anywhere from 60 to 100 MBF per acre. Over a longer than 200 year rotation, 100 MBF constant per acre could be anticipated.

References Cited (Radtke)

Radtke, Hans D. and Shannon W. Davis. Economic Considerations of the Future Use of the Tillamook State Forest With Emphasis on the Trask River Basin. Prepared for Oregon Trout with funding from Northwest Area Foundation. August 1997.

Radtke, Hans D. and Shannon W. Davis. Economic Considerations of Municipal Watershed Use: To Grow Timber or Water. Oregon Natural Resources Council. April 1996.

Botkin, D., K. Cummins, T. Dunne, H. Regier, M. Sobel, L. Talbot, and L. Simpson. Status and Future of Salmon of Western Oregon and Northern California: Findings and Options. The Center for the Study of the Environment. Research Report No. 8. Santa Barbara, CA. 1995. 300 pp.

Forest Ecosystem Management: An Ecological, Economic, and Social Assessment. Report of the Forest Ecosystem Management Assessment Team. Team Leader: Jack Ward Thomas, Deputy Team Leader: Martin G. Raphael. July 1993.

SALMON ANCHOR HABITAT WORK GROUP AND CONFERENCE, EXPERT RESPONSE

Perceived Costs and Benefits of SAHs, Economic and Social Values: Dr. Randall Rosenberger (Non-Market Benefits)

"What are the benefits of SAHs in terms of market and non-market values?"

INTRODUCTION

The primary purpose of this document is to provide a value classification scheme that elaborates the multiple values of forests. My intent is to provide an orderly framework for future discussions about and/or an accounting of the multiple human values of forests in general and Salmon Anchor Habitats in particular. The primary focus of this comment, however, is on the non-market benefits of natural resources. I will leave the discussion of the market benefits of SAHs to an expert in that area. I also will restrict my discussion to the values of forests, not how SAHs will likely impact local and regional market economies.

Forests and other natural resources are important to people in a variety of ways. People value natural environments, including forests, as part of what constitutes their quality of life. People's dispositions toward their natural environments motivate their behavior and decisions as they allocate scarce resources (time and money) in their pursuit of happiness or well-being. The quantity and quality of natural environments, along with management induced changes in the quantity and quality of natural environments, also affect individuals' abilities to produce value.

I will be primarily referring to an economic definition of value. An environmental good or service has economic value if it increases human well-being. At the root of economic value is the individual human and it is based on this individual's preferences for one thing over another that constitutes economic value; that is, we do not prefer a good or service because it is valuable, it is valuable because we prefer it. The economic value of a good or service is derived when an individual uses a resource to produce satisfaction (or value or benefit), where this use is an allocation of scarce resources (time and money) in the production of preferred outcomes, experiences, or knowledge. The appropriate context for economic valuation is estimation of the relative value of a good in relation to what a person is willing to give up ('willing to pay') to have that good or service. In a broader context, this is the root of the cost-benefit analysis framework.

An efficient outcome occurs when the benefits of an action (for example, allocation of resources) outweigh the costs of that action. In a democratic society, values permeate resource allocation decisions related to land and resource management. An administrator's or manager's decisions should reflect the values held by their stakeholders, including the general public, in the formulation, selection and implementation of management alternatives (Lewis 1995). Therefore, understanding how stakeholders, including the general public, value forests and other natural resources is critical to the efficient allocation of resources.

VALUE CLASSIFICATION SCHEMES

A. *An Economic Schematic*

What does it mean to 'use' a resource in order to produce value? Economics does not narrowly define how resources are used by humans. Two primary distinctions are between active use value and passive use value (Figure 1).

- Active use value is the value derived from actively using a resource. Active use of a resource can be on-site (on the forest or SAH) or off-site (not on the forest or SAH).
    - On-site use value is the value derived from directly using a resource on-site. These on-site values can be derived from consumptive use of a resource (such as timber harvesting or hunting on-site in which the resource is 'used up' and not available for others to use); or they can be derived from non-consumptive use of a resource (such as hiking on-site or wildlife viewing or photography on-site in which the resource is not used up; the resource is available for others to consumptively or non-consumptively use).
    - Many other values are derived off-site (not immediately on the forest or SAH). Off-site use values also may be consumptive (fishing for salmon off-site, burning of firewood) or non-consumptive (reading stories about SAHs, swimming in clean water).
- People also may derive value from forests or SAHs based on passive uses of the resource. All passive use values accrue to people off-site and are non-consumptive. Passive use values are values derived from the passive use of a resource. Three types of passive uses have been identified, including option value, bequest value and existence value.
    - Option value is the value a person places on retaining the option to actively use the resource sometime in the future; it is a risk premium.
    - Bequest value is the value a person derives from knowing that a resource exists for future generations' active or passive uses.
    - Existence value is the value a person derives from knowing that a resource exists in the future independent of any current or future active or passive use. Most commonly expressed existence values are for scarce environmental resources such as endangered species or remnant wild natural landscapes such as old growth forests or wilderness areas.

Total economic non-market value is the sum of active use value and passive use value.

B. *Morton's Expanded Schematic*

Pete Morton, an economist with The Wilderness Society, merged the economic value classification schematic with Holmes Rolston III's, an environmental philosopher, 11 human-derived values from natural areas. Figure 2 reproduces Morton's value classification schematic.

- People may derive direct use benefits from forested environments and SAHs. Direct use benefits may include on-site recreation; mental, physical and/or spiritual regeneration; cultural heritage (both as natural history such as unique rock formations, cultural history such as archeological sites, or natural/cultural heritage and symbolization such as salmon's or timber's role in the history of the Pacific Northwest or the beaver as the state animal); and commercial uses (such as timber harvesting, mineral extraction, and collection of non-timber resources).

- People may derive community benefits from forests as they support jobs, whether these jobs are recreation and tourism-based or resource extraction-based, and other contributions to the quality of a place to live and/or do business.
- People may derive benefits from the scientific values of SAHs in the form of research areas, educational tools, and evaluation of management outcomes (an important component to adaptive management).
- SAHs may provide off-site benefits to people in the form of off-site hunting and fishing, off-site recreation, scenic viewsheds, enhanced property values, and other non-consumptive uses (photos, books, stories about SAHs and salmon).
- SAHs may provide biodiversity conservation benefits that include preserving genetic diversity and can support non-consumptive uses of animals and plants through wildlife viewing (a recreation value on-site or off-site), nature photography, and harvesting of non-timber forest products. Biodiversity conservation also sustains passive use values by providing sanctuaries for rare or endangered species.
- SAHs may provide benefits through sustaining ecological services such as the protection of watersheds, nutrient recycling and carbon storage.
- People may derive option value benefits from SAHs for future active use of the areas both on-site and off-site.
- People may derive bequest value benefits by knowing that SAHs and all they protect will be there for future generations' benefits.
- And people may derive existence value benefits from knowing that areas such as SAHs and the salmon they support will exist into the future, independent of any human active use of the resources.

Two primary data points are necessary for estimating the total economic non-market value of a resource: (1) the number of units (households, acres, visitation rates, tons per acre, etc.); and (2) an estimate of the dollar value per unit. Below I offer some indicators of the potential magnitude of values associated with SAHs.

INDICATORS OF VALUE MAGNITUDE

A. *The Total Economic Value of Roadless Areas*

Loomis and Richardson (2000) conducted an analysis of the economic value of 42 million acres of roadless areas in the 48 conterminous states in the U.S. They followed Morton's value classification schematic. They estimated that the 42 million acres of roadless lands are expected to provide:

- Nearly $600 million in recreation benefits each year (in 1999 dollars; $41 per recreation day times 14.6 million recreation days). Adjusting for inflation to 2003 dollars, aggregate recreation benefits would be about $662 million, or $45 per recreation day.
- More than $280 million in passive use values (in 1999 dollars). Adjusting for inflation to 2003 dollars, aggregate passive use values would be about $309 million, or roughly $7.40 per acre of western U.S. wilderness and $4.60 per acre of eastern U.S. wilderness passive use value.
- Between $490 million and $1 billion in carbon sequestration services (in 1999 dollars). Adjusting for inflation to 2003 dollars, aggregate carbon sequestration services would be about $540 million to $1.1 billion, or $39 per acre per year for the low estimate to $72 per ton of sequestered carbon.
- $490 million in waste treatment services. Adjusting for inflation to 2003 dollars, aggregate waste treatment services would be about $540 million per year, or about $39 per acre per year in waste treatment services.

Using the low estimate for carbon sequestration values, the result is over $49 in non-market benefits per acre of roadless area protected (in 2003 dollars). Of course, this rough estimate of per acre value assumes each acre of roadless land supports the same amount of benefits as all other acres, which is unrealistic. Estimates for other value categories are provided in Loomis and Richardson's report.

B. *Recreation Use Value of the Siuslaw National Forest*

The recreation value reported in Loomis and Richardson's study was driven by empirical evidence for wilderness recreation. The closest substitute for the (potential) multiple recreation use of the Clatsop and Tillamook State Forests is arguably the Siuslaw National Forest. The US Forest Service, based on surveys conducted on the forest in 2001/2002 as part of the National Visitor Use Monitoring project, estimated recreation use to be about 2 million visits annually to the Suislaw National Forest, which offers an array of recreation activities. At about 2 days per visit, the Siuslaw National Forest supports over 4 million recreation activity days. In a separate study, Rosenberger and Loomis (2001) gathered estimates of recreation values for North America from studies conducted between 1969 and 1998. For the Pacific Coastal region, 82 separate estimates across 22 recreation activities resulted in an average value of about $39 per recreation activity day in 2003 dollars. Multiplying this average value by the total recreation activity days for the Siuslaw National Forest shows this forest supports over $155 million in recreation benefits annually (in 2003 dollars).

Power and Ruder (2003) cite a study conducted by Oregon State University and the Oregon Department of Forestry (ODF 1996) that estimated recreation use values for Oregon's forests to be about $128.11 per trip in 1992 dollars; adjusting for inflation this amounts to $159 per trip in

2003 dollars. If we assume about two days per trip, then the OSU/ODF estimate is about $80 per recreation day, which is still twice as large as the estimate used above.

C. *Sportfishing Values*

Unique resources can provide substantially higher benefits than resources that are plentiful. One case worth considering is the active use value and passive use value of salmon, which are directly affected by SAHs. In a study conducted by Oregon State University, Johnson et al. (1994) reviewed the literature current at the time of their study that reported direct use values (sportfishing) for salmon and steelhead. All estimates provided below have been adjusted for inflation to 2003 dollars. Steelhead estimates ranged from $26 per day to $79 per day, while salmon estimates ranged from $24 per day to $79 per day for river fishing for salmon and $37 per day to $100 per day for ocean sportfishing for salmon. Johnson et al. also estimated the total sportfishing values for various watersheds, which ranged from $3.8 million to $11.8 million for the Rogue watershed, $3.3 million to $10.1 million for the Tillamook watershed, down to $0.01 million to $0.04 million for the North Coast watershed. Of course, these estimates should be used with caution given that the total quantity of fish and anglers has likely changed, and per day value estimates may have changed over time.

D. *Passive Use Values for Salmon*

Indicators of the magnitude of passive use values for salmon can also be extracted from the literature. Based on the literature, passive use values for a variety of increases in salmon populations ranged from $36 per household to $257 per household (adjusted for inflation to 2003 dollars) (Rosenberger and Loomis 2003). The median value per fish, when taking into consideration the total number of households and total increase in salmon population, was about $2,594 in passive use value per additional fish supplied.

Loomis and White (1996) provide other evidence regarding the magnitude of value estimates for rare and endangered species based on a review of the literature. The following are some of the average value estimates for a variety of species (all estimates are adjusted for inflation to 2003 dollars):

- Northern spotted owls, $89 per household per year;
- Pacific salmon/steelhead, $80 per household per year;
- Gray whales, $33 per household per year; and
- Bald eagles, $31 per household per year.

Some rare and endangered species values were estimated in the form of a one-time payment:

- Bald eagles, $275 per household;
- Humpback whales, $220 per household;
- Gray wolf, $85 per household; and
- Arctic grayling/Cutthroat trout, $19 per household.

The above estimates are dominated by their passive use value component; however, part of these estimates is for an active use value component. In a statistical analysis of the value estimates, Loomis and White found estimated values were higher for people that either have or intend to directly view a species as compared to households that have never viewed the species or have no intention of ever viewing the species (bequest and existence value expressions).

FACTORS AFFECTING THE MAGNITUDE OF VALUES FOR SAHs

The estimates provided above are indicators of the magnitude of the non-market values supported by SAHs. Below are some additional factors that may influence the extent and magnitude of the non-market values for SAHs.

A. *Location, Substitution and Access*

Local or regional scarcities of certain types of natural areas contribute to the magnitude of certain values. If there are numerous other types of natural areas with similar features and recreation opportunities, then these 'substitutes' would reduce the overall value of SAHs. With numerous substitute sites, recreation values have been estimated to be about half of what estimates of recreation use value are for rare or unique sites. However, location is a significant factor for active use values. Given the proximity of the Clatsop and Tillamook State Forests relative to Portland, recreation values are potentially high depending upon both the relative value per unit of use and the overall use rate of these forests, especially if there is good access to these forests for recreation.

B. *The Extent of the Market*

Passive use values can dominate active use values. Passive use values do not depend upon direct use of the resource; passive use values by definition are off-site and non-consumptive. Therefore, the extent of the market for endangered species can arguably be the entire U.S. and beyond. People can care about and have positive values for species that they never intend to directly interact with. Even small per person values can be extremely large when aggregated up to the entire population of the U.S.

For example, an individual living in Maine can hold a positive passive use value for salmon provided by SAHs, but have zero active use value for salmon given he or she has no intent to travel to Oregon to fish for or view salmon in Oregon's rivers. In fact, Pate and Loomis (1997) found that people's values for a river and salmon improvement project in the San Joaquin Valley of California did not decline based on distance from respondents' residences to the site (non-residents included people sampled from California outside the San Joaquin Valley, and Oregon, Washington and Nevada residents). They did find people's values for a wetland habitat and wildlife program and a wildlife contamination control program did decline with distance from the San Joaquin Valley. In a separate study, Loomis (1996) conducted a nationwide survey that elicited people's willingness to pay for the removal of two dams on the Elwha River in Washington to enhance salmon spawning runs. Although residential distance from the river had a mild effect on expressed values, the appropriate extent of the market is the nation. Loomis's estimated values per household were $80 for Washington state residents and $91 for the rest of the U.S. (in 2003 dollars). With nearly 92 million households in the U.S. at the time of the study, this amounts to over $7 billion in benefits should the dams be removed.

The extent of the market for active use values requires interaction with the resource and therefore is very sensitive to the geographic location of the resource. People are faced with two significant constraints, time and income. Two associated costs of directly using resources are time (both for travel and use) and travel expenses (gas, food, entrance fees). Therefore, more distant resources from people's homes are used or visited less frequently than resources close to home. Conversely, resources that are closer to home typically have higher use and visitation rates for local residents than more distant resources. Direct use benefits, then, are determined by distance of travel necessary to use the resource and characteristics of the site. The extent of the market for direct use benefits is typically smaller in scope than passive use benefits.

C. *Passive Use Values vs. Active Use Values*

For those people that accrue both active use values and passive use values, their passive use values are typically twice as large as their active use values (Brown 1993). First, passive use values, recall, can include the option value for future active use of the resource in addition to the other passive use value components. Second, there are likely few substitutes for resources with high passive use values, such as endangered species and rare landscapes. Many people do not feel wolves in Alaska are a substitute for wolves in Yellowstone National Park. In many cases, the place-specific occurrence of resources matters.

D. *Marginal Values of Management Alternatives*

SAHs also are not the only management alternative that can provide many of the non-market benefits that are likely to accrue from SAHs. In many cases, timber production and other extractive uses of land can jointly contribute to the production of recreation and other non-market values. When comparing different management alternatives, it is the marginal contribution of SAHs to non-market value production that should be measured (for example, the net increase in the number of salmon spawning in Oregon's rivers due to SAHs).

CONCLUSIONS

I expect the non-market values accruing to SAHs to be substantial provided the myriad of values people derive from forested environments. The marginal non-market value associated with SAHs relative to other management alternatives is an empirical question that would require a significant investment of time and funding to answer. Therefore, I have not attempted to provide specific measures of these non-market benefits; instead I have provided some indicators from past research that show the variety and relative magnitudes of these types of values.

References Cited (Rosenberger)

Bergstrom, J.C. and J.B. Loomis. 1994. Economic dimensions of ecosystem management. Paper presented at the Integrating Social Science and Ecosystem Management conference, December 1994, Unicoi Lodge, Helena, MT.

Brown, T.C. 1993. Measuring Nonuse Value: A Comparison of Recent Contingent Valuation Studies. In: J.C. Bergstrom (compiler), 1993, Western Regional Research Publication, W-133 *Benefits and Costs Transfer in Natural Resource Planning*, Sixth Interim Report. Athens, GA: University of Georgia.

Johnson, R.L., H.D. Radtke, S.W. Davis and R.W. Berrens. 1994. *Economic Values and Impacts of Anadromous Sportfishing in Oregon Coastal Rivers: Assessment of Available Information*. Santa Barbara, CA: The Center for the Study of the Environment.

Lewis, B.J. 1995. *Value and Valuation Methodology in Forestry and Natural Resource Management Contexts*. Project report. Minneapolis, MN: University of Minnesota.

Loomis, J.B. 1996. How large is the extent of the market for public goods: Evidence from a nationwide contingent valuation survey. *Applied Economics* 28:779-782.

Loomis, J.B. and D.S. White. 1996. Economic benefits of rare and endangered species: Summary and meta-analysis. *Ecological Economics* 18(3):197-206.

Loomis, J.B. and R.Richardson. 2000. *Economic Values of Protecting Roadless Areas in the United States*. Washington, DC: The Wilderness Society.

Morton, P. 1999. The economic benefits of wilderness: Theory and practice. *University of Denver Law Review* 76(2):465-518.

Pate, J. and J. Loomis. 1997. The effect of distance on willingness to pay values: A case study of wetlands and salmon in California. *Ecological Economics* 20(3):199-207.

Power, T.M. and Ruder, P.J. 2003. *Economic Realities in the Tillamook and Clatsop State Forests: Possibilities for Economic Expansion and Diversification*. Portland, OR: The Tillamook Rainforest Coalition.

Rolston, H., III. 1985. Valuing wildlands. *Environmental Ethics* 7(1):23-48.

Rosenberger, R.S. and J.B. Loomis. 2001. *Benefit Transfer of Outdoor Recreation Use Values: A Technical Document Supporting the Forest Service Strategic Plan (2000 revision*). Gen. Tech. Rep. RMRS-GTR-72. Fort Collins CO: USFS Rocky Mtn Research Station.

Rosenberger, R.S. and J.B. Loomis. 2003. Benefit Transfer. In P.A. Champ, K.J. Boyle and T.C. Brown (eds.), 2003, *A Primer on Nonmarket Valuation*. Dordrecht, The Netherlands: Kluwer Academic Publishers. Pp. 445-482.

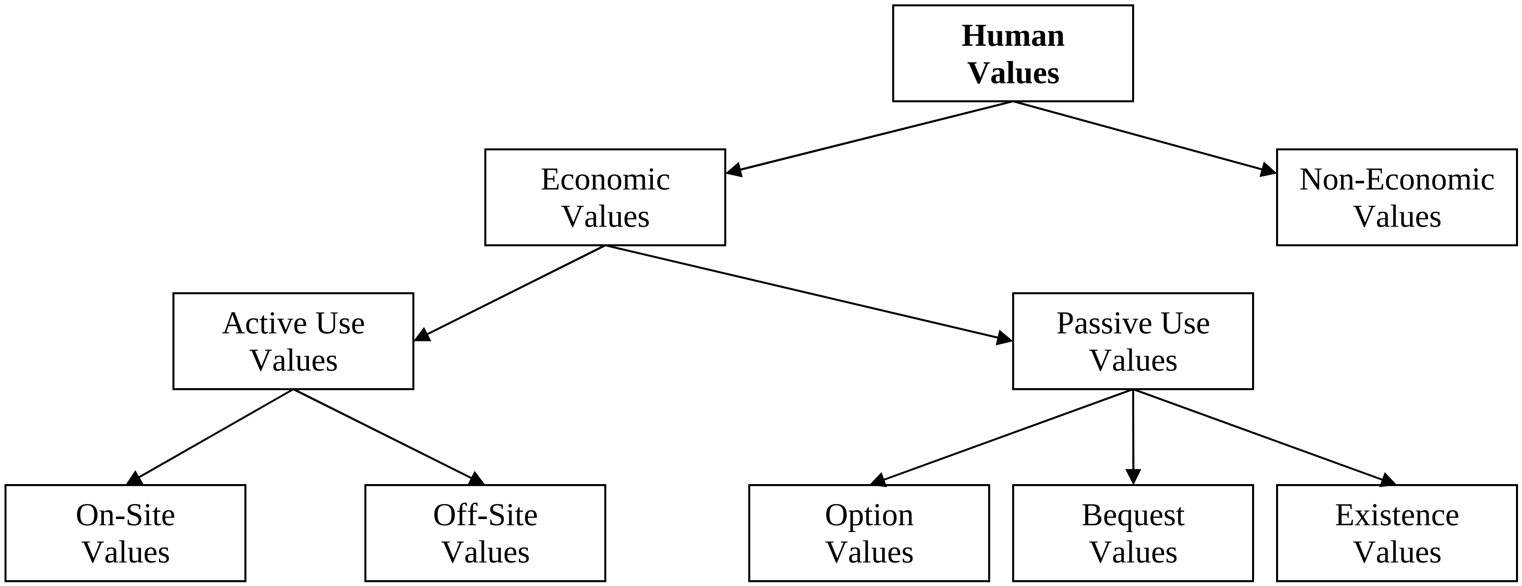


Figure 1. Economic value classification schematic (adapted from Bergstrom and Loomis, 1994).

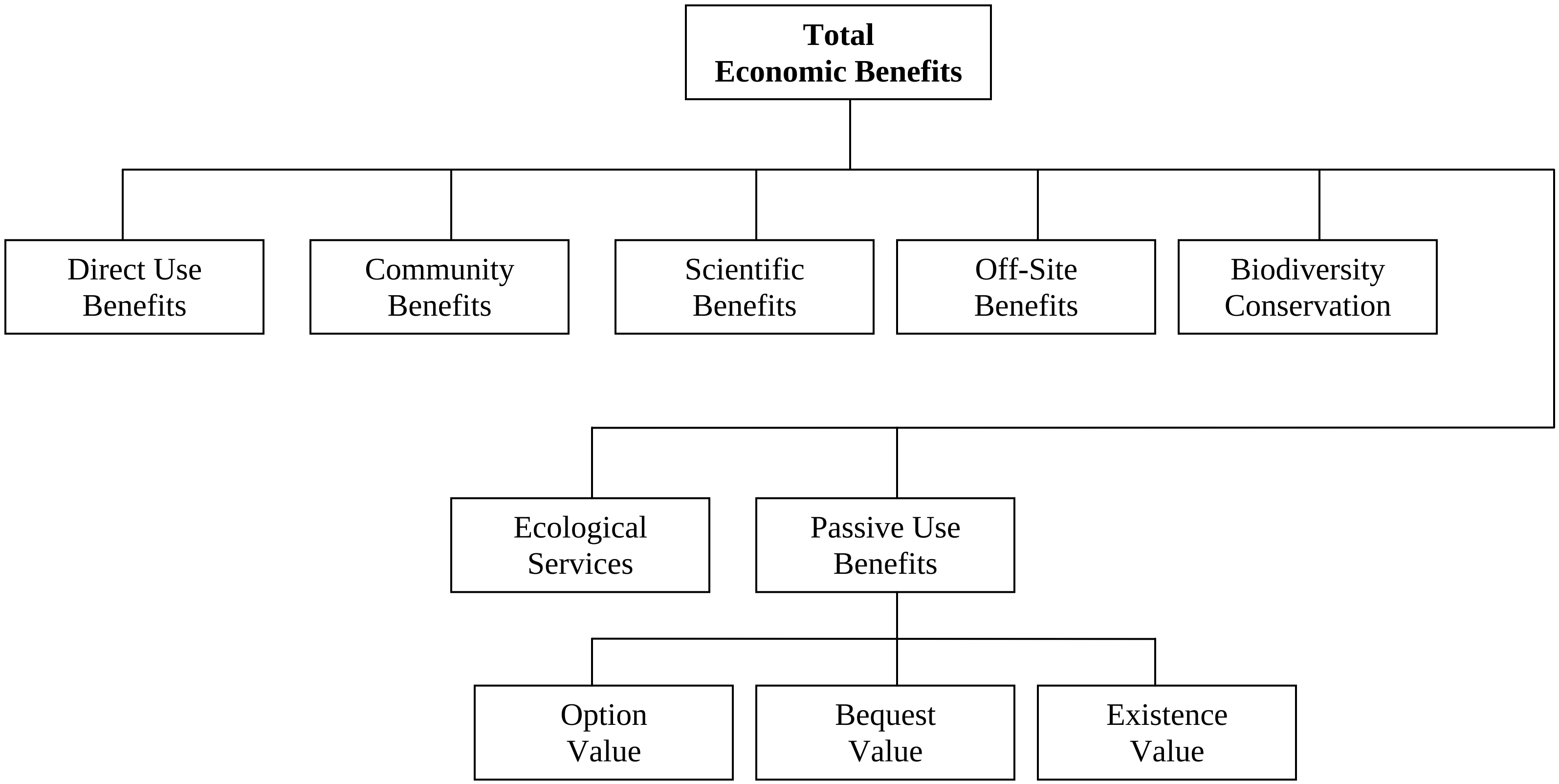


Figure 2. Morton's value classification schematic for wilderness areas (adapted from Morton 1999).

SALMON ANCHOR HABITAT WORK GROUP AND CONFERENCE, EXPERT RESPONSE

Perceived Costs and Benefits of SAHs, Economic and Social Values: Dr. Richard Haynes (Jobs, Timber Rotations)

"What are the economic affects of ODF's proposed harvest increases over the long term compared with harvesting on a longer rotation?"

Recent socioeconomic impact work of proposed forestry operations considers both economic and community impacts (see Horne and Haynes (1997) and McCool and others (1997). Such work increasingly is using broader notions of well-being that includes both economic well-being (as measured by jobs) and descriptors of the social and economic health of communities. This work also uses broader notions of what constitutes the economic base of the functional economy. Recent work as part of assessing progress towards sustainable forest management (SFM) has focused on both employment and the viability and adaptability to changing economic conditions of forest dependent communities.

The Job Issue

Jobs associated with timber harvesting and processing have been a perennial part of the forest policy debate and in the 1990s reemerged as part of the jobs vs. the environment debates (see Power and Ruder 2003 as an example). Recently jobs have been seen as a proxy for economic well-being in broader discussions of community health in the context of sustainable development.

Since the early 1990s (starting with the FEMAT 1993 report) the convention when speaking of jobs has been to refer only to direct employment in the manufacturing sectors (Lumber and Wood Products and Paper and Allied Products industries). Recent experience suggests that indirect job losses associated with harvest declines are difficult to verify and consequently often are not estimated in ecoregion types of assessments[24]. The impacts of direct job losses were observable but the traditional notions of indirect job losses were not evident. Figure 1 shows total employment in Oregon in the forest sector except for forestry service jobs. This has and continues to be a small category of jobs. Figure 1 shows the large downward adjustment in employment in the early 1980s as the industry substituted capital for labor to lower processing costs to remain competitive relative to solid wood products producers in Canada and the U.S. south. Figure 2 shows the trend in employment per million board feet harvested using the employment and harvest data discussed earlier. What is notable is that the gradual declines that had been observed during the period until the mid 1970s have been reversed. Employment per million board feet has increased in the 1990s as a function of increases in value added manufacturing. Figure 3 shows forest industry employment and total employment. During the past decade, employment in the forest products sector has fallen 22 percent or nearly 16,000

24 Various federal economic impact studies have reported only direct employment effects (See FEMAT 1993, Haynes and Horne 1997, and Robertson 2003).

jobs, this rate of decline is less than the rate of decline for harvest because of growth in employment in value added manufacturing. Figure 4 shows forest industry employment as a proportion of total employment. The decline is due both to the loss of jobs within the forest sector and the growth of jobs in the rest of the economy. During the past decade the State of Oregon has added 351,000 jobs. Currently the forest products industry accounts for about 3.5 percent of the jobs in Oregon.

Appendix tables 1-3 provide basic harvest and employment data. This data is shown in figures 5-8. Figures 6 and 8 illustrate harvest and employment data for the four county area where the Tillamook and Clatsop State forests are located.

From the data for Washington and Oregon we can estimate that during the period 1990-2002 there has been 12.7 jobs per million board feet harvested. Most of these jobs (9.8 about half in logging and half in primary manufacture) will be in logging and primary manufacturing often located relatively close to the source of the logs while 2.8 of the jobs will be created in the pulp and paper industry which utilizes the residues from the primary manufacturing and for the most part these mills are located in the Willamette valley.

Using the direct job multiplier of 12.7 jobs per million board feet, timber harvests on the Tillamook and Clatsop State forests can be expected to create, depending on the harvest levels, the following levels of direct employment:

	Million board feet	Number of jobs
Sessions (ODF)	279	3,543
Tillamook and Clatsop	176	2,273
50 percent reserve plan	112.6	1,430

These are full time equivalents and actual employment might differ depending on the number of seasonal jobs. Slightly more than a fifth of these jobs will be in the pulp and paper manufacturing located in the Willamette valley. Whether these are additional jobs or not depends on the extent the ODF timber is added to the total harvest and not offset by declines in private harvests. Finally, there is little guarantee that these jobs will be in local communities in the four county area. The forest products industry and its employees are highly mobile moving throughout western Oregon and southwestern Washington in support of operations.

Recently, much interest has been expressed in forestry jobs involved in restoration activities (whether as part of habitat restoration or hazardous fuels reduction activities). Multipliers for these activities range from 30 jobs per million dollars of expenditures for light treatments (say brush disposal) to 5 or less jobs per million dollars of expenditures for equipment intensive types of treatments (say culvert replacements). Many of these jobs are seasonal and a single job could potentially impact multiple employees.

Community Impacts

In some of the background material the issue of community impacts was raised. Oregon is a pilot state in the application of the Montreal Process and as part of its Approximation reports assessed the viability and adaptability of forest dependent communities to changing economic conditions (ODF 2000). One indicator (number 46) focuses on the adaptability of communities to changing economic conditions. It challenges us to consider how sustainable forest management influences social well-being where well-being includes concerns about determinants of economic well-being as well as concerns about community well-being.

The Forest Service is shifting its focus from dependency to concepts like resiliency (see McCool and others 1997, Horne and Haynes 1999). Based on the work by Harris and others (2000) factors useful in assessing community resiliency or adaptability are:

1) Population size—Resiliency ratings vary directly with population size.
    a. Small (and often lower resiliency) less than 1,500 people
    b. Large (often associated with higher resiliency) greater than 5,000 people
2) Economic Diversity—Resiliency ratings vary directly with population size
3) Civic Infrastructure—Higher resiliency associated with strong civic leadership, positive attitudes towards changes, strong social cohesion
4) Amenities—combines both civic amenities as well as natural amenities
5) Location—locations on major trade routes; near service centers; shopping, service or resort destinations are associated with higher resiliency. Spatial isolation often a characteristic of lower resiliency.

Various research studies suggest that communities are more complex than labels such as "timber dependent" would imply (see Haynes and others 1996). Most communities have mixed economies and their vitality is often linked to other factors besides commodity production. Many of the communities thought of as timber dependent have been confronted with economically significant challenges, such as mill closures, and have displayed resilient behavior as they have dealt with change. In general, the results of recent and current work suggest that connectivity to broad regional economies, community cohesiveness and place attachment, and civic leadership are greater factors in determining adaptability than employment based factors.

Donoghue and Haynes (2002) estimated that there are roughly 400 communities in Oregon and that 24 in western Oregon (and 30 in eastern Oregon) have low resiliency and that might merit further attention from State or federal land managers as they assess the affects of land management actions. However, none of these 24 communities are in the four county area being considered.

"Are there alternative forest management prescriptions that could be applied to the SAH areas that will protect key habitats and processes, as well as provide greater timber revenues over a longer time frame than can be obtained by the short term high harvest regime currently in operation?"

In the shifting discussions about land management paradigms during the late 1980s early 1990s the idea of long rotations was proposed as a way to produce a broader array of ecosystem goods, services and conditions especially in terms of wildlife habitat and timber quality. Much of this discussion is summarized by Weigand and others (1994) who described the results from a High Quality Workshop held in the spring of 1993. The advent of Record of Decision (USDA and

USDI 1994) implementing the FEMAT strategy for habitat conservation shifted discussions about public land management paradigms to approaches other than longer rotations.

The original proposal was described by Gus Kuehne (President, Northwest Independent Forest Manufacturers) in the fall of 1990 as "High Quality Forestry (HQF): an alternative for management of National Forest lands"[25.] HQF called for extending harvest rotation lengthens to a range between 150 and 200 years; severely reducing clearcutting and giving emphasis to multiple management goals. HQF relied on pre-commercial thinning (PCT), pruning and commercial thinnings to accommodate both the needs of wildlife species and to maintain and improve timber yields. The intervals between intermediate cuts would vary from 15 to 30 years depending on site and terrain.

For my purposes here I look at the differences between three management regimes. The first is currently employed on 47 percent of forest industry timberlands in western Oregon and Washington (see table 3 in Haynes and others 2003). It consists of planting, PCT (at age 15 years), fertilization especially on forest industry timberlands, and final harvest around 45 years. The second regime is one often favored by silviculturists who rely on rotation lengths set by culmination of mean annual increment often observed around 80 years. This regime also includes planting, PCT and a commercial thinning at about 50 years designed to reduce stand volumes by one fifth and to capture potential mortality between age 50 and 80 years. A third management regime was examined that represents Kuehne's long rotation proposals. This regime includes planting, precommerical thinning, pruning, a series of commercial thinnings (at ages 50, 80 and 120), and final harvest at age 160. The thinning intervals are longer than originally envisioned by Kuehne because in early analysis of his proposals (see Weigand 1994) thinning frequently and lightly as he envisioned was not economically feasible.

The results of these regimes are summarized in figure 9 where the soil expectation values (SEV) for the three alternative regimes are displayed. These results depend on several key assumptions.

1) Prices and costs are in real terms (that is they are net of inflation). There are higher price premiums associated with each regime reflecting larger proportions of high grade products (see appendix table 4) for a discussion.
2) There is little expectation for price appreciation in stumpage markets. Price projections from Haynes (2003) suggest stumpage price appreciation of 0.2 percent per year over the next 50 years.
3) Figure10 shows an empirical yield function for Douglas-fir derived from FAI data for western Oregon. This represents actual yields for relatively full stocking observed in actual stands. Actual stand stocking is between 60 and 65 percent for the two private timberland owners in western Oregon suggesting that actual yields will be less than shown in figure 10.

Figure 9 demonstrates that, say, at 4 percent there are positive returns for each of the three management regimes displayed but if we were to consider the value of each as a perpetual periodic annuity than the value of the 40 year rotation is more than 400 times that of the 160 rotation (assuming real interest rates of 4 percent). These results confirm what has generally

---

[25] His proposal is included as an appendix in Weigand and others (1994)

been know for the last decade and the behavior observed among private timberland owners where rotation ages are declining (see fig. 3 in Haynes and others 2003).

References Cited (Haynes)

Donoghue, E.M.; Haynes, R.W. 2002. Assessing the viability and adaptability of Oregon communities. Gen. Tech. Rep. PNW-GTR-549. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 13 p.

Forest Ecosystem Management Assessment Team [FEMAT]. 1993. Forest ecosystem management: an ecological, economic, and social assessment. Portland, OR: U.S. Department of Agriculture; U.S. Department of the Interior [et al.]. [Irregular pagination].

Harris, C.C.; McLaughlin, W.; Brown, G.; Decker, D. 2000. Rural communities in the inland Northwest: an assessment of small communities in the interior and upper Columbia River basins. Gen. Tech. Rep. PNW-GTR-477. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 120 p. (Quigley, T.M., ed. Interior Columbia Basin Ecosystem Management Project: scientific assessment).

Haynes, R.W., tech. coord. 2003. An analysis of the timber situation in the United States: 1952 to 2050. Gen. Tech. Rep. PNW-GTR-560. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 254 p.

Haynes, R.W.; Adams, D.M.; Mills, J.R. 2003. Contemporary management regimes in the Pacific Northwest: balancing biophysical and economic concerns. In: Monserud, R.A.; Haynes, R.W., Johnson, A.C., eds. Compatible forest management. Dordrecht, The Netherlands: Kluwer Academic Publishers: 267-296. Chapter 10.

Haynes, R.W.; Horne, A.L. 1997. Economic assessment of the Basin. In: Quigley, T.M.; Arbelbide, S.J., tech. eds. An assessment of ecosystem components in the interior Columbia basin and portions of the Klamath and Great Basins. Gen. Tech. Rep. PNW-GTR-405. Portland, OR: U.S. Department of Agriculture, Forest Service: Vol. 4. 1723-1869.

Haynes, R.W.; McCool, S.; Horne, A.; Birchfield, J. 1996. Natural resource management and community well being. Wildlife Society Bulletin. 24(2): 222-226.

Horne, A.L.; Haynes, R.W. 1999. Developing measures of socioeconomic resiliency in the interior Columbia basin. Gen. Tech. Rep. PNW-GTR-453. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 41 p. (Quigley, T.M., ed. Interior Columbia Basin Ecosystem Management Project: scientific assessment).

Kuehne, M.J. 1994. An alternative for management of national forest lands in western Washington. In: Weigand, J.F.; Haynes, R.W.; Mikowski, J.L., comps. High quality forestry workshop: the idea of long rotations. Proceedings. CINTRAFOR SP 15. Seattle, WA: University of Washington, College of Forest Resources: 211-242..

McCool, S.F.; Burchfield, J.A.; Allen, S.D. 1997. Social assessment. In: Quigley, T.M.; Arbelbide, S.J., tech. eds. An assessment of ecosystem components in the interior Columbia basin and portions of the Klamath and Great Basins. Gen. Tech. Rep. PNW-GTR-405. Portland, OR: U.S. Department of Agriculture, Forest Service: Vol. 4. 1873-2009.

Power, T.M.; Ruder, P.J. 2003. Economic realities in the Tillamook and Clatsop State Forests. Portland, OR: Tillamook Rainforest Coalition. 74 p.

Robertson, G.C. 2003. A test of the economic base hypothesis in the small forest communities of southeast Alaska. Gen. Tech. Rep. PNW-GTR-592. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 101 p.

Oregon Department of Forestry [ODF]. 2000. Oregon's first approximation report for forest sustainability. Salem, OR: 222 p. http://www.odf.state.or.us/Divisions/Resource policy/Resource Planning/far/far

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. [Place of publication unknown]. 74p. [plus attachment A: standards and guidelines].

Weigand, J.F.; Haynes, R.W.; Mikowski, J.L., comps. 1994. High quality forestry workshop: the idea of long rotations. Proceedings. CINTRAFOR SP 15. Seattle, WA: University of Washington, College of Forest Resources. 242 p. [Plus appendix].

Figure List (Haynes)

Figure 1—Pacific Northwest employment in total forest products industry and in lumber industry.

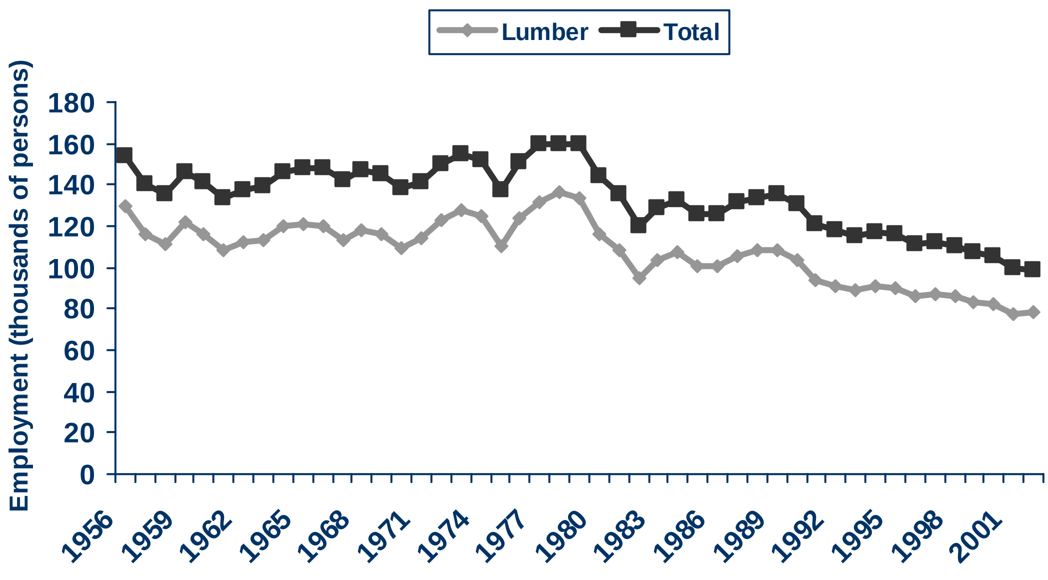


Figure 2—Pacific Northwest employment in lumber, wood products, paper and allied products industries.

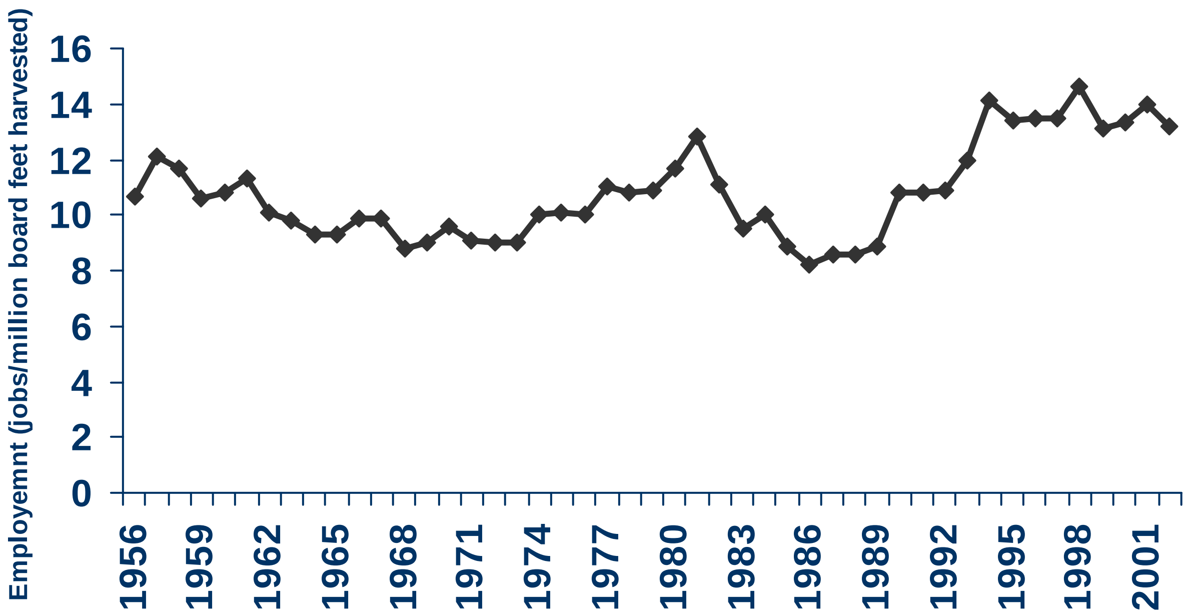


Figure 3—Nonagricultural employment and employment in forest industry in Pacific Northwest.

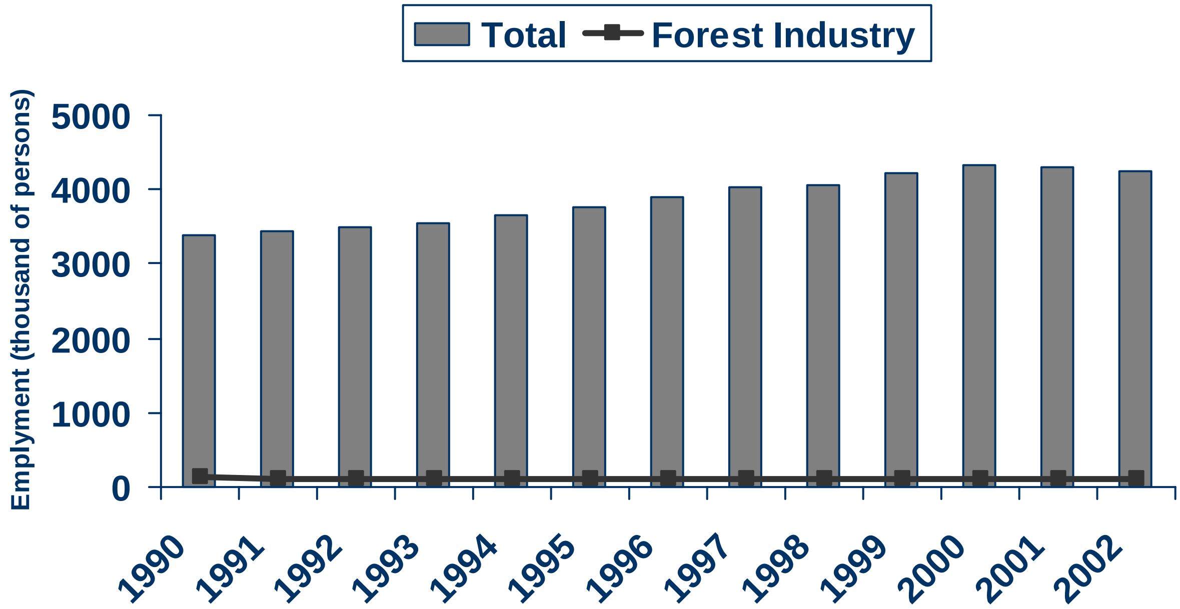


Figure 4—Percent of Pacific Northwest nonagricultural employment in the forest industries.

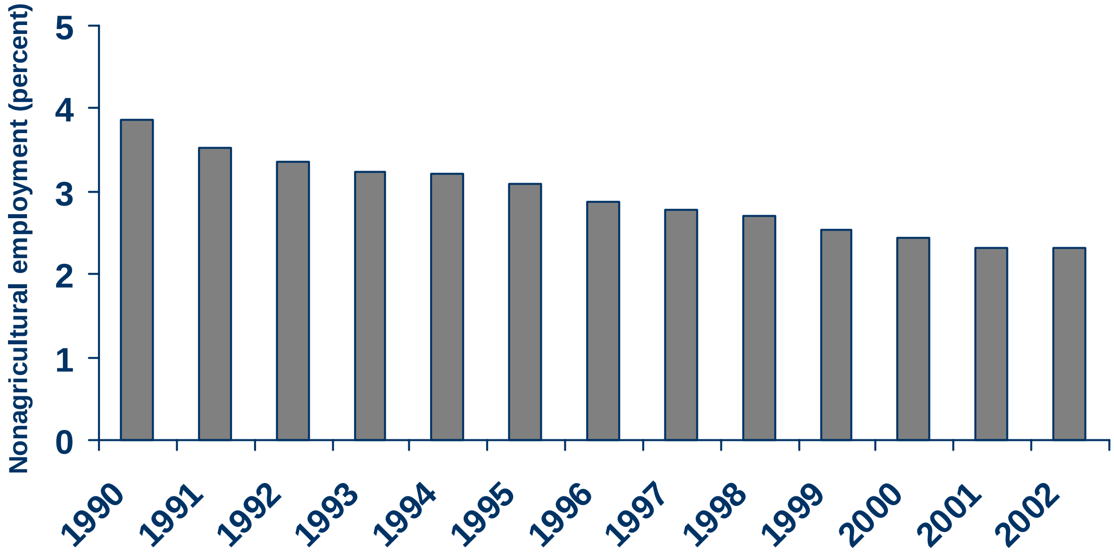


Figure 5—Oregon harvest by owner group.

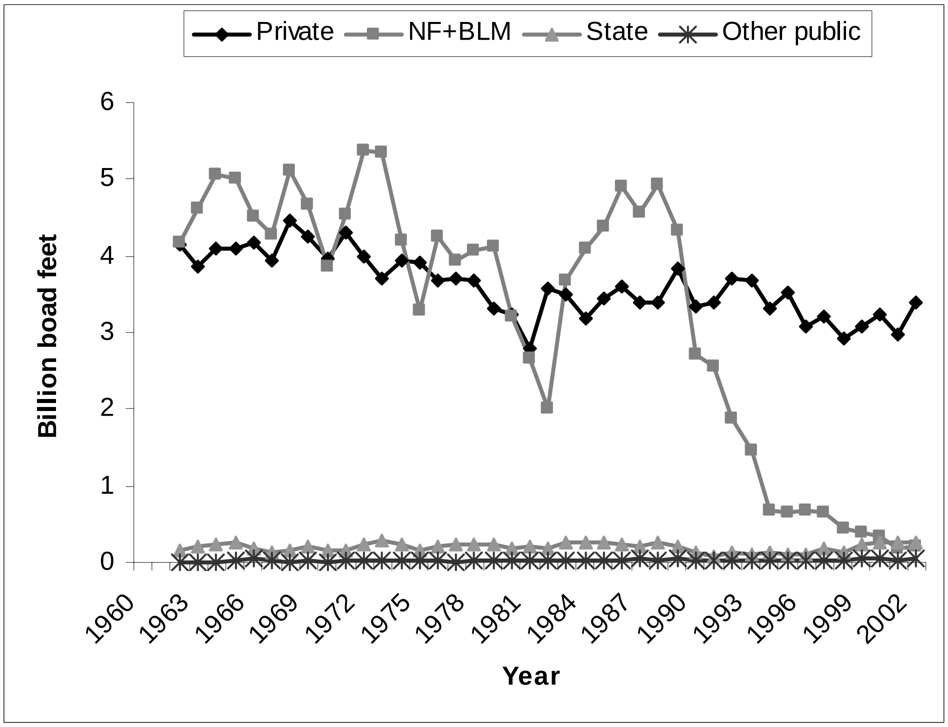


Figure 6—Harvest in Oregon for selected counties.

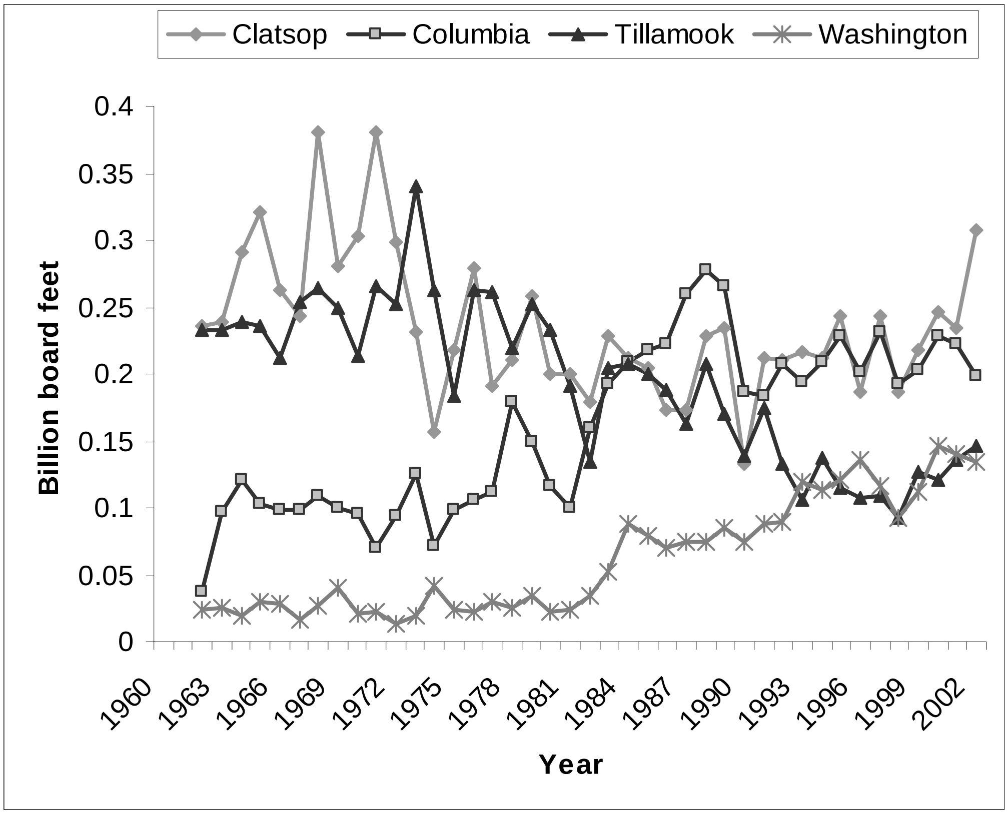


Figure 7—Oregon covered employment, total for selected counties.

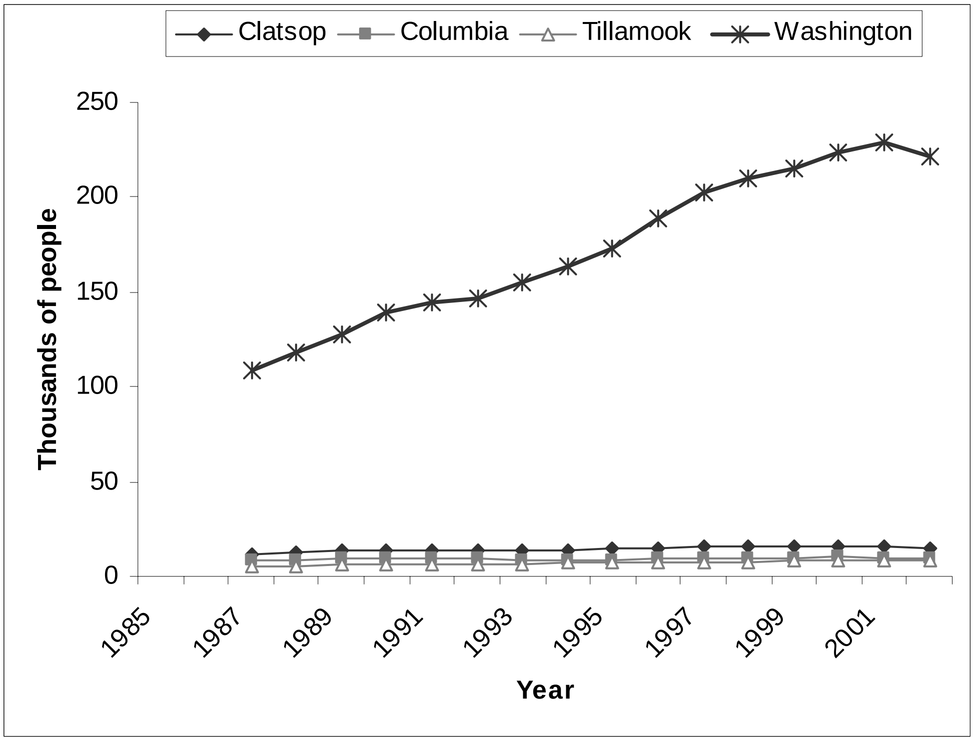


Figure 8—Oregon covered employment SIC 24 for selected counties.

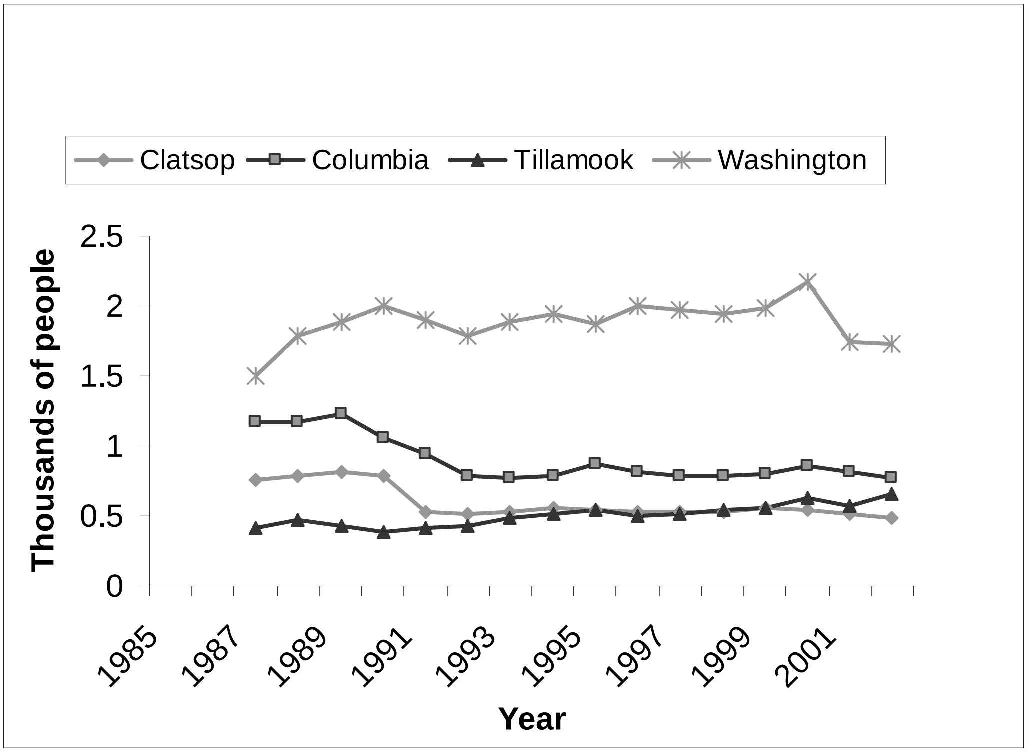


Figure 9—Social expectation value of three management regimes.

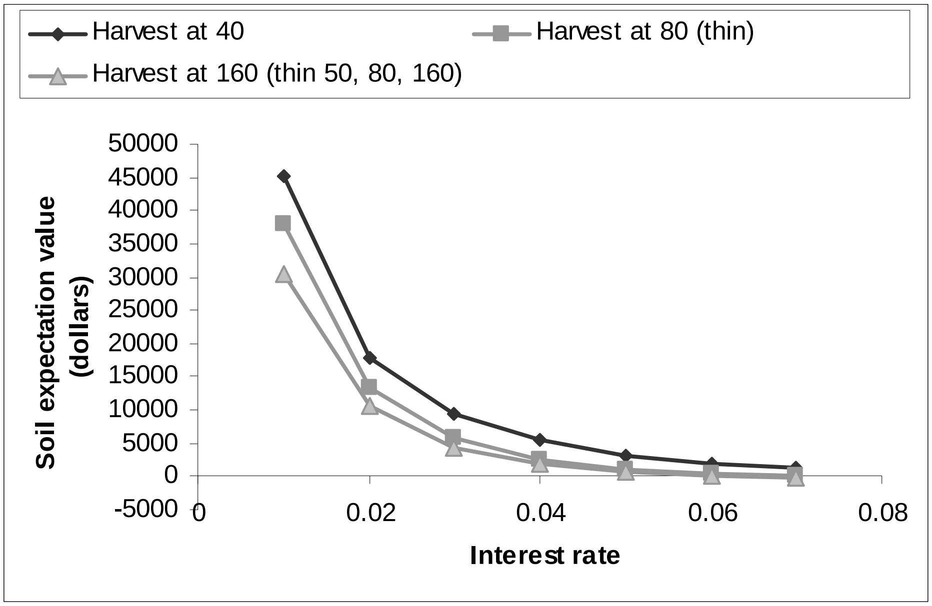
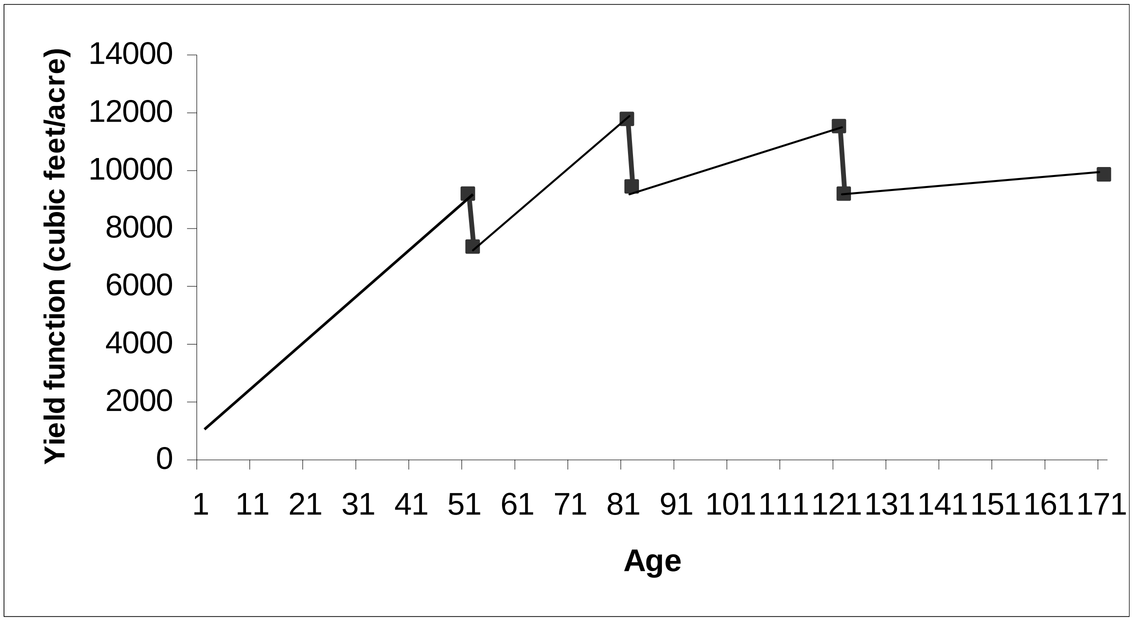


Figure 10—Empirical yield function for Douglas-fir with thinnings at 40, 80, 120 years.



Appendix: Background tables

Table 1: Oregon harvest by owner group

Year	Private	NF+BLM	State	Other public	Total
	Thousand board feet				
1962	4,152,209	4,178,942	168,987	0	8,500,138
1963	3,847,944	4,612,928	214,556	0	8,675,428
1964	4,104,549	5,068,956	244,475	0	9,417,980
1965	4,107,416	5,020,866	253,820	38,705	9,420,807
1966	4,183,616	4,512,814	184,082	40,894	8,921,406
1967	3,942,491	4,273,104	127,253	14,366	8,357,214
1968	4,453,243	5,111,912	166,009	11,598	9,742,762
1969	4,257,148	4,670,336	199,559	23,337	9,150,380
1970	3,952,996	3,868,781	149,649	9,526	7,980,952
1971	4,317,048	4,536,654	157,537	16,432	9,027,671
1972	3,999,302	5,362,888	245,616	21,828	9,629,634
1973	3,704,720	5,336,582	287,713	35,615	9,364,630
1974	3,932,945	4,188,097	225,273	15,086	8,361,401
1975	3,904,053	3,286,797	159,865	19,990	7,370,705
1976	3,668,970	4,255,890	203,441	25,210	8,153,511
1977	3,704,616	3,933,282	227,914	10,576	7,876,388
1978	3,670,660	4,069,699	234,667	21,650	7,996,676
1979	3,319,393	4,122,875	223,431	28,649	7,694,348
1980	3,238,843	3,195,979	185,699	18,928	6,639,449
1981	2,796,936	2,658,093	215,843	24,283	5,695,155
1982	3,566,384	1,999,739	174,562	17,217	5,757,902
1983	3,485,481	3,690,474	256,923	31,110	7,463,988
1984	3,179,960	4,083,109	249,131	37,563	7,549,763
1985	3,453,134	4,371,535	268,218	34,368	8,127,255
1986	3,597,434	4,891,795	225,291	28,104	8,742,624
1987	3,397,554	4,566,463	199,286	51,982	8,215,285
1988	3,380,578	4,926,072	269,743	38,662	8,615,055
1989	3,845,364	4,332,860	197,774	43,900	8,419,898
1990	3,326,848	2,717,808	136,848	37,110	6,218,614
1991	3,399,186	2,554,480	88,725	35,865	6,078,256
1992	3,691,565	1,886,132	135,206	29,458	5,742,361
1993	3,683,929	1,463,274	115,949	30,815	5,293,967
1994	3,323,812	687,973	129,946	25,435	4,167,166
1995	3,510,898	654,470	109,104	29,686	4,304,158
1996	3,089,409	689,918	114,379	28,593	3,922,299
1997	3,211,868	658,936	176,065	34,546	4,081,415
1998	2,911,287	454,774	141,186	24,656	3,531,903
1999	3,081,609	382,891	246,098	48,740	3,759,338
2000	3,229,292	327,762	254,857	41,603	3,853,514
2001	2,967,450	173,459	268,389	30,496	3,439,794
2002	3,389,743	221,631	268,922	42,062	3,922,358

Table 2: Oregon harvest for selected counties

	Clatsop county					Columbia county				
	Private	NF+BLM	State	Other public	Clatsop Total	Private	BLM	State	Other public	Columbia Total
	Thousand board feet									
1962	212,099		24,340		236,439	36,669				36,669
1963	196,800		41,422		238,222	94,685	1,527	1,184		97,396
1964	255,829		35,443		291,272	117,533	2,079	1,786		121,398
1965	289,737		31,433	140	321,310	100,398	75	2,015	125	102,613
1966	238,280		23,833		262,113	96,091	843	977	1,210	99,121
1967	215,269		28,047	688	244,004	93,118	91	3,975	775	97,959
1968	342,943		37,728	37	380,708	106,900	956	741	677	109,274
1969	254,445		24,484	1,457	280,386	99,645		453		100,098
1970	281,556		21,693		303,249	95,294	178	525		95,997
1971	355,861		24,965		380,826	66,486	755	488	2,930	70,659
1972	243,621		54,310		297,931	85,288	3,320	3,181	1,721	93,510
1973	163,805		62,988	4,127	230,920	110,609		7,801	6,599	125,009
1974	126,667		30,488	272	157,427	70,277	464	1,228	114	72,083
1975	189,312		27,668	389	217,369	96,153	54	1,101	756	98,064
1976	209,533		69,292	236	279,061	102,229	42	2,880	1,153	106,304
1977	144,459	885	46,125		191,469	109,881		1,309	286	111,476
1978	154,750		55,370		210,120	172,606	1,633	3,960	915	179,114
1979	185,105		72,413	345	257,863	137,216	4,834	5,088	1,395	148,533
1980	138,669		60,583	169	199,421	107,264	6,712	2,278	85	116,339
1981	128,391		71,440	180	200,011	96,549	394	2,577	1,183	100,703
1982	125,627		54,007	2	179,636	157,849	1,337	192	945	160,323
1983	137,024		90,716	35	227,775	182,064	3,182	4,479	2,095	191,820
1984	113,605		97,982	668	212,255	197,838		3,833	7,386	209,057
1985	119,723		84,572	245	204,540	209,802	286	5,091	2,789	217,968
1986	125,946		45,931	1,002	172,879	208,265	3,263	7,101	4,494	223,123
1987	126,180	17	44,382	1,981	172,560	247,085	4,316	5,283	3,572	260,256

1988	132,589		94,415	1,135	228,139	265,297	5,197	3,754	2,645	276,893
1989	200,194		32,723	1,412	234,329	255,934	1,273	2,956	4,887	265,050
1990	113,752		16,062	2,863	132,677	181,233	38	5,398	220	186,889
1991	181,457		24,647	5,816	211,920	183,414			62	183,476
1992	181,519		27,447	2,053	211,019	204,415	382	3,192	34	208,023
1993	190,809		23,496	1,746	216,051	181,466	3,457	9,469	84	194,476
1994	160,684		49,655	1,239	211,578	194,581	5,052	9,422	56	209,111
1995	190,033	5,013	47,643	710	243,399	220,629	3,394	3,478	1,459	228,960
1996	163,609		22,350	318	186,277	192,377	1,786	4,834	1,998	200,995
1997	181,624		61,205	217	243,046	227,361	1,202	1,408	1,615	231,586
1998	163,481		22,950	27	186,458	187,922	1,326	75	2,793	192,116
1999	163,645		53,654		217,299	192,920	1,515	4,012	4,494	202,941
2000	167,421		77,671	957	246,049	220,617	1,131	5,039	2,157	228,944
2001	166,437		68,252	15	234,704	210,821		7,822	3,680	222,323
2002	203,436		103,468	126	307,030	183,611	154	7,637	6,600	198,002
	Tillamook County					Washington County				
1950					515,438					123,710
1951					572,155					100,738
1952					609,624					132,606
1953					483,899					138,985
1954					389,907					103,557
1955					404,697					85,749
1956		44,634			413,642		1,273			94,409
1957		60,095			284,361		3,427			67,233
1958		50,437	74,663		276,574		2,969	632		41,849
1959		72,285	61,791		269,446		830	1,864		37,562
1960		63,583	73,053		294,668					0
1961	90,057	59,456	55,903		205,416	8430		1,605		10,035
1962	102,254	67,168	62,883		232,305	17,439	4,671	1,966		24,076
1963	97,924	71,683	63,914		233,521	22,378	943	2,142		25,463
1964	94,345	83,656	61,468		239,469	13,009	5,147	1,822		19,978
1965	122,946	68,757	43,249	800	235,752	22,447	5,859	1,937		30,243

1966	98,927	63,272	40,943	9,260	212,402	23,724	4,662			28,386
1967	122,732	100,905	27,871	1,723	253,231	14,038	3,010	69		17,117
1968	112,725	99,951	50,988	180	263,844	25,160	2,056			27,216
1969	144,008	55,480	49,297	830	249,615	39,085	600	620		40,305
1970	118,015	63,356	31,597	30	212,998	18,174		2,261		20,435
1971	183,119	50,893	32,224		266,236	21,496	946	625		23,067
1972	102,415	114,063	36,095		252,573	10,240	385	1,440	1,200	13,265
1973	129,244	152,000	58,995	519	340,758	17,155	222	2,591		19,968
1974	145,955	84,609	31,876		262,440	32,892		8,169		41,061
1975	107,211	41,275	34,301	299	183,086	23,188		1,054	211	24,453
1976	141,183	96,979	24,459	160	262,781	20,754		792	241	21,787
1977	146,681	73,533	41,156		261,370	24,540	57	4,988	5	29,590
1978	147,286	56,492	14,764	500	219,042	21,865	1,355	2,065		25,285
1979	147,485	76,667	27,211	386	251,749	29,801	51	4,145		33,997
1980	119,996	83,416	28,905	523	232,840	21,716	521	513		22,750
1981	103,915	50,390	37,027	50	191,382	18,646	162	4,149	1,300	24,257
1982	84,941	31,364	18,173		134,478	30,321	324	3,997		34,642
1983	88,751	63,955	51,563		204,269	40,330	856	11,032	362	52,580
1984	66,953	111,459	26,875	1,632	206,919	63,089	1,769	22,756	368	87,982
1985	50,973	118,934	29,693	596	200,196	73,692	2,549	3,410	95	79,746
1986	59,172	96,900	30,720	1,804	188,596	60,789	15	9,139	696	70,639
1987	67,221	71,693	20,555	3,420	162,889	70,412	582	1,234	1,975	74,203
1988	40,033	109,623	53,822	3,615	207,093	73,494	37	16	1,347	74,894
1989	48,737	85,931	34,748	244	169,660	79,847	2,725	2,302	39	84,913
1990	66,305	47,850	19,119	5,956	139,230	72,279	1	2,259	66	74,605
1991	100,959	52,491	21,560	22	175,032	84,575		1,076	1,684	87,335
1992	82,629	21,478	27,975	944	133,026	82,914	4,231	2,822	294	90,261
1993	72,997	15,911	17,115	388	106,411	117,460	2	2,360	60	119,882
1994	99,629	1,171	33,442	2,394	136,636	110,526		3,065		113,591
1995	88,464	6,157	20,047	731	115,399	111,001		8,135	1,871	121,007
1996	74,387	3,226	28,349	1,173	107,135	121,513	2	13,444	1,511	136,470
1997	56,051	8,282	44,229	360	108,922	102,604		13,064	152	115,820
1998	51,410	5,013	35,366	1,464	93,253	85,223	13	7,345	461	93,042

1999	54,623	1,099	70,929	126,651	94,854		14,982	1,370	111,206
2000	62,529	1,260	57,203	120,992	125,138	32	19,747	684	145,601
2001	66,604		68,661	135,265	108,002		31,527	635	140,164
2002	83,486	135	62,807	146,428	120,664	77	12,371	1,089	134,201

Table 3: Oregon employment for selected counties

	Average annual covered employment		Average weekly watge			
County	Total	Sic 24	Total	Sic 24	Unemployment	Population
Clatsop						
1987	12,067	761	331.90	442.54	6.6	32,122
1988	12,848	789	349.87	438.51	5.8	32,417
1989	13,917	816	366.32	452.49	6.4	33,040
1990	13,699	783	370.89	431.44	7.0	33,301
1991	13,262	523	382.65	478.66	7.1	33,809
1992	13,587	515	400.06	534.94	8.5	34,220
1993	13,734	530	396.92	537.44	8.6	34,608
1994	14,197	551	400.26	538.19	6.3	35,125
1995	14,616	541	411.22	560.33	5.0	35,393
1996	14,870	533	422.23	576.91	6.3	35,306
1997	15,498	534	429.62	595.65	6.7	35,546
1998	15,417	535	443.38	633.38	6.0	35,424
1999	15,303	551	467.46	661.27	5.6	35,323
2000	15,479	544	475.52	691.18	4.6	35,630
2001	15,338	511	487.16	740.04	5.2	35,586
2002	14,999	484	505.55	763.06	6.5	35,791
Columbia						
1987	8,035	1,166	403.06	413.47	8.2	35,954
1988	8,537	1,172	404.79	440.61	7.6	36,228
1989	9,081	1,232	432.06	455.90	7.3	36,708
1990	9,417	1,054	457.68	458.15	6.4	37,557
1991	9,712	942	500.53	474.67	6.6	38,711
1992	9,363	787	495.79	526.08	9.3	39,266
1993	8,740	769	477.34	533.94	9.6	40,106
1994	8,665	781	461.92	568.45	6.5	40,770
1995	8,913	874	492.60	578.74	4.8	41,701
1996	9,264	821	492.57	578.62	6.1	42,880
1997	9,496	791	506.39	632.58	6.1	43,751
1998	9,793	789	526.33	655.01	5.8	44,416
1999	9,850	799	547.06	661.85	6.2	45,368
2000	10,115	853	558.74	677.76	5.1	43,560
2001	9,991	810	570.93	692.40	8.4	44,547
2002	9,873	776	587.09	732.99	10.4	45,313
Tillamook						
1987	5,511	421	277.60	344.01	8.2	21,102
1988	5,657	475	293.37	383.69	7.1	21,163
1989	5,812	423	301.70	410.57	6.8	21,356

1990	6,146	389	309.65	454.62	5.9	21,570
1991	6,483	410	320.88	471.35	6.0	21,999
1992	6,504	434	341.20	501.41	6.8	22,296
1993	6,640	491	353.73	491.62	6.4	22,806
1994	7,069	516	363.74	542.97	4.8	23,177
1995	7,319	536	374.69	529.74	5.0	23,676
1996	7,637	498	385.52	587.02	6.0	24,094
1997	7,672	518	404.14	621.69	6.6	24,384
1998	7,769	541	418.48	631.70	6.0	24,356
1999	8,028	555	437.47	653.18	5.2	24,420
2000	8,092	633	460.16	668.18	4.4	24,262
2001	8,078	569	471.28	699.93	5.5	24,308
2002	8,094	657	488.50	746.09	6.0	24,613
Washington						
1987	108,959	1,501	398.52	413.20	3.9	282,252
1988	117,964	1,782	417.82	438.07	3.3	292,467
1989	127,579	1,888	432.17	450.94	3.0	300,230
1990	139,131	1,994	465.37	480.49	3.4	311,554
1991	144,255	1,907	487.05	489.42	4.3	327,852
1992	146,974	1,792	522.32	542.64	5.9	339,159
1993	155,061	1,892	533.23	556.85	5.2	350,212
1994	163,724	1,950	554.81	548.41	3.7	360,332
1995	173,238	1,878	598.54	541.42	3.1	371,404
1996	189,120	1,994	630.59	712.10	3.8	382,363
1997	202,209	1,966	671.23	609.75	3.9	391,335
1998	209,519	1,941	705.00	617.68	3.9	399,697
1999	214,805	1,981	753.81	646.99	4.1	409,305
2000	224,015	2,172	855.02	703.19	3.3	445,342
2001	228,509	1,737	811.74	731.18	5.1	461,119
2002	221,543	1,729	807.01	796.09	6.7	473,263

Note: 2000-2002 employment is for SIC 25 and NAICS 8, value is for SIC 24 only

Table 4: Proportion of Douglas-fir recovery by grade groups

Age class	Factory & selects	Select structural	No 2 & better	Utility & economy
	Percent			
40	0	21.1	70.4	8.6
80	2.3	22.3	66.8	8.6
160	7.5	24.7	59.2	8.6

SALMON ANCHOR HABITAT WORK GROUP AND CONFERENCE, EXPERT RESPONSE

Perceived Costs and Benefits of SAHs, Economic and Social Values: Dr. John Sessions and Pamela Overhulser (Timber Harvest Scenarios)

IMPORTANT NOTE: The following response was completed for the Salmon Anchor Habitat Conference that took place on June 24th, 2004. New forest inventory data for the Tillamook and Clatsop State Forests is being developed by the Oregon Department of Forestry as part of the Harvest and Habitat Project, but this data was not available at the time the following response was developed.

Therefore, timber harvest output estimates in this example are derived from older inventory data, and yield tables developed in 1999 and 2000. The model examples provide an informative *relative comparison* among harvest scenarios, harvest volume estimates in the following response are NOT to be viewed as *operationally accurate*.

Introduction

The primary purpose of this document is to describe the methodology and results of comparing harvests between a model that represents the Northwest Oregon State Forests Management Plan and Habitat Conservation Plan (FMP/HCP) strategy being implemented by the Oregon Department of Forestry with and without the Salmon Anchor Habitat (SAH) strategy. This report provides a *relative comparison* of timber and revenue outputs and forest structure conditions for the 2001-2010 period as well as over a longer 20 decade planning horizon.

Harvest modeling was determined to be the best method of providing a response. However, there are several challenges in providing this comparison for the June 24, 2004 conference. The Harvest and Habitat (H&H) project is in the process of updating the input data for the ODF model created in 1999 and 2000 under a cooperative agreement between ODF and the OSU College of Forestry, however the updated data will not be available until July 2004. The original model was for the purpose of providing an economic analysis of several management scenarios for the Board of Forestry's deliberation on the passage of the Northwest Oregon Forest Management Plan (FMP). It was created in a relatively short timeframe with limited district input. Several subsequent analyses of the original model suggested changes to the model in order for it to better reflect ODF inventory and operational practices.

The H&H model team is charged with completing the updates, rerunning the model and providing feedback to the Implementation Planning process. The most significant improvements are:

(1) ODF district staff are involved in the process at every level
(2) The inventory data on which to base a comparison will use the new stand level inventory (see Overhulser's response in Silvicultural Issues & Strategies, p. --)
(3) A set of yield projections to estimate timber outputs, cash flows, and forest structure is being revised under an outside contract

(4) A harvesting and roading plan is currently being prepared under outside contract
(5) Harvesting prescriptions are being developed to better reflect ODF management
(6) A structure definition has been refined to include more stand level characteristics
(7) The most current FMP/HCP strategies will be incorporated, including those for owls, murrelets, landscape design for complex structure distribution, and Salmon Anchor Habitats.

Although we will have better data when the H&H project is complete, we feel that the original model data will provide a *relative comparison* that can be made between a "representative" strategy that incorporates management direction consistent with the FMP/HCP with no SAH strategy and one that also includes the SAH strategy. Using one of the original models permits explicit representation of the SAH strategy as described in March 2003 Implementation Plan, (see Appendix A for specific SAH modeling strategies).

Available Data

This model uses yield tables based on the ODF OSCUR inventory projected to 1999 that was available for the 2000 planning effort. The GIS layer recognizes timber stands, a crude set of operational units based on topography, riparian zones, uplands, operationally limited areas, murrelet and owl habitat, district drawn desired future condition for location of complex structures, and severity of Swiss needle cast infection. The GIS data results in approximately 180,000 individual spatially explicit parcels grouped into 2600 operational units. Each parcel can be assigned one of a maximum of 55 thinning schedules with rotation age options of 45 years to 160 years or longer. Thinning prescriptions and rotation age can change at each final harvest assigned during the 200 year planning horizon.

Methodology

The harvest scheduling model was run for a 200 year projection period with and without the SAH Strategy requirements active in the first ten year planning period. The model maximized harvest volume flow subject to (1) achieving the desired future condition (DFC) of a "representative" scenario, both spatially and as overall percentages of the landscape, (2) maintaining a nondeclining harvest flow, and (3) not exceeding a maximum size of clearcut. We have recognized the following elements of the SAH Strategy:

(1) The seventeen individual SAH management basins that have been defined in GIS and available from ODF.
(2) The specific percentage limits on first period clearcut harvest, thinning harvest, and maximum area of stands 15 years or less of age specified in the SAH Strategy.
(3) The no-harvest and additional retention riparian zones outlined in the SAH Strategy.

We are not able to explicitly define operational units, road construction, reconstruction needs, traffic routes, and traffic loads. This data is under preparation but will not be available until midsummer 2004.

For this analysis we made model runs of the "no SAH" strategies and compared them with runs of the SAH strategies under 2 scenarios of volume flow. The first SAH scenario, "Fix Decade 1", set the first decade harvest volume equal to the same level as the first decade of the "no

SAH" run. The other 19 decades had the goal of non-declining flow of volume. The second scenario, "Fix Decades 1-10", set the harvest volume equal to the first 10 decades of the "no SAH" run with the rest of the decades under non-declining flow.

Harvest Scheduling Outputs

The harvest scheduling outputs show timber volumes, revenues, and complex structure over the three northwest districts of Astoria, Forest Grove, and Tillamook for twenty ten-year periods. Estimated cash flows consider species, timber size, volume per acre, and harvest method.

"How will Salmon Anchor Habitats be incorporated into, and affect, the Harvest and Habitat Model?"

The H & H model will simulate the SAH strategies in a similar method as this analysis, but may also include the slope stability strategy if spatial data can be developed. The effect on the H & H model outputs is uncertain until the model is constructed and run. However, there is reason to expect that the results will show similar trends, though the magnitude of difference may change, on volume and revenue as this analysis.

"If clearcut harvests are limited within SAHs and some planned harvests are moved elsewhere within the Clatsop and Tillamook State Forests, what are the longer term implications for harvests from those areas and for overall harvest levels, given that SAHs expire in January 2010?"

In a harvest modeling sense if one constrained some group of stands from harvest selection in the first decade, one would expect there to be some negative effect on volume outputs in subsequent decades since the model would not have the ability to choose the best from all available stands to meet the goals. More acres of some lesser volume stands would probably be selected to meet the same volume goal and some acres of rapidly growing stands would be cut earlier than they would have been otherwise. The case that would show little effect is if those constrained stands were not the best harvest candidates in the first period. In the case of SAHs, there is no reason to think that the stands in the SAHs are any worse candidates for first period harvest than the rest of the stands in the planning area.

In this analysis we looked at the harvest levels over 200 years. In order to estimate the effect of SAH strategies we modeled volume flow and compared the effect with and without the SAH strategies. Since the effects of SAHs on volume could be characterized in a number of ways depending on the goal of the flow of volume desired, we modeled 2 different scenarios, "Fix Decade 1" and "Fix Decades 1-10", described in the Methodology above.

The annual volume in Chart 1 shows that, for the SAH strategy, "Fix Decade 1" scenario, when the volume goal for decade 1 is set at the level of the "No SAH" scenario, the period 2 volume is 20% less than "No SAH", increasing to less than 5% difference by decade 9. The probable reason for the decrease in decade 2 –9 is that, due to the SAH constraints, in the first decade the model clearcut more acres (Chart 2) with lower volume per acre (Chart 3) to match the "No SAH" volume making less acres available for clearcut in the following 9 decades.

“Fix Decades 1 –10” shows nearly identical volume for the first 10 decades when the goal is to match the “No SAH” scenario. The effect of the SAHs shows in decade 11 with a decrease of volume when the goal changes to non-declining flow of volume. After decade 10 there are fewer clearcut acres per year in “Fix Period 1-10” than in “No SAH”.

“What are the costs of SAHs to counties and the state in terms of revenue impacts? (Will revenue to counties and state be permanently forgone, or deferred until after 2010?)”

In the three scenarios the revenues (Chart 4) follow a similar trend as seen in the volume charts. In the first decade both SAH scenarios have 10% higher annual revenues than the “No SAH”. All three scenarios harvest similar total volume in the first decade, but more volume is derived from clearcut acres in the SAH scenarios where revenues per acre are higher than those from thinning acres. In the second decade the lower revenues for the “Fix Decade 1” scenario is mostly attributed to fewer clearcut acres. Beyond 100 years the annual revenues for all three scenarios become similar.

“What are the economic effects of ODF’s proposed harvest increases over the long term compared with harvesting on a longer rotation? (Please clarify the impact of SAHs on harvest levels and economic impacts on counties and state using 50-80 year rotation, and a 120 year rotation.)”

In the ODF modeling, each stand is allowed to have a different age at clearcut each time it is harvested with some stands never being clearcut. Therefore, since there is no average rotation age, we calculate an average age of stands that are clearcut. For the models used in this analysis, the average age of clearcut stands is about 110 years or close to the 120-year rotation. In order to model a 50 – 80 year rotation we would need more discussion of the relationship between rotation age and the FMP strategies, specifically the goals for the desired future condition of 50% of the landscape in older forest structure (OFS) and layered (LYR) stand structure types. Both of those structures require more than 80 years to develop. We would need to define where these structures would develop and to what stands does the 50 – 80 year rotation apply.

Discussion

The discussion of the outputs is not complete until we examine how each of the scenarios meets the FMP strategies represented by the model goals. The responses to the questions focused on harvest volume and revenues; however, the structure goals are pivotal in the FMP. The goals for the model were crafted to reflect how ODF envisions achieving the strategies in the FMP and include achieving certain levels of complex structure in a functional landscape design and harvesting a non-declining flow of volume, which also has a relationship to non-declining revenues, over time. The structure goals in the model, 25% older forest structure (OFS) and 25% layered (LYR) structure, represent the mid-range of the FMP structure.

In examining the volume and revenues it first appears that the SAH scenario “Fix Decades 1-10” is the best strategy because it maintains high volume and revenues and has good non-declining flow of volume and revenues. However, the high volume and revenue is at a cost to achieving structure targets. It achieves the 50% OFS and LYR two decades later than the SAH “Fix Decade 1” and one decade later than the “No SAH” strategy. The SAH “Fix Decade 1” scenario has high volume and revenues in the first period, but departs from non-declining volume flow in the second period to the lowest volume and revenue level of the three scenarios, remaining the lowest for the first 100 years. However, it achieves the structure goals faster than either of the other two scenarios. Even the “No SAH” scenario which has high volume and revenues with a good non-declining flow pattern achieves the structure goals a decade later than SAH “Fix Decade 1”. Thus the “best” scenario depends on the view of the best tradeoff between competing goals.

It is important that in examining the results of the model outputs one looks at the relationship between volume, revenue, even flow, and structure. These SAH scenarios are only two examples of many other combinations of outputs that can be produced depending on the weight given to the goals of structure targets and non-declining flow of volume.

Conclusions

ODF is in the midst of a major planning effort including acquisition of improved inventory, yield tables, and harvest and road operations databases. The some of the strategies that will be used are also in development. Nevertheless, we expect that the harvest scheduling comparisons in this analysis that uses the original data provide useful, but not perfect information.

In this analysis when the SAH strategies are implemented, the results suggest there is some impact on the volume in subsequent decades. The impact is due to higher clearcut levels in SAH scenarios in order to make up for less than optimal stand selection opportunities.

There is reason to expect that the H & H model will show similar trends on volume and revenue as this analysis, although the magnitude of difference may change.

The responses to the questions focused on harvest volume and revenues; however, the structure goals are pivotal in the FMP. It is important that in examining the results of the model outputs one looks at the relationship between volume, revenue, even flow, and structure. The outputs from these three example scenarios shows that there are tradeoffs in achieving competing goals and the challenge is valuing the various combinations of the outputs to identify the best solution.

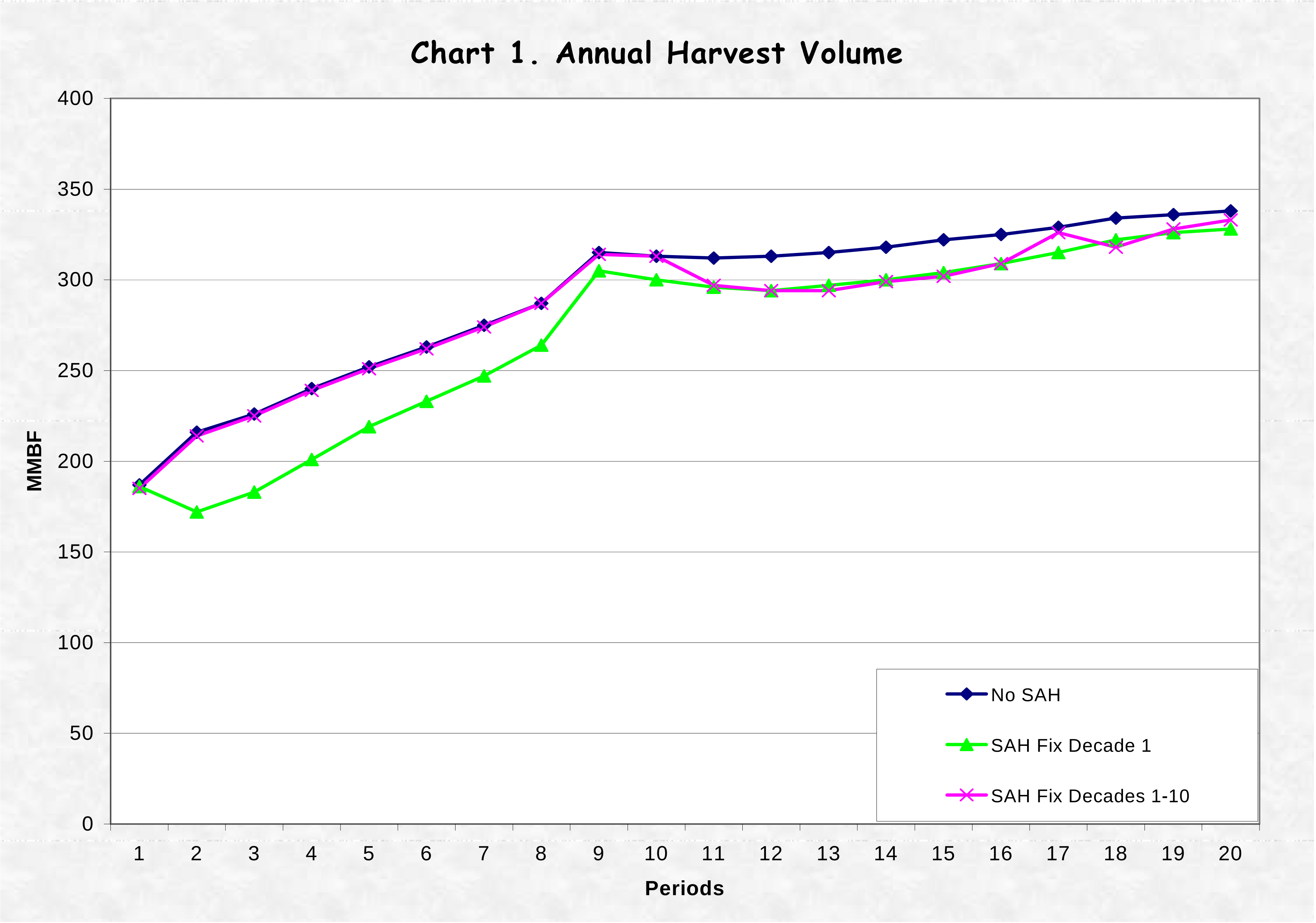


Chart 1. Annual Harvest Volume
400
350
300
250
200
150
100
50
0
MMBF
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
Periods
No SAH
SAH Fix Decade 1
SAH Fix Decades 1-10

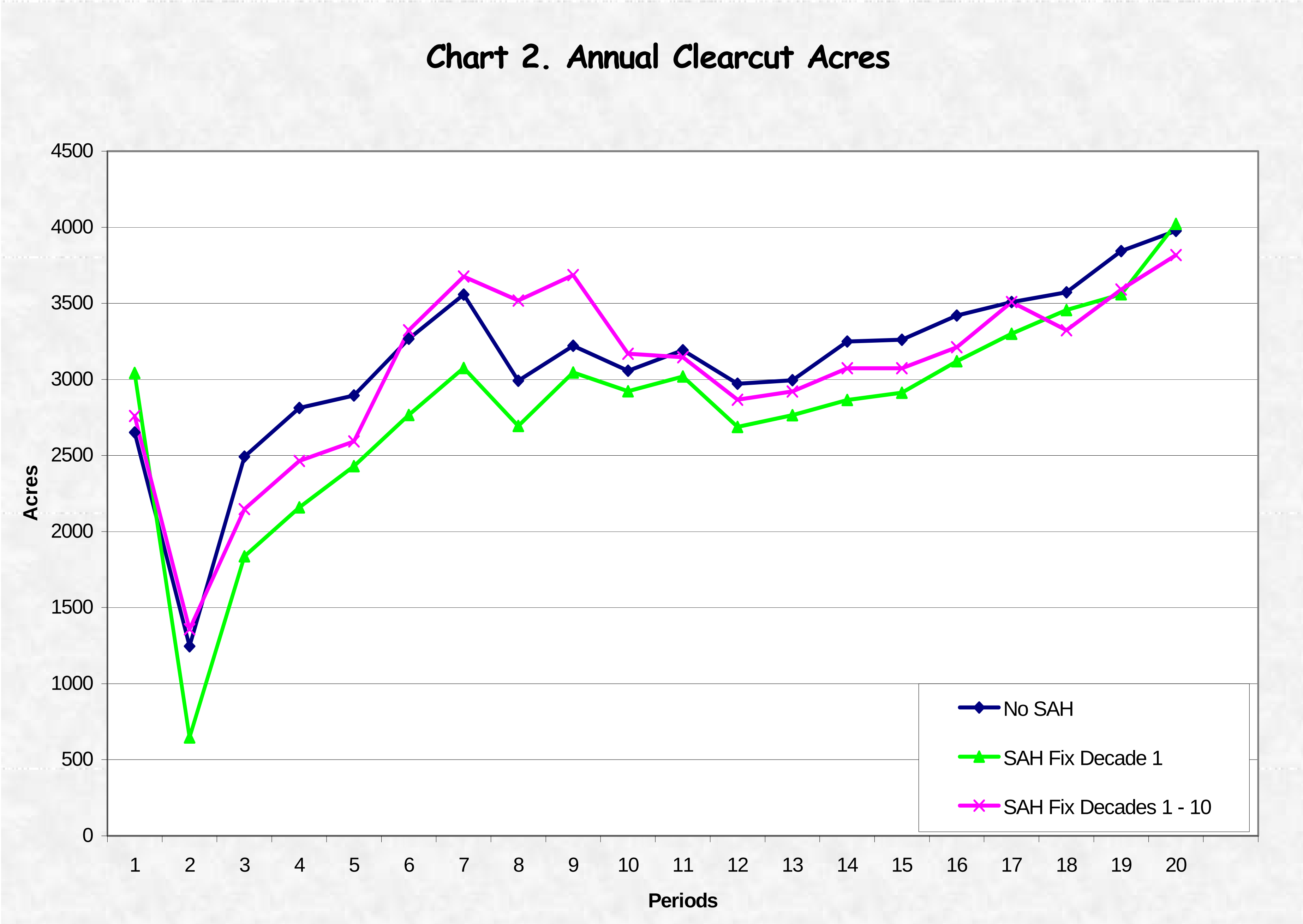


Chart 2. Annual Clearcut Acres
Acres
4500
4000
3500
3000
2500
2000
1500
1000
500
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
Periods
No SAH
SAH Fix Decade 1
SAH Fix Decades 1 - 10

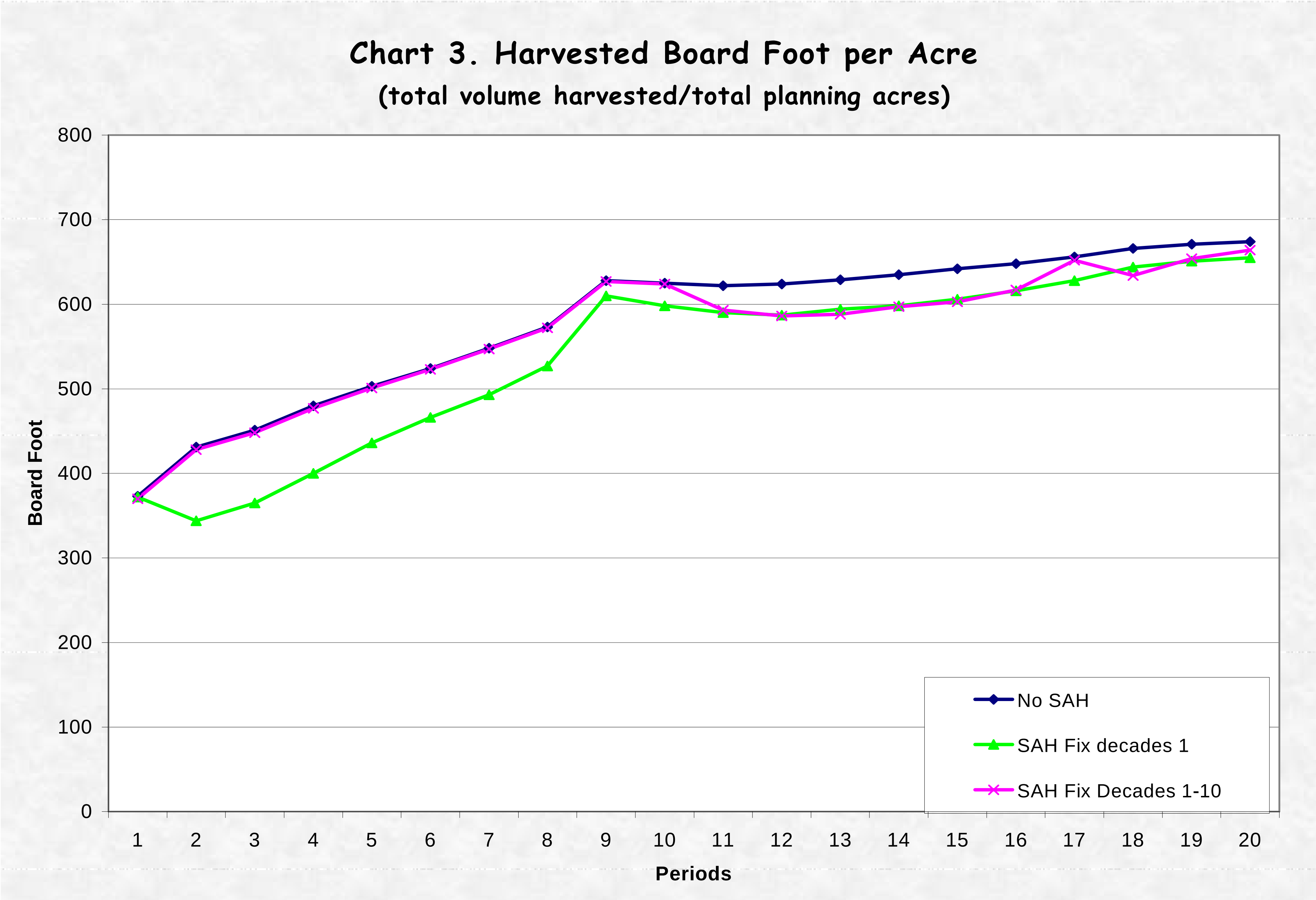


Chart 3. Harvested Board Foot per Acre
(total volume harvested/total planning acres)
Board Foot
800
700
600
500
400
300
200
100
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Periods
No SAH
SAH Fix decades 1
SAH Fix Decades 1-10

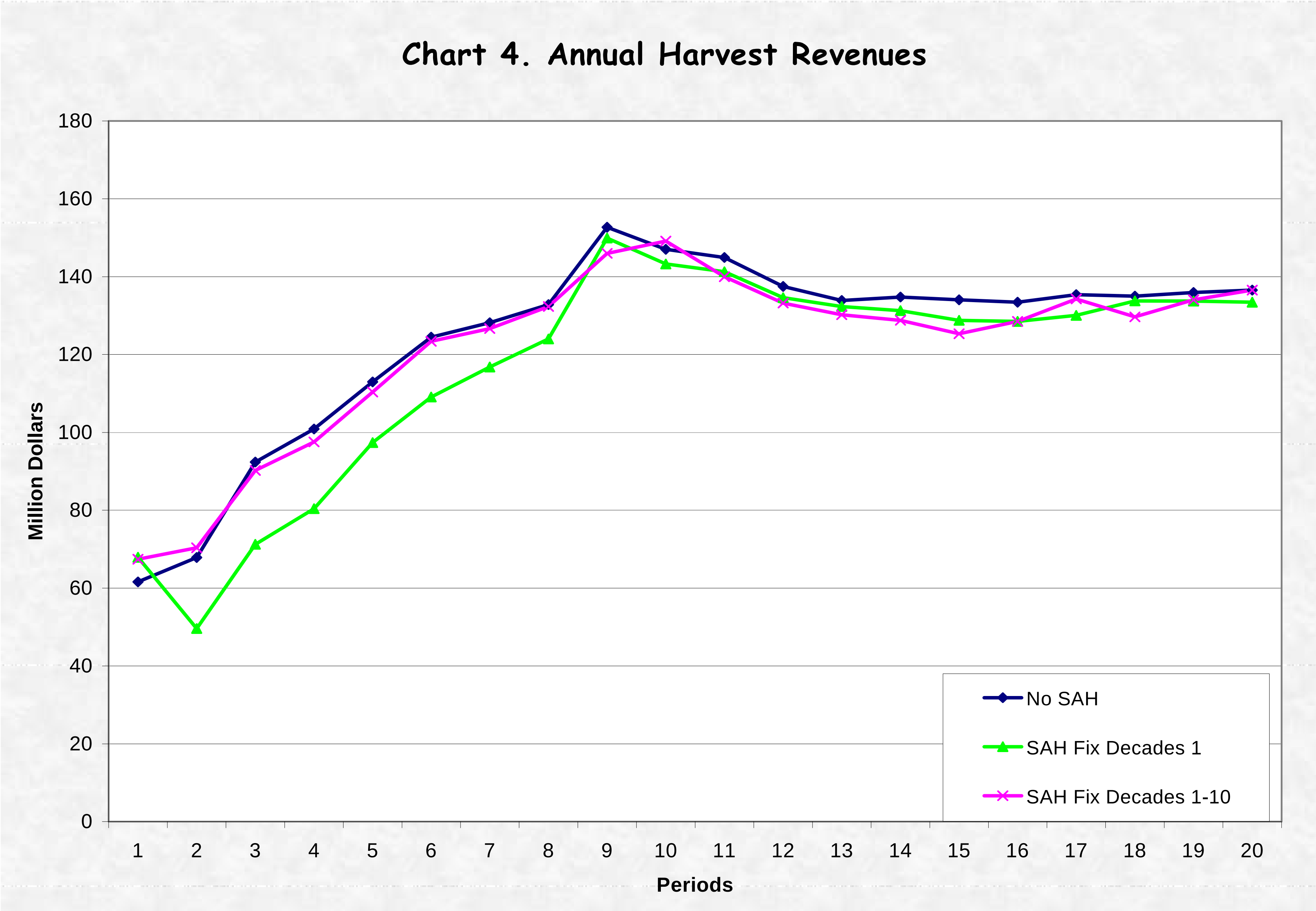


Chart 4. Annual Harvest Revenues
180
160
140
120
100
80
60
40
20
0
Million Dollars
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
Periods
No SAH
SAH Fix Decades 1
SAH Fix Decades 1-10

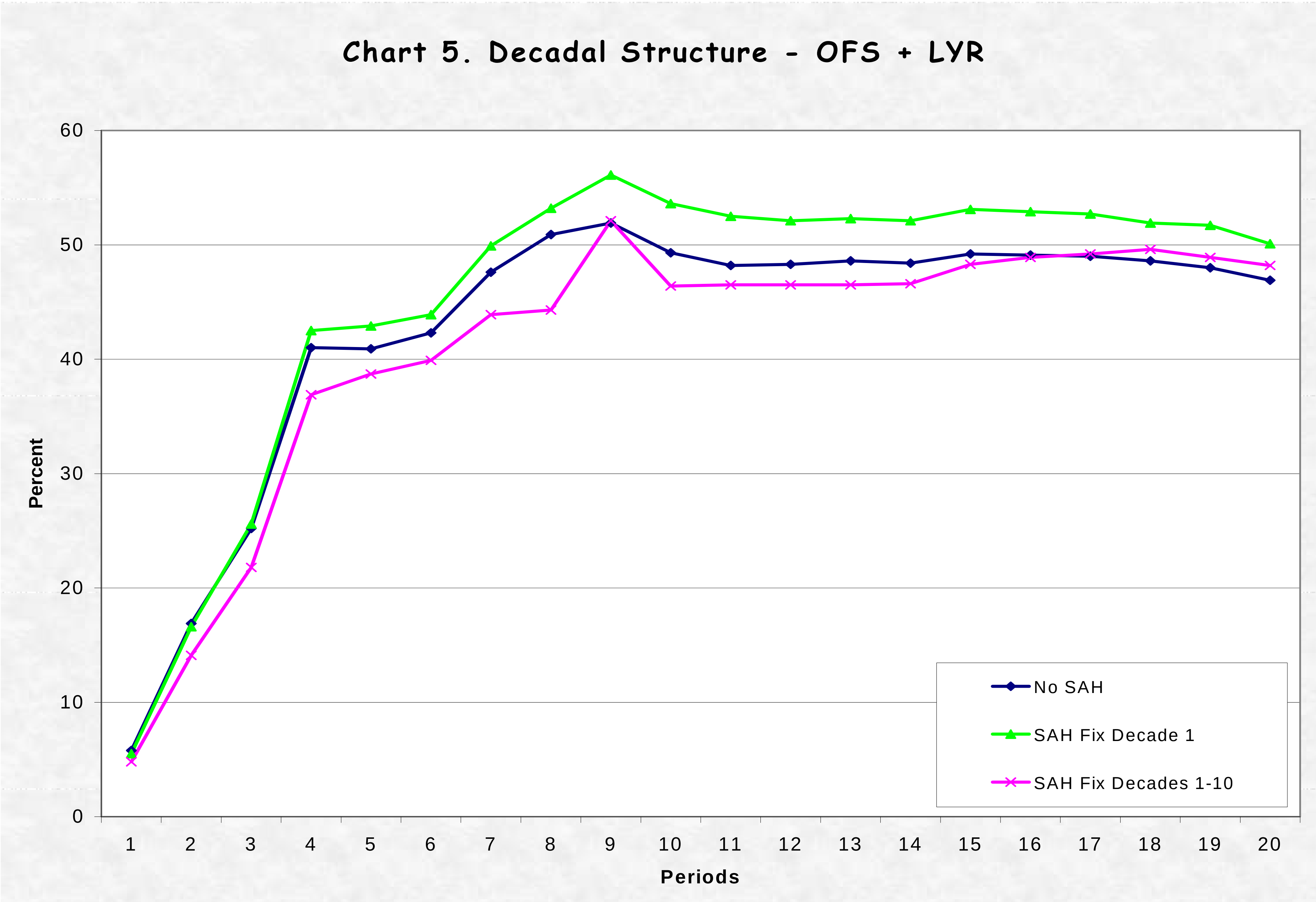


Chart 5. Decadal Structure - OFS + LYR
Percent
Periods
0
10
20
30
40
50
60
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
No SAH
SAH Fix Decade 1
SAH Fix Decades 1-10

Appendix A: Modeled Salmon Anchor Habitat Strategies

Strategy 2 – Apply management standards for aquatic and riparian areas, with the following additions:

- For all harvest operations that border **Type F and Large and Medium Type N** streams **–** the inner zone (100 feet) will be a no-harvest area.
- For partial cut harvest operations retaining at least a 25% Stand Density Index (SDI) that border **Small Type N, perennial streams –** no ground based equipment operation is allowed within 50 feet of the aquatic zone.
- For clearcuts and any other harvest operation which reduces stand density below 25% SDI that border **Small Type N, perennial** streams – no harvest allowed within 50 feet of the aquatic zone and a minimum of 15-25 conifer trees and snags per acre will be retained in the area between 50 and 100 feet from the aquatic zone.
- For partial cut harvest operations retaining at least a 25% SDI that border **Small Type N, seasonal** streams – no ground based equipment operation is allowed within 50 feet of the aquatic zone.
- For clearcuts and any other harvest operation which reduces stand density below 25% SDI that border **Small Type N, seasonal** streams – no ground based equipment is allowed within 50 feet of the aquatic zone and 15-25 conifer trees and snags per acre will be retained within 50 feet of the aquatic zone.

Strategy 6 **–** Slope stability.

- The concepts and the approaches described in the slope stability strategy in the NW FMP will apply. Adjustments to this strategy are intended to further reduce the likelihood of sediment delivery to streams from management related landslides through closer scrutiny by geotechnical specialists. Steepness of slope is the criteria used for initial screening for High Landslide Hazard Locations. Geotechnical specialists review all proposed harvest operations as part of the Annual Operation Plan process. High Landslide Hazard Locations and high risk potential are identified through site specific analysis. Operations must avoid specific High Landslide Hazard Locations that pose the greatest risk to streams.

Specific Limitations on Timber Harvest Activities

Group 1

Group 1 includes Buster Creek, Lousignont Creek, and Devils Lake Fork of the Wilson River. A maximum of 20% of the state forests acreage within each of these SAH basins may be included in Annual Operations Plans for commercial thinning, regeneration harvests (includes clearcuts), or any other timber harvest activity during the 10 year period. Of the 20% total that may be subject to timber harvest, clearcut harvest will not exceed 5% of the total acreage in the SAH. Clearcut harvest will not be allowed where the

percentage of stands that are 15 years old or less would exceed 15 percent of the ODF acreage in the SAH as a result of the harvest.

Group 2

Upper North Fork of the Nehalem River, Fishhawk and Upper Rock are SAHs that have more limited amounts of state forest on those portions of the stream used by anadromous salmonids. In Fishhawk and Upper Rock, major waterfalls create natural barriers to fish passage near the boundaries and fish use is primarily downstream from state forests. The primary benefits state forests will provide to these salmon habitats are through downstream effects. Thus, providing sources for large wood and good water quality are the primary focus for state forests. State forests comprise about 47% of the ownership in Fishhawk and Upper Rock, and only about 42% in the Upper North Fork of the Nehalem River.

In the Upper North Fork of the Nehalem River, Fishhawk and Upper Rock there is no limit on thinning acreage, however Annual Operations Plans for clearcut harvests will not exceed 7% of the total state forests acreage in the salmon anchor habitat in each basin during the 10 year period. Clearcut harvest will not be allowed where the percentage of stands that are 15 years old or less would exceed 15 percent of the ODF acreage in the SAH as a result of the harvest.

Group 3

Group 3 includes 11 SAH basins.

1. **The amount of clearcut harvest included in annual operations plans to date and the maximum clearcut harvest levels that will be allowed in operations plans for the 10 year period in these basins are described in the following table:**

Basin	*ODF Acres*			*Maximum Allowable Acres (% Basin) Clearcut Harvests in Annual Operation Plans – July 2001 through June 2011*
	Tillamook District	*Forest Grove District*	*Total*	
Foley Cr.	4,403	–	4,403	10 %
S. Fk. Salmonberry	2,813	5,685	8,498	10 %
Middle Kilchis	14,155	–	14,155	10 %
Elkhorn	3,860	1,047	4,907	10 %
Miami	13,910	–	13,910	12 %
Coal Cr.	1,237	–	1,237	25 %
Cook Cr.	18,286	–	18,286	25 %

L. N. Fk. Wilson	10,310	–	10,310	16 %
E. Fk. S. Fk. Trask	15,627	–	15,627	25 %
Cedar Cr.	7,214	–	7,214	25 %
Ben Smith	3,602	2,333	5,935	10 %
TOTAL:	**95,417**	**9,065**	**104,482**	

2. **Thinning in some stands may occur, primarily for the purposes of learning more about stand responses to thinning. For those basins where basin plans are required – any proposed thinning will be addressed. In the rest of the basins, no more than 5% of the acreage in each basin would be allowed, and all thinning will comport with SAH guidelines.**