Final Report

Science Review of the Oregon Department of Forestry's Proposed Species of Concern Strategy and the Board of Forestry's State Forests Performance Measures

Institute for Natural Resources

28 February 2011

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Prepared by

The Institute for Natural Resources

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for

The Oregon Board of Forestry

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Executive Summary

On behalf of the Board of Forestry (the Board), the Oregon Department of Forestry (ODF) approached the Oregon University System's (OUS) Institute for Natural Resources (INR) to conduct an independent, outside review of the body of science ODF considered as it evaluated forest management plans and developed the Species of Concern (SOC) Strategy. Two products developed by ODF staff were the focus of this science review: *The Influence of Modeled Management Scenarios on Habitat for Species of Concern* (ODF, 2009a; hereafter referred to as "SOC analysis") and the *Board of Forestry State Forests Performance Measures: An Evaluation of the Achievement* (ODF, 2009b).

INR identified (1) a time-efficient project management structure that solicited and incorporated insights from a Science Advisory Team (SAT) comprised of OSU faculty and federal researchers, (2) a review process that enabled the SAT to accumulate discipline-specific perspectives on the strengths and weaknesses of the information in the ODF reports (ODF, 2009 a, b) provided to the Board, and (3) an agreement to reach consensus on the final interdisciplinary assessment of the information in reports (ODF, 2009 a, b) provided to the Board.

The purpose of the review and this SAT report is to: (1) characterize the environmental, economic, and social analyses that were conducted by ODF in 2009 and discuss whether ODF analyses were consistent with best available science in each field; (2) identify and discuss gaps; (3) discuss the range of uncertainty of expected outcomes as detailed in the ODF reports; (4) present other ways to conduct analysis or think about the questions, if applicable; and (5) recommend, if necessary, performance measures for measuring environmental, economic, and social outcomes.

The resources made available over the last several years are not sufficient to address the needs of the Board and the stated objectives of this report. There is a fairly sizable disconnect between what is wanted in terms of planning and justification for the SOC approach and the resources available to do it well. Our review of the examined information, the planning process, and the supporting science is as much a critique of that disconnect as it is the reports issued by ODF.

Given the time and resource constraints we faced, it was not possible to review in detail every one of the assumptions and outcomes that informed the development of limiting factors, surrogates and performance measures plus species of concern (PM + SOC) trends. Our SAT review report addresses some of the more important gaps in assumptions and application of scientific research in order to illustrate the advantages of adopting more robust analytical methods.

Review of SOC Analysis

The objective of the PM+SOC strategy is to better balance the economic, social, and environmental benefits. The SOC analysis identified responses to specific biophysical conditions. ODF used biophysical conditions (e.g., amount of older forest) as surrogates for habitat for species, which is not supported by current science. Nonetheless, the projections of these surrogate conditions seemed to reasonably reflect the influence of forest management on these conditions. The trends in surrogate conditions were consistent between ODF projections and those previously conducted by CLAMS.

It is critical to note that ***the conclusions reached by the ODF are in the nature of statements made about the quantitative difference in conditions that result from implementation of the PM + SOC strategy. Based on the information available to the SAT, these statements are accurate and supported by the analysis undertaken***. However, this does not mean that these statements reflect the state of the science or answer fundamental questions about economic performance or species protection. The ***amount*** of change in different surrogates does not necessarily describe the ***effect*** of that change, even when the surrogates reported are accurate representations of key drivers of effects to species.

The field of landscape ecology, which integrates biophysical and social drivers of variation in landscapes at different scales, is the appropriate discipline to address the question of whether ODF's new management strategy can meet SOC goals. Analysis of effects to species in a modern landscape ecology framework typically makes use of sophisticated spatial statistics, landscape habitat metrics, and concepts and methods from wildlife biology to characterize changes in habitat and species' response to these changes (Fahrig, 2003; Turner et al., 2001). Modern landscape ecology investigations often predict the movement and distributional patterns of organisms with multi-scale simulation models (Spies et al., 2007). ***To the extent that the ODF SOC analysis does not consider the interactions of process and pattern that result from management changes at multiple scales, and does not make use of robust, spatially explicit modeling tools, ODF's methods cannot be said to reflect the state of the field of landscape ecology.***

Key Issues

Based on our review of the SOC analysis, we raise several key issues that need to be taken into consideration for the analyses themselves and for the Board's decision on changing the forest management plans for the northwestern coastal Oregon state forests:

- **Distinguishing conclusions from information**
    - COMMENT: ODF does not provide conclusions per se for the SAT to review. Instead, ODF makes statements about the quantitative difference in conditions that result from implementation of the PM + SOC strategy. This information may be important, but it does not necessarily allow conclusions ("a reasoned judgment") about how species will be affected by adopting a different management strategy. Species may respond non-linearly to changes to surrogates (a threshold may trigger cascading change, for example), or changes to surrogates may interact with other ecological patterns and processes at different temporal and spatial scales to create results not predicted by measurement of surrogates.
    - RECOMMENDATION: Use existing landscape ecology tools and models (described in this report) to allow inferences about effects to SOC.

- **Uncertainty**
  - COMMENT: ODF could have specified that information about species is incomplete and effects to species are uncertain.
  - RECOMMENDATION: Plans should address uncertainties and have the flexibility to adapt to changing social views about biodiversity protection, economic goods and services, and other values.
- **Combining information among state forests**
  - COMMENT: Based on our knowledge of the current age class distribution of the Tillamook and Clatsop State Forests, it would seem that projections of future conditions could vary considerably among these forests and that benefits or risks to species could also vary considerably within a forest and from one forest to another.
  - RECOMMENDATION: Impacts of changing policy should be approached separately on each forest as initial conditions vary among forests and the context for the forests (the surrounding forest conditions) also varies.
- **Lack of use of habitat models**
  - COMMENT: The information provided to illustrate likely changes in habitat availability for SOC is based on using forest stand classes as surrogates for habitat for many of the SOC. Since habitat is a species-specific concept, lumping species into stand classes is a crude estimate of habitat availability.
  - RECOMMENDATION: Consider the use of spatially explicit models of habitat availability for species that include some of the SOC considered in this report.
- **Coarse-, meso-, and fine-filter approaches to ensuring protection of species**
  - COMMENT: Though many species are listed as SOC and listed as being represented by the models, the aggregations of species into stand structural conditions ignore major differences in their individual distributions, life histories, and ecological requirements. In addition, there are many other species that could be influenced by management activities that were not considered. A question remains regarding the potential for either positive or adverse effects on other species not selected for analyses.
  - COMMENT: The ODF analyses assumed a direct relationship between a biophysical class and habitat for each of the SOC rather than using the biophysical classes as surrogates for other species that could occur on these forests as is typically done in this type of analysis.
  - COMMENT: Since model projections are based on stand inventory information and growth models, it seems that the ODF analysis could have explicitly considered the likely changes in snag and log abundances, tree size distributions, and tree species composition over time.
  - RECOMMENDATION: Coarse-, meso-, and fine-filter approaches should be used to allow a more comprehensive analysis of risks to biodiversity than simply SOC.
  - RECOMMENDATION: Use of species specific habitat models, population viability analysis models, or other approaches that are widely available can be used to ensure that the SOC are likely to persist under each of the management scenarios on each state forest.

- **Lack of spatial considerations**
    - COMMENT: ODF's analysis was not spatially explicit. They identify how surrogates change but do not relate that change to specific spatial and temporal relationships.
    - COMMENT: Based on our interpretation of the models used in projecting future forest conditions, assessment of the sizes and spatial arrangement of species-specific habitat patches or distributions along the stream reaches would seem to be possible, but there is little evidence of that in the documents provided.
    - RECOMMENDATION: ODF needs to conduct spatially explicit analysis.
- **Comparisons to appropriate baseline conditions**
    - COMMENT: The ODF projections and summaries of relative differences in acres of habitat between management plans may allow for a comparison of plans, but does not provide a comparison to a reference condition that reflects the ecological capacity of the system to meet the needs for each species or for ecosystems processes.
    - RECOMMENDATION: Consider using the historical range of variability (HRV) as a reference condition in each region in which each state forest is located.
- **Using stand types as surrogates for habitat**
    - RECOMMENDATION: Given the significance of the SOC in the comparative analyses conducted by ODF, habitat should be defined for each species and should include the structural and compositional elements of habitat necessary to support populations over space and through time.
- **Use of other GIS data that could inform habitat availability**
    - COMMENT: Several of the SOC identified as important components of these ecosystems were not analyzed apparently because of lack of information.
    - RECOMMENDATION: Combining information from other data layers with information on overlain stand conditions, or more ideally included within species specific habitat models, would allow a more complete understanding of habitat trends over time.
- **Considerations of dispersal habitat especially for species with limited mobility**
    - COMMENT: Without a more complete understanding of the risks associated with changes in landscape connectivity, it is not clear how much confidence we can place in projections that simply show changes in a surrogate for habitat availability.
- **Considerations of thresholds and tipping points in achieving anticipated results**
    - COMMENT: We need to ask if synergies among these stressors and uncertainties ***could*** lead to a tipping point for any of the species.
- **Limited use of available literature to not only support statements made**
    - COMMENT: Although we are sure that ODF staff are aware of literature beyond what was cited in the two documents that we were asked to review, the literature cited sections are indeed very sparse and some of the highly relevant information collected on state forest land was not included.
- **Lack of social, economic, and legal "limiting factors"**
    - COMMENT: Social, economic, or legal factors are not considered "limiting factors" in the SOC analysis. The lack of analysis of these factors may lead to ineffectual choices and

decisions as the Board of Forestry moves forward with policy decisions, regardless of the soundness of the biophysical analysis.

- RECOMMENDATION: Consider social, economic, and legal factors as "limiting factors."

Management Scenario Effects

Under the time constraints of this review, we were unable to examine each of the 40 SOC ODF included in its analyses. Instead, we used red tree voles, northern spotted owls, and aquatic amphibians to illustrate an alternative approach that ODF could use to analyze effects on individual species. The review structure used four questions to determine if other science is available and how it can be integrated into the ecological effects analysis. We do not offer a complete list of information needs but rather components that do not appear to be incorporated in the modeling scenarios.

CLAMS

In order to provide an independent assessment of the trajectories of trend lines presented in ODF's SOC analysis, we extracted trends for structural classes and predicted habitat for three species on the Clatsop and Tillamook State forests using the Coastal Landscape and Modeling System (CLAMS) base case. We compared trends in structural conditions and habitat between the ODF base case and the CLAMS base case simply as a way of characterizing consistencies or inconsistencies in trends over time but do not make assumptions about which projection is most accurate. Rather, where trends are consistent we assume that the trends are more likely to be realistic projections whereas inconsistencies raise questions about one or both model projections and accentuate uncertainties associated with interpretations of risk to resources. It is important to note that we did not rerun the CLAMS projections under the PM + SOC assumptions to compare trends with the ODF PM + SOC projections. Such an effort would have entailed much more time and funds than were allocated to this review process.

Based on the similarity between the trends produced by CLAMS and ODF's Harvest and Habitat Model for the current management approach, we can assume that the results would similarly approximate ODF conclusions about the percentage of land in various cover types.

In summary, the base case projections were reasonably consistent between ODF projections and the CLAMS projections. This increases confidence that the ODF projections are indeed reasonable representations of stand structural conditions likely to be seen in the future under both scenarios.

Review of Performance Measures

Our review of scientific information considered in developing and evaluating the forest management plan strategies suggests to us that current analyses have not utilized the full breadth of methods and information potentially available. The analysis has focused on examining several performance measures intended to address socioeconomic and environmental factors. We evaluated each of these performance measures according to how well they meet indicator effectiveness criteria ensuring relevance, understandability, reliability, and accessibility:

- **Relevant** – each indicator shows you something about the system that you ***need*** to know;
- **Easy to understand** – each indicator is clear and transparently ***associated*** with what you're trying to measure;
- **Reliable and Valid**– each indicator collects information that is ***consistently correct***; and
- **Accessible** – each indicator uses information that is ***easily and regularly collected***.

In our opinion, only Performance Measure 1 fully meets these criteria and might be considered a successful application of available science information. Other performance measures provide only partial information pertaining to the environmental and socioeconomic factors they are intended to address. Performance Measures 2 and 3 lack information describing the potential impacts of forest management changes on the direct and indirect financial contributions to communities and to local and state government. Performance Measures 4, 5, and 6 – while relevant to the long-term productivity of many ecosystem goods and services, aquatic-associated resources, and habitat for a suite of politically or legally significant species – lack information on the monitoring needed to understand occurrences and changes in distributions of diseases and especially invasive species in these forests. They also lack clear articulation as to how the metrics trigger management changes and policy decisions. In the case of Performance Measure 6, the relationships between the data and the function of the habitat to sustain populations of each focal species are not supportable.

Performance Measure 7 lacks information characterizing potential changes in the supply and demand for recreation in state forests. Similarly, Performance Measures 8 and 9 could include additional information addressing public and stakeholder involvement and Oregonians' awareness and support of management changes under consideration. Additional performance measures characterizing potential influences on community well-being and ecosystem services could have also been considered.

In our view, there is a reasonable chance that the incompleteness of the performance measures examined may be sufficient to mischaracterize the anticipated impacts of proposed forest management alternatives. ODF (2009b) rationalizes the absence of key information by stating the unavailability of needed data to fully implement the performance measures outlined. However, we do not feel that the absence of key data owes to any shortcoming in existing scientific method necessary to develop or procure needed data.

We recognize that funding and other constraints may obligate state agencies to do more with less. But if this is the case, perhaps a different set of performance measures—ones for which complete data are already available—might be considered by the Board. This might necessarily entail acknowledging that some potential effects are left unmeasured. Alternatively, the Board might consider investing in the resources necessary to conduct the type of comprehensive analysis they envision. Either way, given that the information, process and science will never be perfect or complete, moving forward with elements common to the existing plan and the proposed SOC guidelines should only proceed using landscape ecology and adaptive management frameworks and with full recognition and acknowledgement of potential shortcomings regarding existing data and analysis.

This executive summary serves as a consensus statement of all members of the SAT.

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List of Acronyms and Abbreviations

AAW	Aquatic Anchor Watershed
CLAMS	Coastal Landscape and Modeling System
DBH	Diameter at Breast Height
ESA	Endangered Species Act
FMPs	Forest Management Plans
GIS	Geographic Information System
HCP	Habitat Conservation Plan
HRV	Historical Range of Variability
IMST	Independent Multidisciplinary Science Team
INR	Institute for Natural Resources
OCCCP	Oregon Coast Coho Conservation Plan
ODF	Oregon Department of Forestry
ODFW	Oregon Department of Fish and Wildlife
OSU	Oregon State University
OUS	Oregon University System
PM+SOC	Performance Measures plus Species of Concern
SAT	Science Advisory Team
SOC	Species of Concern
WHR	Wildlife Habitat Relationships

Introduction

Background and Project Purpose

The Northwest and Southwest Forest Management Plans (FMPs) provide management direction for over 600,000 acres of forestland in Oregon. Currently the Oregon Board of Forestry (the Board) is examining a potential balance of benefits provided through forest management on these forests and is considering two changes to the existing forest management plans:

1. Replacing reliance on the Draft West Oregon Habitat Conservation Plan (HCP) for habitat protections and replacing it with a set of strategies to manage for terrestrial and aquatic vertebrate species of concern; and,
2. Recalibrating the stand structure classes in the Northwest FMP to reflect a range of 30-50% for complex structures (defined as Layered and Older Forest Structure).

On behalf of the Board, the Oregon Department of Forestry (ODF) approached the Oregon University System's (OUS) Institute for Natural Resources (INR) to conduct an independent, outside review of the body of science ODF considered as it evaluated forest management plans and developed the Species of Concern Strategy. Two products developed by ODF staff were the focus of this science review:

- *The Influence of Modeled Management Scenarios on Habitat for Species of Concern* (ODF, 2009a; hereafter referred to as "SOC analysis") compares the environmental effects of two different management strategies on 40 different "species of concern" based on trends in 26 "limiting factors". This document acknowledges that it provides comparative, not necessarily analytical results. It describes how key indicators (e.g., amount of late successional forest) differ under the two different management strategies.
- The *Board of Forestry State Forests Performance Measures* (ODF, 2009b). In addition, background references included in the document titled *Board of Forestry State Forests Performance Measures Employment & Personal Income* were also considered during the review.

Purpose of this report

The purpose of this review report is to: (1) characterize the environmental, economic, and social analyses that were conducted by ODF in 2009 and discuss whether ODF analyses were consistent with best available science in each field; (2) identify and discuss gaps; (3) discuss the range of uncertainty of expected outcomes as detailed in the ODF reports; (4) present other ways to conduct analysis or think about the questions, if applicable; and (5) recommend, if necessary, performance measures for measuring environmental, economic, and social outcomes.

Project Approach

This review solely focuses on the science considered, and gaps that may be present in the science considered, by ODF in its development of the Species of Concern (SOC) Strategy and the Board's performance measures. This is not a review of the management decisions themselves, as these are informed by policy considerations in addition to the technical information. The intent of the review is to provide the Board and ODF with an independent scientific perspective on the information on which future decisions could be based.

INR identified (1) a time-efficient project management structure that solicited and incorporated insights from a Science Advisory Team (SAT) comprised of OSU faculty and federal researchers, (2) a review process that enabled the SAT to accumulate discipline-specific perspectives on the strengths and weaknesses of the information in the ODF reports (ODF, 2009 a, b) provided to the Board, and (3) an agreement to reach consensus on the final interdisciplinary assessment of the information in reports (ODF, 2009 a, b) provided to the Board.

Management structure of the review

The project team consisted of a *Project Manager* who oversaw the project team and the production of the key deliverables; an *SAT Chair* who facilitated the work of the SAT; an *interdisciplinary SAT*, comprised of OSU faculty and federal researchers with expertise in forest management research in Oregon; and *secondary reviewers* from Portland State University, Oregon State University, the University of Oregon, the U.S. Forest Service, and the National Center for Ecological Analysis and Synthesis in Santa Barbara, California who critically reviewed the SAT report.

Selection of the Science Advisory Team (SAT)

"A defensible systematic review hinges on qualified reviewers—ideally, academic scientists in the field under which the review question falls who do not have a vested interest in review outcomes..." (Behan, 2008:4). Based on this goal, INR engaged researchers from four academic units within Oregon State University and from the U.S. Forest Service.

The intent of the SAT selection process was to identify and solicit scientists considered to be top experts in their fields to participate on the SAT (Table 1). The SAT was interdisciplinary to ensure, to the degree possible, that the underlying scientific issues related to the social, economic and environmental aspects of the question(s) (see *Review Approach* below) were understood and that the current state of knowledge could be relayed to the Board in a manner that could be applied to Oregon forest management decisions. All SAT members were familiar with the *Oregon State Forests Management Plan*.

Table 1. Characteristics of the INR Science Advisory Team

Characteristic	Description
Independence	Members of the SAT should be independent of the Board of Forestry and of ODF. They should be selected by the Chair of the SAT and the Project Manager. The Chair should be a senior scientist with knowledge of forest management in Oregon and has no direct affiliation with the Board or ODF.
Credibility	Members of the SAT should be senior scientists with tenure or a comparable level of professional stature and who are recognized by their peers as being experts on natural resource issues.
Balance	Despite the desire to be objective in interpretation of scientific information, professional perspectives and interpretations are based on individual knowledge and research experience. The members of the SAT should represent, to the degree possible, philosophies that span a range of views.
Interdisciplinary	Members of the SAT should be interdisciplinary in their approach to the problem. In this approach the resulting analysis of the existing state of knowledge is truly different than a result that would be achieved through individual reports from multiple individuals.
Consensus	The SAT should agree at the outset that each of the resulting report(s) will be those that represent a consensus of the appropriate sub-committees (i.e., environmental, economic, and social) of the SAT. The SAT should also agree at the outset that the integration report will be a consensus report. In only rare cases would a minority report be offered in addition to the SAT integration report.
Transparency	The report issued by the SAT will be available for input by other scientists for a specified period to allow additional input to the assessment. Using the approach that with enough eyes on a problem even complex problems are solvable, the SAT can take advantage of input from other scientists and stakeholders to ensure that they have thought through the issues as completely as possible.
Reliability	The report produced by the SAT should clearly explain, where possible, the levels of certainty and uncertainty associated with their findings.
Advisory	The SAT needs to realize that their information is only part of a decision-making process. The SAT is being asked to assess the technical basis for management decisions; they are not being asked to give management recommendations.

Review process

The purpose of the science review was to examine the models and concepts used in two ODF documents (see *Background and Project Purpose* section) and determine whether the relevant science information was considered, reasonably interpreted, and applied with consideration to uncertainties and consequences. These two ODF documents, in addition to this review, are being used to assist the Board in developing and evaluating Oregon state forests' forest management plan strategies.

The Board was specifically interested in having the SAT consider the following questions, which set the parameters of the review:

- Are the environmental, economic, and social analyses conducted and reported by ODF consistent with the science in each field?
- Are the conclusions supported by the analysis?
- What is the weight of evidence that supports or conflicts with the conclusions?
    - Based on this weight of evidence, what range of conclusions could be reported instead of the specific conclusions drawn by ODF?
- What other ways are there to conduct the reported analyses?
- What other ways are there to measure environmental, economic, and social outcomes to facilitate forest management decision making?

To address these questions the review process consisted of: (1) holding six SAT meetings to discuss the scope of the work (including the questions), participating in a public meeting, speaking to ODF staff to gather additional documentation, discussing and reviewing the primary and *Group 1* documents, and discussing the SAT's review report; (2) gathering, cataloguing, and documenting primary and group documents (Appendix A); (3) reviewing the primary documents; (4) engaging in outreach; (5) writing and revising the SAT review report; and (6) having the report undergo secondary review (Appendix B) and public comment (Appendix C).

Systematic methods were used to gather and catalogue documents (i.e., peer reviewed and non-peer reviewed literature, agency reports, etc.). In addition to the primary documents of this review, three groups of documents were catalogued (Appendix A). *Group 1* documents consist of documents referenced in the two primary ODF reports and include documents the SAT requested from ODF, such as additional information about the models used in the SOC analysis. *Group 2* are documents that the SAT cite in this review report and documents that the SAT provided as a representative sample of the science but are not referenced in this review report. *Group 3* documents are ones that the public submitted to the SAT prior to the writing of this report as part of our public outreach efforts.

Transparency and input was a very important part of the review process. Several opportunities were provided to the public to participate. A project website was established at http://oregonstate.edu/inr/node/232. A press release about the project and a public meeting was posted on the project website. It was also sent via U.S. mail and electronically to several contact lists, including those of the Independent Multidisciplinary Science Team (IMST), the Board, and ODF, among others. A public meeting to introduce the project was held 1 October 2010, at the OSU Campus in Richardson Hall. The public was invited to suggest science-related references that the SAT team could take under consideration (all references provided by the public prior to the production of the first draft of this report were catalogued in an Excel database, *Group 2* documents). The SAT Chair and Project Manager also presented the draft Executive Summary and an overview of the process at a 5 January 2011 Board meeting in Salem, Oregon. The public was invited to comment on the SAT review document when it was issued during a two-week time period. Substantive public comments were added as an addendum to the final SAT review report (see Appendix C).

A secondary review process was used to ensure that the SAT report addressed only its charge and did not go beyond it, that the findings were supported by the scientific evidence and arguments presented, and that the report was impartial and objective. The SAT was asked to respond to, if necessary, but need not have agreed with, the independent secondary reviewer comments in a detailed “response to review” (see Appendix B). This was examined by the SAT Chair and Project Manager to make sure that the report review criteria had been satisfied. Five experts from the University of Oregon, Portland State University, Oregon State University, the U.S. Forest Service, and the National Center for Ecological Analysis and Synthesis in California served on the secondary review team.

Organization of the Report

The report is organized as follows: Section 2 presents the SAT’s review of ODF’s SOC analysis, details key issues and management scenario effects, and includes the Coastal Landscape and Modeling System (CLAMS) analyses of state structure classes for all state forests, wildlife for state forests, and steelhead and Coho intrinsic potential; Section 3 reviews each of the nine Board of Forestry state forests performance measures and suggests additional performance measures. Section 4 is an integrated conclusion of the work of the SAT.

The recommendations presented in the report are meant to stimulate discussion among the members of the Board of Forestry, not be the definitive options available to the Board in their future discussions. The appendices provide the background documents, making the review process more transparent.

This report serves as the SAT’s formal review and is one of the deliverables to the Board.

Review of the SOC Analysis

Introduction

Overview of ODF's SOC analysis

In 2009 the Board directed ODF "to identify specific strategies to maintain, enhance and restore habitats for fish and wildlife species of concern on the Clatsop and Tillamook State Forests, while striving to achieve performance measure targets for financial contributions to government services and for fish wildlife habitat in the next two decades (ODF, 2009a: 3)." In April 2009, ODF—working with the Oregon Department of Fish and Wildlife (ODFW)—drafted a proposed set of SOC strategies in which the scientific and policy bases are described in the Northwest State Forest Management Plan (FMP), the 2005 Oregon Coast Coho Conservation Plan (OCCCP), and the 2005 Oregon Conservation Strategy.

As requested by the Board, the purpose of ODF's analysis was to provide a relative assessment of risk and benefits to habitat for 40 SOC between two modeled forest management scenarios. The ODF analysis concentrated on trends in a small set of habitat conditions that result from modeled forest management scenarios and intended to estimate the relative probability that potential FMP modifications would maintain and enhance habitat as compared to the current FMP. The specific objectives of the ODF SOC analysis were to:

- evaluate if modeled management scenarios that strive to meet performance measures with SOC strategies (PM+SOC) will maintain and enhance habitats for species of concern; and,
- compare PM+SOC model results to a model simulating current approaches under the FMP – original Implementation Plan landscape designs, long-term structure goals, and draft habitat conservation plan strategies (Base model).

ODF compared trends in forest structure under two modeled scenarios to determine how each scenario would maintain or enhance habitats for 40 SOC. The two model scenarios characterized: (1) the current 2001 Forest Management Plan implemented with draft Habitat Conservation Plan strategies (Base); and, (2) a modified 2001 management plan implemented with proposed draft species of concern strategies (PM+SOC).

The analytical framework (Figure 1) for the SOC analysis centered on the identification of the limiting factors, the relationships between limiting factors and forest management, and the surrogates for these relationships for each of the SOC (See ODF, 2009a for more details about the methods).

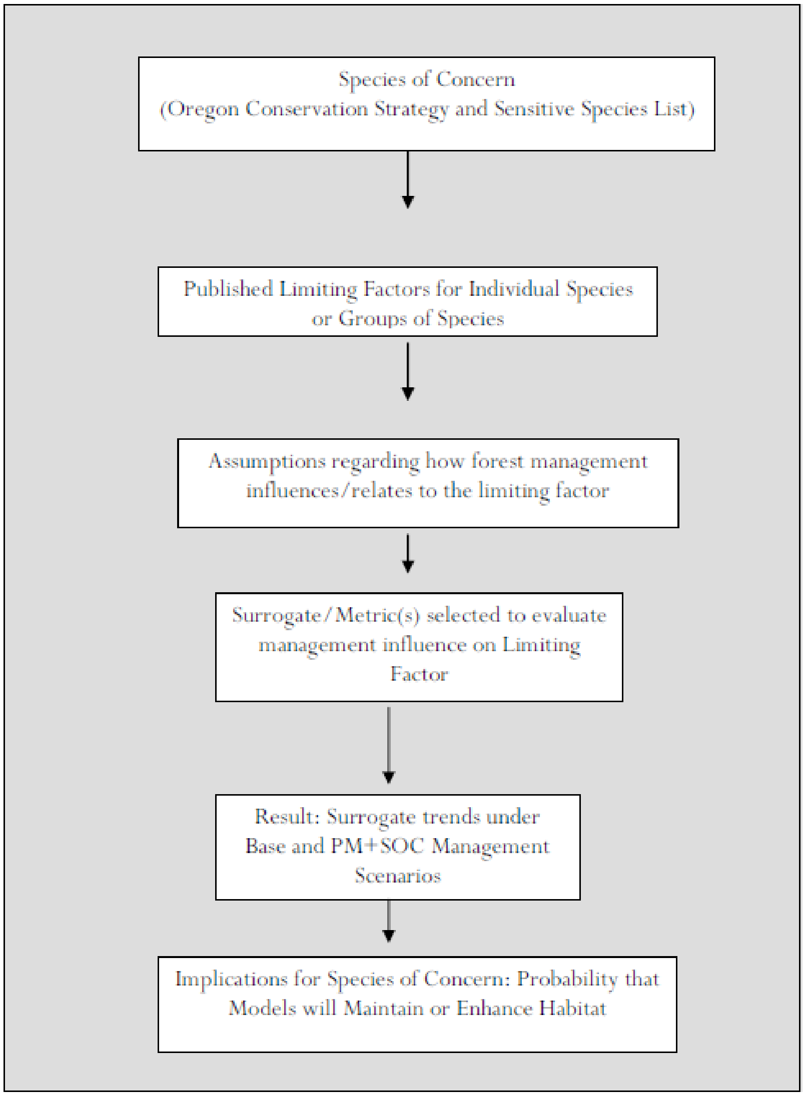

Figure 1. Schematic of ODF's analytical framework for evaluating effects on habitat for species of concern. Figure reproduced from the SOC analysis (Figure 1 in ODF, 2009a).

ODF acknowledged in the report that the selection of surrogates is limited to those that could be extracted from the H & H model, and that in some cases the limiting factors could not be related to modeled surrogates. As such, ODF's SOC analysis primarily focused on a subset of the 26 limiting factors mentioned in the analysis.

Overview of the review of the SOC analysis

In this section, we provide a general overview of the approach taken by ODF staff in providing estimates of likely changes in availability of habitat for fish and wildlife species identified as SOC. Although we point out general concerns with some of the approaches taken, we want to emphasize that the staff was charged with an overwhelming task in a short time frame.

Review of the SOC analysis conclusions

The objective of the PM+SOC strategy is to better balance economic, social, and environmental benefits. The SOC analysis identified responses to specific biophysical conditions. ODF used biophysical conditions (e.g., amount of older forest) as surrogates for habitat for species, which is not supported by current science. Nonetheless, the projections of these surrogate conditions seemed to reasonably reflect the influence of forest management on these conditions. The trends in surrogate conditions were consistent between ODF projections and those previously conducted by CLAMS.

The SAT was asked to review the conclusions made by ODF; however, ODF does not make conclusions as such. Instead, ODF makes statements regarding the quantitative difference in conditions that result from implementation of the PM + SOC strategy. As noted below, based on the information available to the SAT, these statements are accurate and supported by the analysis undertaken. However, ***this does not mean that these statements reflect the state of the science or answer fundamental questions about economic performance or species protection.*** The ***amount*** of change in different surrogates does not necessarily describe the ***effect*** of that change, even when the surrogates reported are accurate representations of key drivers of effects to species. Species may respond non-linearly to changes to surrogates (a threshold may trigger cascading change), for example. In addition, changes to surrogates may interact with other ecological patterns and processes at different temporal and spatial scales to create results not predicted by measurement of surrogates.

The field of landscape ecology, which integrates biophysical and social drivers of variation in landscapes at different scales, is the appropriate discipline to address the question of whether ODF's new management strategy can meet SOC protection mandates. Modern landscape ecology research investigates the interactions of processes (e.g., disturbance processes) and pattern (e.g., the distribution of older forest patches). The field of landscape ecology acknowledges that many ecological outcomes (e.g., species viability) vary with the scale of observation (e.g., watershed or region-wide) (Turner, 2005; Levin, 1992). Analysis of effects to species in a modern landscape ecology framework typically makes use of sophisticated spatial statistics, landscape habitat metrics, and concepts and methods from wildlife biology to characterize changes in habitat and species' response to these changes (Fahrig, 2003; Turner et al., 2001). Modern landscape ecology investigations often predict the movement and distributional patterns of organisms with multi-scale simulation models (Spies et al., 2007).

To the extent that the ODF report does not consider the interactions of process and pattern that result from management changes at multiple scales, and does not make use of robust, spatially explicit modeling tools, ODF's methods cannot be said to reflect the state of the field of landscape ecology. Given the time and resource constraints faced by the SAT, it was not possible to review in detail every one of the assumptions and outcomes that informed the development of limiting factors, surrogates and PM + SOC trends. This document addresses some of the more important gaps in assumptions and applications of scientific research in order to illustrate the advantages of adopting more robust analytical methods.

ODF's Management Scenario discussion of effects to salmonids illustrates how a landscape ecology framework might yield different conclusions than the summary of limiting factor trends analysis. Coho, Chum, Fall Chinook, Spring Chinook, Coastal Cutthroat, Winter Steelhead, Western Brook, and Pacific Lamprey are listed as SOC. Complex Forest Structure, cumulative clearcut acreage, amount of stands less than 20 years of age that exceeds 30% of watershed area, and amount of harvest within riparian areas are selected as surrogates for watershed function (one of ODF's limiting factors). ODF states that under different management scenarios these conditions would vary. These statements are accurate; however, this comparison does not necessarily answer the underlying question of interest: what will be the effect of changed management practices on the SOC? To answer this question, ODF's analysis would need to address the current spatial arrangement of habitat, the processes that create that habitat, and the interactions of watershed processes and human management.

The questions that the SAT has been asked by ODF to answer include:

- Are the environmental, economic, and social analyses conducted and reported by ODF consistent with the science in each field?
- Are the conclusions supported by the analyses?
- What is the weight of evidence that supports or conflicts with the conclusions?
    - Based on this weight of evidence, what might be the range of conclusions that could be reported instead of the specific conclusions drawn by ODF?
- What other ways are there to conduct the reported analyses?
- What other ways are there to measure environmental, economic, and social outcomes to facilitate forest management decision making?

The following matrix (Table 2) summarizes the limiting factors, surrogates for limiting factors, SOC affected, and conclusions reached by ODF (statements that compare the base strategy to the PM + SOC strategy as reported in the ODF Management Scenario documents). Columns to the right are responsive to the questions above but may not provide the exact answer being sought. The table should be interpreted as follows:

Consistent with science? A summary answer to the question: "Are the environmental analyses conducted and reported by ODF consistent with the science in each field? A "Yes" means that the analyses conducted are consistent with the science in each field.

Conclusions supported by analysis? A summary answer to the question: "Are the conclusions supported by the analyses?" <u>In this column the SAT is responding to whether or not the base versus PM + SOC comparisons summarized are accurate.</u> A "Yes" means that the summaries are accurate. The SAT is not offering a judgment as to whether legal or social expectations for species protection are being met.

Weight of evidence. A summary answer to the question: "What is the weight of evidence that supports or conflicts with the conclusions?" <u>In this column the SAT is noting whether there are other methods or scientific information available that might offer a different perspective on the affects to the SOC</u>. A "Yes" answer means there are other methods or scientific information available.

Other ways to conduct analysis? A summary answer to the question: "What other ways are there to conduct the reported analyses?" In this column, the SAT is offering a judgment as to whether there are other ways to conduct an analysis of affects to SOC that are standard or acceptable practice in wildlife biology and/or landscape ecology. A "Yes" means that there are other ways to conduct the analysis.

More detailed answers to the questions posed by the ODF can be found in the narrative within this document. The final question above: "What other ways are there to measure environmental, economic, and social outcomes to facilitate forest management decision making?" is also addressed explicitly throughout the narrative of this document.

Table 2. Summary of the limiting factors, surrogates for limiting factors, species of concern affected, conclusions reached by the ODF

No.	Limiting Factor	Surrogate for Limiting Factor	Assumptions	SOC	PM + SOC compared to Base	Consistent with science?	Conclusions supported by analysis?	Weight of evidence.	Other ways to conduct analysis?
1	Amount Late-successional forest (1)	**Amount of Landscape in Complex Structure**	Complex structure stands will provide habitat components needed for suitable habitat for the affected species.	American Marten, Hoary Bat, Red Tree Vole, Spotted Owl, Olive-sided Flycatcher	Base = 20% more complex structure by year 80 than PM + SOC.	No (Amount of late-successional habitat alone does not allow inferences about effects to late-successional species; comparison to reference conditions are standard practice)	Yes (Summaries appear accurate)	Yes (Other definitions of late successional; other ways of measuring pattern)	Yes (Spatially explicit models allow inferences about pattern)
2	Amount Late-successional forest (2): Amount of large nesting trees	**Percent of Landscape in Older Forest** (> 100 years old)	Complex stands need to be present on the landscape for an extended period of time to develop large diameter and large branch structure required for nesting by marbled murrelets and bald eagles.	Marbled Murrelet Bald Eagle Osprey	Base = additional 15% of the landscape over PM + SOC.	No (It is unclear that >100 year old stands are sufficient to develop habitat structures reported.)	Yes (Summaries appear accurate)	Yes (Species occur in specific areas; spatially explicit modeling necessary for conclusions)	Yes (Growth and yield models can provide more temporally and spatially explicit results.)

No.	Limiting Factor	Surrogate for Limiting Factor	Assumptions	SOC	PM + SOC compared to Base	Consistent with science?	Conclusions supported by analysis?	Weight of evidence.	Other ways to conduct analysis?
3	Amount of snags and downed logs	**Amount of Landscape in Older Forest Structure** (percent OFS)	Targets for amounts of snags and downed wood are higher for OFS than for other structural stages in the FMP.	California Myotis Fringed Myotis Long-legged Myotis Silver-haired Bat Clouded Salamander	Before 25 years, base and PM + SOC have the same amount of snags and downed logs. After 25 years, base = 12% more snags and downed logs than PM + SOC.	No (It is unclear to what extent different structural stages provide different habitat structures)	No (There is no estimate provided for threshold amounts of habitat structures necessary or comparison to reference conditions.)	No	Yes (Models, e.g., DecAID exist for quantifying effects to species from management decisions
4	Fragmentation/ Patch Size	**Number of Complex Structure Patches** (> 120, 200, 520, or 2180 acres)	Larger patches provide more interior habitat. Larger patches are less susceptible to edge effects. For red tree vole, larger patches are more likely to provide for self-sustaining populations.	American Marten, Red Tree Vole, Marbled Murrelet, Spotted Owl	Base = 1-9 more >2180 acre patches than PM + SOC. Base = 14 more >520 acre patches than PM + SOC Base = 65 more >200 acre patches than PM + SOC Base = 10-95 more >120 acre patchest than PM + SOC	No (Patch size alone does not accurately describe landscape fragmentation)	Yes (Summaries appear accurate)	Yes (Many other landscape metrics exist for quantifying and qualifying landscape scale fragmentation)	Yes (Analytical tools, e.g., FRAGSTATS, exist for quantifying and qualifying landscape scale fragmentation effects)

No.	Limiting Factor	Surrogate for Limiting Factor	Assumptions	SOC	PM + SOC compared to Base	Consistent with science?	Conclusions supported by analysis?	Weight of evidence.	Other ways to conduct analysis?
5	Fragmentation/ Limited Dispersal Ability	**Acres < 20 years old**	Stands < 20 years old represent a barrier to movement and/or dispersal	American Marten, Red Tree Vole	Base = 10% less young forest than PM + SOC.	No (Unclear why stands <20 present barrier to movement)	No (There is no estimate provided for threshold amounts of <20 forest habitat creates effects or description of reference conditions.)	Yes (Many other landscape metrics exist for quantifying and qualifying landscape scale fragmentation)	Yes (Analytical tools, e.g., FRAGSTATS, exist for quantifying and qualifying landscape scale fragmentation effects)
6	Watershed Function (1): Hydrology, Water Quality, Wood Recruitment	**Complex Forest Structure** at the landscape level and in the Aquatic Anchor Watershed AAWs; at current, 20, 40, and 80 years.	Watersheds with greater percent of complex structure are beneficial for watershed functions such as large wood recruitment and stream temperature.	Coho, Chum, Fall Chinook, Spring Chinook, Coastal Cutthroat, Winter Steelhead, Western Brook, and Pacific Lamprey	Base = 51% complex forest in 80 years. PM + SOC = 32% complex forest in 80 years.	No (Wood contribution to streams varies with topography, and amount of late successional wood in a watershed will have variable influences in different watersheds).	No (There is no estimate provided for threshold of large wood needed for salmon recovery targets or description of reference conditions)	Yes (Spatially explicit descriptions required for accurate estimates)	Yes (Analytical tools, e.g., STREAMWOOD, exist for describing large wood contributions to streams)

No.	Limiting Factor	Surrogate for Limiting Factor	Assumptions	SOC	PM + SOC compared to Base	Consistent with science?	Conclusions supported by analysis?	Weight of evidence.	Other ways to conduct analysis?
7	Complex Fish Habitat	**Complex Forest Structure** at the landscape level and in AAWs; at current, 20, 40, and 80 years. **Current Condition**	Increasing complex forest structure in watersheds will increase probability to provide large trees for instream complex habitat. Data from watershed analyses, Coho Assessment, Oregon Coast Coho Conservation Plan (OCCCP) on current habitat condition	Coho, Fall Chinook (especially in larger rivers)	Base = Twice the numbers of AAWs have beneficial levels of complex forest structure by year 80 than PM + SOC	No (Wood contribution to streams varies with topography, and amount of late successional wood in a watershed will have variable influences in different watersheds).	No (There is no estimate provided for threshold of large wood needed for salmon recovery targets or description of reference conditions)	Yes (Spatially explicit descriptions required for accurate estimates)	Yes (Analytical tools, e.g., STREAMWOOD, exist for describing large wood contributions to streams)
8	Watershed Function (2): Water Quality (stream temperature), Wood Recruitment	**Cumulative Clearcut** harvest in two 40-year time frames in AAWs.	Watersheds with a range of cumulative clearcut acreage present a range of risks to watershed function - based on Pollock et al. (2009) and Reeves et al. (1993)	Same as above	Base = Cumulative clearcut ranges from 7-51% PM + SOC = Cumulative clearcut ranges from 17-71%	No (Unclear how thresholds were established and how amount of clearcut harvest interacts with other key variables such as road networks.)	No (There is no estimate provided for threshold of large wood needed for salmon recovery targets or description of reference conditions)	Yes (Spatially explicit descriptions required for accurate estimates)	No

No.	Limiting Factor	Surrogate for Limiting Factor	Assumptions	SOC	PM + SOC compared to Base	Consistent with science?	Conclusions supported by analysis?	Weight of evidence.	Other ways to conduct analysis?
9	Hydrology	**Stand less than 20 Years** in AAWs; at current, 20, 40, and 80 years.	If stands less than 20-years exceeds 30% of the watershed area there is a risk to increasing small peak flows (<5 year return period) based on Grant et al (2008).	Fall Chinook, Spring Chinook, Coastal Cutthroat, Winter Steelhead,	PM+SOC = in years 20 and 80, four out of 17 AAWs exceed 30%.	(Unclear how thresholds were established and how amount of younger forest interacts with other key variables such as road networks.)	No (There is no estimate provided for threshold of young forest retarding salmon recovery targets, or description of reference conditions)	Yes (Spatially explicit descriptions required for accurate estimates)	Yes (Spatially explicit models (e.g., CLAMS) allow inferences about interactions of young forest cover and distinct stream reaches/habitat)
10	Riparian Function: Large Conifer trees in riparian areas, wood recruitment, shade	**Amount of Clearcut and Thinning Harvest in Riparian Areas** for AAWs and Management Basins; at 5, 20, 40 and 80 years.	Greater harvesting within 100 feet of streams risks a reduction in overall wood recruitment in small streams and increases in stream temperature. Risk ranking of High, Moderate, and Low based on Pollock (2009)	Coho, Fall Chinook, Spring Chinook, Coastal Cutthroat, Winter Steelhead, Western Brook and Pacific Lamprey.	Little difference in risk between base and PM + SOC	No (Measurement is most meaningful when related to specific stream reaches/specific salmon habitat)	No (There is no estimate provided for threshold of young forest retarding salmon recovery targets or description of reference conditions)	Yes (Spatially explicit descriptions required for accurate estimates)	Yes (Spatially explicit models (e.g., CLAMS and STREAMWOOD) allow inferences about interactions of young forest cover and distinct stream reaches/habitat)

No.	Limiting Factor	Surrogate for Limiting Factor	Assumptions	SOC	PM + SOC compared to Base	Consistent with science?	Conclusions supported by analysis?	Weight of evidence.	Other ways to conduct analysis?
11	Water Quality: Summer stream temperature	**Amount of Clearcut and Thinning Harvest in Riparian Areas** for AAWs and Management Basins; at 5, 20, 40 and 80 years.	Greater harvesting within 100 feet of streams may increase stream temperature. Risk ranking of High, Moderate, and Low. Wider buffers maintain amphibian species richness and higher abundance for some stream amphibians	Coho, Fall Chinook, Spring Chinook, Coastal Cutthroat, Winter Steelhead, Western Brook and Pacific Lamprey, Cope's Giant and Columbia Torrent Salamander, Tailed Frog	No difference in risk to riparian functions between the PM+SOC and base models in management basins.	No (Measurement is most meaningful when related to specific stream reaches/specific salmon habitat)	No (There is no estimate provided for threshold of young forest retarding salmon recovery targets or description of reference conditions)	Yes (Spatially explicit descriptions required for accurate estimates)	Yes (Spatially explicit models (e.g., CLAMS and STREAMWOOD) allow inferences about interactions of young forest cover and distinct stream reaches/habitat

Key Issues

Based on our review of the SOC analyses, we raise several key issues that need to be taken into consideration for the analyses themselves and for the Board's decision on changing the forest management plans for the northwestern coastal Oregon state forests.

Uncertainty

In the documents provided, the 5-year projections of forest conditions up to 80 years into the future are pictured as deterministic with no estimates of variability about the trend lines. There are uncertainties associated with these model projections of forest conditions, and these uncertainties should be recognized and represented in the charts and text, to the degree possible. Although the relative differences in lines was proposed as an indicator of trends, one could easily envision confidence intervals that overlap between any two projections. Without an explicit (or even implicit) estimate of uncertainty in projections, two lines that may seem different (e.g. Figure 2) may not, in fact, be different at all or may be much more different than what is depicted.

What are possible sources of uncertainty that can influence variability in projections and the interpretation of the projections? One of the greatest uncertainties facing forest planners is the development of management strategies with incomplete information about the suite of species under consideration. Past research on many species allows us to develop reasonable management plans for them. For some species we know very little. The SOC used in this analysis ranged from northern spotted owls, one of the most intensely studied species on earth, to silver-haired bats, for which we have little information on which to base management in the Oregon Coast Range. We have included references that could be used to help understand current levels of knowledge about responses to forest management practices for the SOC under consideration. If a primary goal is to reduce the risk of losing a species from all or part of its geographic range, and we have little information about that species, then a reasonable course of action would be to follow the precautionary principle and err on the side of conservation over resource extraction. If risk to species is a secondary goal, and other social values take precedence over species conservation, then risk, and the uncertainty associated with that risk, should be quantified. Uncertainty will vary from species to species.

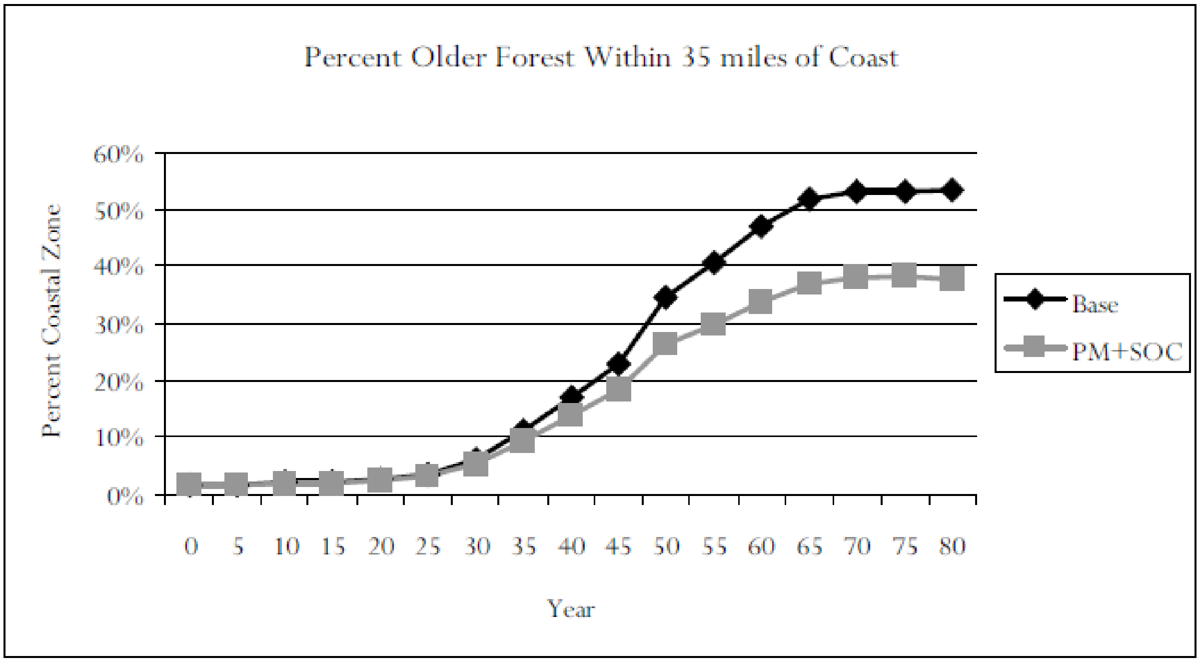

Figure 2. Amount of older forests (> 100 years old) within 35 miles of the Oregon coast developed over time. Figure reproduced from the SOC analysis (Figure 4 in ODF 2009a).

There are biophysical uncertainties – fires, floods, invasive plants and animals, disease, ocean conditions, and global climate change – that should be considered relative to the resistance or resilience of the forest. For instance, there are regional estimates of climate change impacts that could be considered. How might these changes influence habitat for the SOC? In some cases, these risks can be expressed as a departure from the historical range of variability (HRV); however, in many settings HRV may not be a reasonable guide. The past may help inform decisions, but we are now seeing ecosystems and social systems develop in new ways given the pressures of development on nearby private lands, climate change, and invasive species proliferation.

Social priorities represent another source of uncertainty in interpretation of modeled projections and species responses. How will societal values change for spotted owls, western toads, and clouded salamanders when weighed against economic and social benefits to rural communities over the next 80 years? We tend to think of goals and objectives for resources on public lands as being relatively stable; however, plans should have the flexibility to adapt to changing social views about biodiversity protection, economic goods and services, and other values. To meet future social goals and objectives, we must consider how the decisions we make today might limit the range and possibilities of future decisions.

There are also political uncertainties. Although political decisions are usually an outcome of societal values, the decisions being made can result in significant constraints on our ability to achieve biodiversity protection goals. Once made, these decisions can significantly affect the certainty or constrain the ability to achieve biodiversity conservation objectives. Changes in federal policies (such as modifications to the Endangered Species Act, Clean Water Act, the National Forest Management Act, and others) are not only likely, they are inevitable given the changes in societal values and political agendas that we can expect over the next 100 years. Such changes will affect the degree to which policies provide a workable legal framework for biodiversity decision making.

Combining information among state forests

Based on our knowledge of the current age class distribution of the Tillamook and Clatsop state forests, it would seem that projections of future conditions could vary considerably among these forests. The benefits or risks to species will also vary considerably from one forest to another and will vary greatly within a forest (e.g., fish distributions throughout the stream networks, spotted owl and murrelet nest sites). Impacts of changing policy should be approached separately on each forest because initial conditions vary among forests and the context for the forests (the surrounding forest condition) also varies among the three forests. We used the CLAMS model projections for each of the three forests to illustrate our concerns (see *CLAMS Assessment* section of this report). Under the base case the trajectory of resource values is expected to differ somewhat on each forest. We would assume that trajectories would also differ under the SOC plan.

Lack of use of habitat models

Likely changes in habitat availability information for SOC are based on using forest stand classes as surrogates for habitat for many of the SOC. Since habitat is a species-specific concept, combining species into stand classes is a crude estimate of habitat, at best, and may be seen as misleading (see Cushman et al., 2008, http://www.umass.edu/landeco/pubs/cushman.et.al.2008a.pdf). Combining species into stand classes is somewhat consistent with the use of a Wildlife Habitat Relationships (WHR) model; however, ODF staff did not use a WHR model per se, though they certainly could have.

The Johnson and O'Neill (2001) summary of wildlife habitat relationships provides a WHR model framework to assist managers and planners in this effort. In addition, other researchers have used spatially explicit models of habitat availability for species that include some of the SOC considered in this report (Spies et al., 2007; Nickelson and Lawson, 1998). These modeling frameworks have been published and are readily available (e.g., http://www.esapubs.org/archive/appl/A017/003/). We readily acknowledge that these model structures have their own weaknesses, but they do consider spatial arrangement of potential habitat patches, with habitat defined uniquely for each species. Finally for species that are of significant political, social and/or economic value, population viability models are available to understand the potential for relative changes in demographic parameters among policies. For species such as the northern spotted owl and coastal coho salmon, these models have been widely used. Granted these models would likely be utilized for landscapes larger than individual state forests (especially for owls), but the capacity is available in other agencies (i.e., U.S. Forest Service, U.S. Environmental Protection Agency, and the U.S. Geological Survey) to examine potential effects of alternative policies on regional trajectories of owl – and other SOC – demographics. Given the potential for contributing to risk to Endangered Species Act (ESA) listed species, such an analysis would seem justified.

Coarse-, meso-, and fine-filter approaches to ensuring protection of species

ODF staff makes a clear case for selecting the SOC for their analyses. The SOC are a subset of the species that could occur on these forests. They were selected for legal, political, and social reasons and because they were considered to be the most vulnerable to management actions. Though many species are listed as SOC and as being represented by the models, the aggregations of species into stand structural conditions ignore major differences in their individual distributions, life histories, and ecological requirements. In addition, there are many other species that could be influenced by management activities that were not considered and a question remains regarding the potential for either positive or adverse effects on other species not selected for analyses. One approach that is commonly taken to minimize the risk of loss of species from a management area is use of coarse-, meso- and fine-filter approaches.

The coarse filter is applied to the landscape by describing the distribution of biophysical classes (e.g., vegetation classes, slope classes, stream classes, etc.) that occur in each forest, and documenting the arrangement and connectivity of these biophysical classes across the landscape. These current conditions can be projected into the future under each of the two management scenarios to allow comparisons (which is what was done in Figure 1, for instance), or compared with past conditions to see how much they have changed over time. The current and possible future conditions are often compared with reference conditions to illustrate movement toward or away from a desired future condition. The ODF analyses did not use a reference condition as a goal for ecological restoration. Further, ODF analyses assumed a direct relationship between a biophysical class and habitat for each of the SOC, rather than using the biophysical classes as surrogates for other species that could occur on these forests, as is typically done in this type of analysis.

Not all species will be 'caught' in the coarse filter. Some require certain structural elements that must be present in plant communities and seral stages to ensure that they will likely persist in the management area. This would indicate using a meso-filter approach that considers the sizes, distribution, and abundance of structural elements such as snags, logs, hollow trees, and other within-stand structural elements distributed across each forest (Hunter, 2004). Since model projections are based on stand inventory information and growth models, it seems that the ODF analysis could have explicitly considered the likely changes in snag and log abundances, tree size distributions, and tree species composition over time. These and other characteristics are known to be important not only to the listed SOC but also other species that may be vulnerable to management activities (e.g., cavity nesters). We were surprised, for instance, that habitat changes for western bluebirds were not estimated. Estimates of snag retention, fall rates and decision support tools such as DecAID could have been used to guide management of dead wood within stands across each forest based on future projections of snag and log recruitment (Mellen et al., 2005).

Species requiring special attention may have low reproductive rates, large territories, or have been adversely affected by habitat loss (or other factors) such that their populations are low enough that they are considered extremely rare. Consequently, a "fine filter" is constructed that maintains the coarse-filter structure and the meso-filter elements but takes special management actions to conserve the set of species identified for fine-filter consideration. It is this level of analysis under which the SOC should be analyzed. Use of species specific habitat models, population viability analysis models, or other approaches that are widely available can be used to ensure that the SOC are likely to persist under each of the management scenarios on each state forest.

Lack of spatial considerations

Although it appears that projections of forest conditions were modeled spatially there is little consideration for spatial distributions of SOC or their habitat requirements. The models rarely incorporate minimum patch size (only four species), nor do they incorporate the structural and compositional characteristics within patches. Because habitat scales differ among species, it will have some minimum patch size to which it might respond (occupy or not). Specific conditions between patches will influence how patches are likely to be colonized (metapopulation dynamics).

Fish species are combined even though they occupy different portions of stream reaches within river basins and use different types of habitats. Based on our interpretation of the models used in projecting future forest conditions, assessment of the sizes and spatial arrangement of species-specific habitat patches or distributions along the stream reaches would seem to be possible, but there is little evidence of that in the documents provided.

Further, for species that respond positively to edges (e.g., olive-sided flycatchers) or negatively to edges (marbled murrelets), documenting edge densities (edges must be defined differently for each species) could be an important step in documenting relative changes in habitat availability over time under each management option.

Comparisons with other projections

All three state forests fall within the Oregon Coast Range, an area where considerable biophysical and economic changes over the next 100 years have been projected. CLAMS data are available by landownership type and can be utilized by state forest. Data are available from CLAMS projection for the ODF base case and include data that would allow coarse-, meso- and fine-filter analyses including fine-filter analyses for species such as northern spotted owls, western bluebirds, and olive-sided flycatchers. These data are available to determine if the projections made by ODF are consistent with CLAMS projections for the base case. In instances where they are consistent in trajectory and relative amounts, then there is some reassurance that the patterns presented are reasonable, given caveats associated with uncertainty. However, if a comparison of projections between approaches is inconsistent, a careful examination of both approaches is warranted to determine why they are inconsistent and to better understand what the risks to those species might be.

Comparisons to appropriate baseline conditions

ODF projections and summaries of relative differences in acres of habitat between management plans may allow for a comparison between plans, but does not provide a comparison to a reference condition that reflects the ecological capacity of the system to meet the needs for each species or for ecosystems processes. Comparison to the HRV in each region in which a state forest is located is one way of assessing movement toward or away from a reference or desired future condition. It is important to understand that when using the HRV as a reference condition, the objective is *not* to return to a past condition; but rather, to consider the range of conditions that species likely encountered in the past and the processes that led to those conditions. Biologists often assume that the species persisted within these ranges of conditions and processes. The more the current and likely future conditions depart from the HRV, the greater the *risk* that genetic variability may be lost from the system. Although both management approaches show an increase in complex forest structure over time, the degree to which each strategy approaches a desired future condition and the rate at which it approaches it are important components of ecological restoration and reducing risk of loss of populations or genes from the systems.

Using stand types as surrogates for habitat

Habitat comprises the set of resources necessary to support a population over space and through time. Each species has its own habitat needs. Garshelis (2000) made the point that often foresters and wildlife biologists both will refer to vegetation types, or other discrete classes of the environment, as habitats. More accurately, these are stand conditions or habitat types in that some species can be associated with some vegetation types and not with others. But these associations occur only because some or all of the resources needed by the species occur in those types. Given the significance of the SOC in the comparative analyses conducted by ODF, habitat should be defined for each species and should include the structural and compositional elements of habitat necessary to support populations over space and through time. Stand conditions or habitat types are useful classifications for understanding coarse filter goals but are inadequate for the fine filter analyses that should be used for SOC.

The model for fish habitat was based on three surrogates— complex forest structure, proportion of young stands (“regeneration stands”), and harvest within 100 feet of perennial streams. Fish habitat, fish populations, or potential to support fish populations are not measured or modeled. The potential fish responses are ranked in coarse “potential benefit” categories as low benefits (<25% complex forest structure), moderate benefits (25 to 50% complex forest structure), and high benefits (>50% complex forest structure). Habitat structure, stream gradient, sediment type, or large wood were not considered. In even the most simple fish models, the potential value for fish habitat for different species is a function of stream size and gradient. The proportion of young stands is intended to represent hydrologic impacts on fish, though no citations are provided as a basis for the relationship between young stands and fish abundance for the SOC. Riparian harvest is expected to range from 0-6% of the riparian stands under the base case and increase to as high as 46% under the SOC scenario (declining through time). The model ranks the risks as low risk (<25% riparian harvest), moderate risk (25 to 50% riparian harvest), and high risk (>50% riparian harvest) but provided no citations or information to relate these levels of harvest to fish abundance or riparian function. These surrogates clearly are related to the abundance and distribution of fish in coastal Oregon, but the categorical rankings of benefit and risk are vague and non-quantitative. If models of fish habitat and population abundance were not available, such simplification might be necessary. But several well-documented models of fish populations (Nickelson and Lawson, 1998) and intrinsic habitat potential (Burnett, 2001; Burnett et al., 2007) have been applied to all of coastal Oregon, including these three state forests.

Use of other GIS data that could inform habitat availability

Several of the SOC identified as important components of these ecosystems were apparently not analyzed because of lack of information. Habitat for species such as torrent salamanders, tailed frogs, and western toads could at least be approximated with a stream and wetland GIS data layer available for the Coast Range (e.g., CLAMS data archive). Similarly, other data layers that may indicate potential habitat for species could have been used (e.g., bridges or buildings for some bat species). It is not clear why this was not attempted. These data layers could have been combined with overlain stand conditions or included within species specific habitat models, which would allow a more complete understanding of habitat trends over time.

Considerations of dispersal habitat especially for species with limited mobility

Although habitat area seems to be the most important feature affecting the occurrence and abundance of many vertebrates on managed forest landscapes, connectivity between patches can become increasingly important to maintaining populations and gene flow when habitat availability is scarce. Landscape pattern would be expected to influence the abundance and distribution of vertebrates more at low levels than if habitat is widely available. Connectivity can mitigate some of the adverse effects of limited habitat area, providing individuals within a population an opportunity for dispersal and exchange of genetic information among patches. As habitat improves, this connectivity can provide space for repopulation that otherwise would have been isolated. Given the potential for a highly fragmented landscape as some stands develop into complex forests and others are harvested, harvest pattern and the connectivity that is retained, recruited or removed becomes increasingly critical on actively managed landscapes. Without a more complete understanding of the risks associated with changes in landscape connectivity, it is not clear how much confidence we can place in projections that simply show changes in a surrogate for habitat availability. Indeed, as habitat availability decreases, and if connectivity is also decreased, the likelihood of population persistence in the landscape could be much lower than what a surrogate habitat metric might indicate.

Considerations of thresholds and tipping points in achieving anticipated results

Population threshold responses to stressors is not a new concept. The population vortex theory has been around for over 20 years. Most recently the theory of thresholds or 'tipping point' in responses of ecological systems to stressors has been applied to climate change effects, but the theory can be broadly applied to other stressors as well (Cairns, 2004). Given the potential for a reduced level of surrogate recovery to habitat under the SOC scenario, the uncertainties associated with dispersal, patch sizes, edge conditions, and within-stand structure and the uncertainties associated with emergent stressors on the system (e.g. climate change, invasive species, and changes to management of surrounding lands), we need to ask if synergies among these stressors and uncertainties COULD lead to a tipping point for any of the species. There is a high probability that it could occur in one or more species. The risk of synergistic effects is unknown and the perceived risk to populations from these forests by society is also unknown. If population persistence is a primary goal, the precautionary principle should be followed.

Limited use of available literature to not only support statements made, but to use relationships derived by other authors

Although we are sure that ODF staff are aware of literature beyond what was cited in the two documents that we were asked to review, the literature cited sections are indeed very sparse and some of the highly relevant information collected on state forest land (e.g. work by John Hayes and colleagues) was not included. We have added a list of references to the citations that we feel should be included in these analyses (see Appendix A).

Lack of social, economic, and legal "limiting factors"

Forest management is about people. Everything we know about and value in the forest derives from our interaction with it as humans. Social science (including economics, political science, and sociology, among other disciplines) can help in generating, analyzing, and integrating information. It can assist forest managers in understanding how decisions and choices are made at every scale, from the individual to the public policy process; in exploring the institutional opportunities and constraints to implementing policies and practices; and in developing robust alternatives and decisions about mitigating, adapting, or preventing the occurrence of unwanted outcomes – as defined by internal and external constituents.

We also wish to point out that social, economic, or legal factors are not considered limiting factors in the SOC analysis (See Appendix D, Table 2 of the SOC analysis). ODF should recognize that social issues are likely to be as limiting as any of the surrogates listed in the table. The lack of analysis of these factors may lead to ineffectual choices and decisions as the Board of Forestry moves forward with policy decisions, regardless of the biophysical analysis soundness.

Management Scenario Effects on Species of Concern

Under the time constraints of this review, the SAT was unable to examine each of the 40 SOC ODF has included in its analyses. In this section, we use red tree voles, northern spotted owls and aquatic amphibians to illustrate an approach ODF could use to for individual species. The review structure used the following four questions to determine if other science is available and how it can be integrated into the ecological effects analysis:

- Are there other similar species or sub-species that should have been considered?
- Are thresholds identified as part of the limiting factors appropriate for characterizing likely management effects on the species (i.e., does research demonstrate a relationship between changes to the limiting factors and effects on species that can be modeled)?
- Do trends in the limiting factors adequately characterize the likely effects on species under each management strategy?
- Are there other gaps in information that, if filled, could help characterize likely effects on species under each management strategy?

There are several SOC that we believe ODF staff needs to examine more closely in their analysis and the type of information that should be incorporated into the analysis. This is not a complete list of information needs but rather components that do not appear to be incorporated in the modeling scenarios.

- Marbled murrelet – a detailed assessment of tree size, not tree age
- American marten – assessment of whether or not marten are present in the state forests
- Bats (all) – need snag information, proximity of bridges to foraging and roosting sites
- Bald eagle – need to overlay a hydrologic layer on forest conditions; human disturbance effects around nest trees, including recreation
- Osprey – need to overlay a hydrologic layer on forest conditions; human disturbance effects around nest trees, including recreation
- Western bluebird – snag information (sizes, numbers) in clearcuts is needed, along with snag fall rate estimates
- Purple martin – snag information (sizes, numbers) in clearcuts is needed, along with snag fall rate estimates
- Little willow flycatcher – shrub data needed, especially important where intensive forest practices my shorten or eliminate the shrub stage
- Band-tailed pigeon – landscape assessment of potential nest stands, shrub stands (food), and mineral springs
- Peregrine falcon – assessment of human disturbance effects around cliffs, including recreation
- Clouded salamanders – persistence of coarse wood left on site through clearcutting operation may not be a valid assumption; how is connectivity among stands ensured? Riparian areas?

Red tree voles

Are there other species that should have been considered?

There is strong evidence that the dusky tree vole (*Arborimus longicaudus silicola*) is a distinct sub-species of red tree vole (Johnson, 1968 as cited in Huff et al., 1992). The range of the dusky tree vole extends throughout north coastal Oregon (Clatsop, Tillamook, and Lincoln Counties) including Tillamook and Clatsop state forests (USFWS, 2008). The dusky tree vole's small population size and geographic isolation may present more significant conservation challenges than the red tree vole (Forsman, 2009 pers. comm.). Huff *et al.* (1992), which ODF does cite in its SOC analysis, stated "because this range is extremely restricted, managers and biologists should take special precautions to provide suitable habitat within this geographic area." The SOC analysis fails to account for the distinctive conservation challenges of this subspecies separately from red tree voles which may have significant, unintended consequences for the dusky tree vole and biodiversity on the Tillamook and Clatsop state forests under the alternate management strategy.

Are thresholds identified as part of the limiting factors appropriate for characterizing effects to species, i.e., does research demonstrate a relationship between changes to the limiting factors and effects to species that can be modeled?

In the SOC analysis, ODF identified limiting factors for red tree voles as *amount of late-successional forest*, *fragmentation/patch size*, and *fragmentation/limited dispersal ability*. Each of these limiting factors is discussed below.

<u>Amount of Late-Successional Forest</u> – ODF uses the amount of complex forest as a surrogate for the amount of late-successional forest. The analysis would be strengthened and the findings would present greater certainty of likely population effects if the limiting factor was clearly tied to red tree vole habitat use. For instance, Gillesberg and Carey (1991) found that the average diameter and height of trees used for nesting by red tree voles was 39 inches DBH (diameter at breast height) and 171 feet in height. Based on red tree vole capture studies, Huff *et al.* (1992) suggested that the mean or median densities of large trees in Oregon Coast Range stands where red tree voles were captured could provide useful reference points for developing management prescriptions.

<u>Fragmentation/Patch Size</u> – The SOC analysis assumes that larger patches are more likely to provide for self-sustaining red tree vole populations (See Appendix D, Table 2 of ODF's SOC analysis). ODF analyzes the projected trend in patches greater than 120 acres for the current and alternate management strategies. However, it is unclear why 120 acres was selected as the lower limit of patch size or what effects the trends in this patch size over space and through time will likely have on red tree vole populations. Huff *et al.* (1992) concluded that the effect of stand size on red tree vole persistence is not known and that stand size, alone, is difficult to determine because of other factors that can influence the effects of stand size on persistence including a stand's position in the landscape, tree species composition, and type and level on disturbance within and outside of a stand. It is unclear how trends in patches over 120 acres in size directly relate to the conservation of this species, or whether there is a real biological difference between the two different management scenarios considered with respect to the patch size limiting factor. It is clear from the scientific literature that the principal threat to this species is forest fragmentation (Carey, 1991), but there is no spatially explicit analysis of the effect of fragmentation, edge effects, or migration corridors on red tree voles in the SOC analysis.

<u>Fragmentation/limited dispersal ability</u> – The SOC analysis assumes that stands <20 years old are a barrier to red tree vole movement and/or dispersal (See Appendix D). The trend in stands <20 years old under the current and alternate management strategies are used to gauge effects on this species. It is unclear from the SOC analysis why the <20 year old stand age threshold was selected for analysis. The scientific literature (see above) makes it clear that red tree roles preferentially select forest stands that are relatively old, and there is no evidence to suggest that stands older than 20 years (e.g., 35–70 years old) will not be barriers to movement or dispersal. The <20 year old stand threshold is also not spatially explicit. It is likely that the spatial and temporal arrangement of young stands is more relevant to biological effects to red tree voles than the simple acreage of stands <20 years old at any point in time.

Do trends in identified limiting factors adequately characterize the effects to species that can be expected from a different management strategy?

The scientific literature on red tree voles appears to recommend a more robust, spatially explicit management strategy for red tree voles than used in the SOC analysis. For example, Huff *et al.* (1992) recommended seven attributes for evaluating red tree vole habitats: Douglas-fir basal area; density of live trees greater than 36 inches DBH; maximum height of live trees; stand age; stand size; stand moisture class; and stand elevation.

Are there other gaps in information that if filled could help characterize effects to species from different management strategies?

There is recent scientific literature that may be useful in analyzing the effects of different management strategies on red tree voles. Dunk and Hawley (2009) describe a predictive model that allows managers to determine if existing reserves adequately conserve red tree vole habitat and whether active management outside of reserves decrease or increase habitat suitability. Because Dunk and Hawley's study did not include forest lands in the northern Oregon Coast Range, it may be difficult to draw direct inferences for the Tillamook and Clatsop state forests without further research. In summary, finer–grain, spatially explicit analysis of changing forest structure and composition over time should be used to draw firm conclusions about the effects of different management strategies on red tree voles in the coastal state forests.

Northern spotted owls

Are thresholds identified as part of the limiting factors appropriate for characterizing effects to species, i.e., does research demonstrate a relationship between changes to the limiting factors and effects to species that can be modeled?

ODF identified two limiting factors in the SOC analysis for northern spotted owls; *the amount of late-successional forest* (complex forest) and *fragmentation/patch size*. The SOC analysis indicates that habitat conditions are expected to improve under both the current management strategy and the alternate management strategy, which seeks to achieve a lower percentage of late-successional structure across the landscape by year 80. The SOC authors conclude that under both scenarios there is a probability that habitat for species associated with late-successional forest structure will be maintained and enhanced. This is in spite of the prediction that the current strategy would provide 20% more habitat than the alternate strategy.

ODF chose a patch size >2,180 acres for the basis of their analysis. This number appears to be a combined estimate of minimum patch size to accommodate both spotted owls and American martens and is lower than the 3,706 acre home ranges recommend by Glenn et al. (2004) for spotted owls in the northern Coast Range. SOC analysis predicts that the number of very large patches (>2,180 acres in size) will steadily increase under the current management strategy through year 80. Under the alternate strategy, very large patches are also expected to increase by year 80 but would result in nine fewer patches at any given time than under the current strategy. The SOC authors concluded that both strategies provide a high likelihood that conditions will be maintained and enhanced. They do conclude that it is difficult to determine how the additional large patches (under the current strategy) would translate into actual use by spotted owl, but it appears that the increased number of patches under the current strategy would likely provide more patches to encompass the home ranges of one or more pairs of spotted owls.

Neither the set of predictions for amount of late-successional habitat nor fragmentation/patch size includes confidence bounds with the projections. Without some measure of confidence it is not clear whether or not there is a significant difference between the two scenarios. It is unclear how either scenario and the predicted availability and distribution of patches will affect owl movements, including juvenile dispersal, within and between patches, nest site availability, prey availability, predator avoidance from great horned owls, or opportunities for cross breeding with the barred owl.

Do trends in identified limiting factors adequately characterize the effects to species that can be expected from a different management strategy?

Glenn et al. (2004) found that their model using traditional habitat values to determine the spotted owl had low predictability in the northern Coast Range, including state forest lands in Tillamook and Clatsop Counties. Within the study area, Glenn et al. (2004) report that individual owls varied greatly in habitat use patterns and appeared to use different survival strategies in these younger forests which had larger tracts on non-forested lands, more pole-sized conifers, and broadleaf stands than on the Elliott State Forest. They concluded that the home-range patterns appeared to correspond with measures of fitness.

Based on their findings, Glenn et al. (2004) concluded that the patterns of home-range size and amount of home-range overlap may provide surrogate measures for evaluating the quality of habitat for spotted owls in these stands. They also recommended "that managers at these sites maintain existing old and mature conifer forest, broadleaf forest, broadleaf-forest edges, and forested riparian areas as owl habitat; avoid timber harvest in core use areas; and plan the size of areas managed for spotted owls to reflect actual home-range and core-area sizes for owls in those forests" (p. 33).

A robust, spatially explicit approach to modeling actual biological effects to owls on state forests appears possible, similar to the case of the red tree vole. The comparative approach used in the SOC analysis may not present biologically useful or meaningful information to decision makers. The authors of the SOC strategy do not reference any meta-analysis of spotted owl research (e.g. Courtney et al., 2007), relevant habitat conservation plans, or the implications of abandoning a habitat conservation plan frameworks which could be used to better evaluate the potential positive and negative effects of the proposed SOC management strategy on spotted owl populations.

Aquatic amphibians

Are there other gaps in information that if filled could help characterize effects to species from different management strategies?

The authors of the SOC analysis stated:

> "Dispersal for stream amphibians could not be modeled as conditions required for successful dispersal are not understood. Dispersal may be limited to within the stream channel for torrent salamanders and Cope's giant salamanders. Tailed frogs also likely disperse through the stream channel, this species is known to disperse across ridges" (ODF, 2009a:22).

A number of recent studies, however (e.g. Olson and Burnett, 2009; Clarke et al., 2008; Burnett and Miller, 2007; Olson et al., 2007; Olson and Weaver, 2007), may allow stream amphibian dispersal to be modeled as part of an effects analysis. The authors also did not consider meta-analysis (e.g., Rodgers et al., 2005; Thom et al., 2000) of stream habitat conditions relevant to management of state forests.

Some of the research cited in the SOC analysis appears to confound some of ODF's assumptions. For instance, the SOC analysis seems to assume that 100-foot riparian buffers are protective of amphibians and facilitate amphibian dispersal (p. 22 and 28-29); however, the literature referenced (Stoddard and Hayes, 2005) indicates that most amphibians were positively associated with wider 151–foot (46 m) buffers.

Coastal Landscape and Modeling System (CLAMS) Assessment

Overview of CLAMS

In order to provide an independent assessment of the trajectories of trend lines presented in ODF's SOC analysis, we extracted trends for structural classes and predicted habitat for three species on the Clatsop and Tillamook State forests using the CLAMS base case. Initial forest conditions and projected forest growth projections using CLAMS assumptions differ somewhat from the projections used by ODF, and the presumed management actions were interpreted independently based on ODF management intentions under their base case. We compared trends in structural conditions and habitat between the ODF base case and the CLAMS base case simply as a way of characterizing consistencies or inconsistencies in trends over time but do not make assumptions about which projection is most accurate. Where trends are consistent, we assume that the trends are more likely to be realistic projections. Inconsistencies raise questions about one or both model projections and accentuate uncertainties associated with interpretations of risk to resources.

It is important to recognize that we did not re-run the CLAMS projections under the PM + SOC assumptions to compare trends with the ODF PM + SOC projections. Such an effort would have entailed much more time and funds than what was allocated to this review process.

Analysis of state structure classes for all state forests

The major trend over time is the substitution of dense closed-canopy stands with "layered" and then "older" forest, using silvicultural thinning aggressively to accelerate that process. The CLAMS projections for stand structure over time under the current management approach (see Figure 3), including the sophisticated spatial aspects to the modeling, approximates the independently produced ODF model output. We did not use CLAMS to model stand structure projections using SOC guidelines; however, based on the similarity between the trends produced by CLAMS and ODF's Harvest and Habitat Model for the current management approach, we can assume that the results would similarly approximate the ODF conclusions about the percentage of land in various cover types. In this case, the percentage of the land base in young, early-seral stands would be increased by several percent and progressively over time, and at the expense of all other forest types in some proportion.

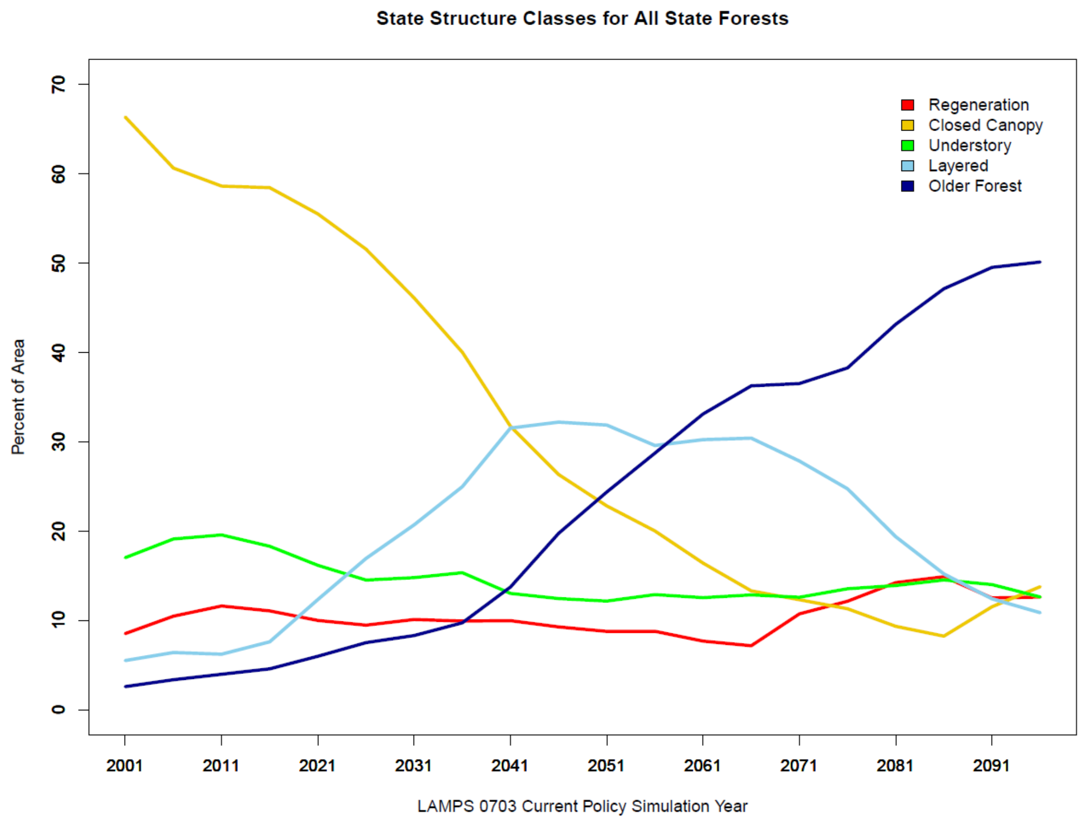

Figure 3. CLAMS assessment of state structure classes for all state forests.

It should be noted the currently projected mix of the five forest types does not produce 20% of each, nor should that be the objective landscape condition/dynamic. Looking in more detail at habitat structures, riparian areas, and social features of the landscape with spatial considerations will allow decision makers to compare the relative economic, environmental, and social costs and benefits of having various proportions of different stand types within the landscape.

Analysis of wildlife for state forests: Trends in habitat for selected species

We used the habitat models developed in CLAMS to project likely available habitat for a species associated with older more complex forests (northern spotted owls), edges (olive-sided flycatchers), and early successional conditions (western bluebirds). Under the base case, habitat for spotted owls is predicted to increase to approximately 40-50% of the area by 2060 and then levels off at that point as harvest levels become more consistent over time. We did not assess trends for this species under the PM + SOC scenario; however, we would anticipate that the amount of habitat for spotted owls (Figure 4) would be less than the base case, the degree of departure likely dependent on the harvest planning effects on patch sizes and arrangement. Should habitat decline to 20-25% of the landscape, connectivity and population viability may become questionable. Finally, greater harvest levels increase the likelihood that newly developed habitat would be adversely affected by timber harvest, resulting in take under the ESA. How take will be avoided is unclear.

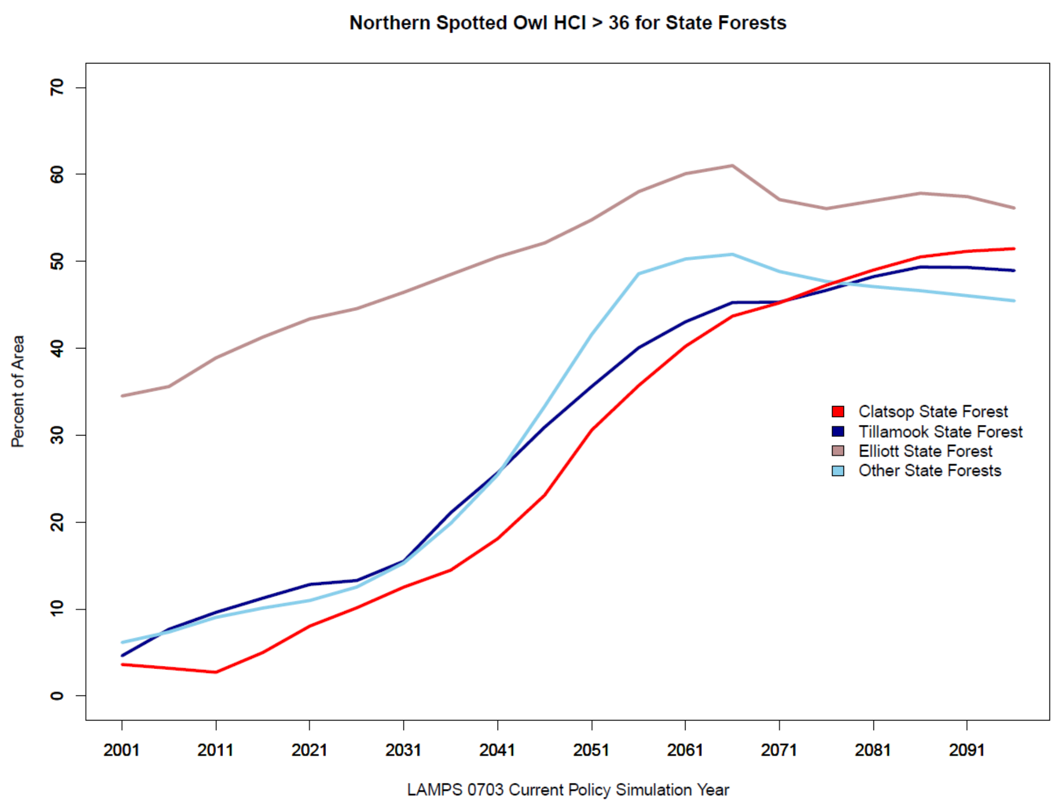

Figure 4. CLAMS assessment of Northern Spotted Owl HCI > 36 for state forests.

Olive-sided flycatcher (Figure 5) habitat is projected to decline slightly through 2030 then increase as thinning is replaced by final harvests. We would predict that this species would see increased habitat availability earlier under the PM + SOC scenario, as final harvests are more regularly represented on the landscape. Increase in habitat for this species would be most likely realized if new harvest units (clearcuts) are adjacent to mature or older stands, a harvest planning strategy that would adversely impact habitat for spotted owls and other late successional species.

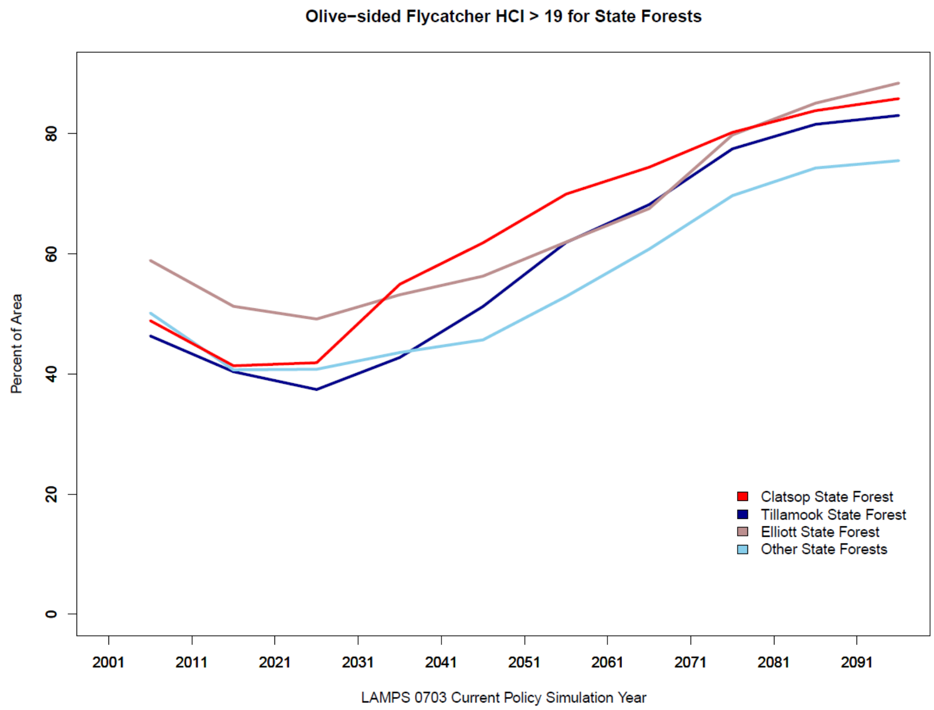

Figure 5. CLAMS assessment of Olive-sided Flycatcher HCI > 19 for state forests.

Western bluebird (Figure 6) habitat is projected to be highly variable over time and be represented on a very small proportion of the Tillamook and Clatsop state forests. As thinning declines and final harvests increase, assuming that snags and legacy trees are retained, then bluebird habitat increases until crowns of young conifers close. We would predict that if legacy features are retained in clearcuts, then bluebird habitat could increase under the PM + SOC scenario.

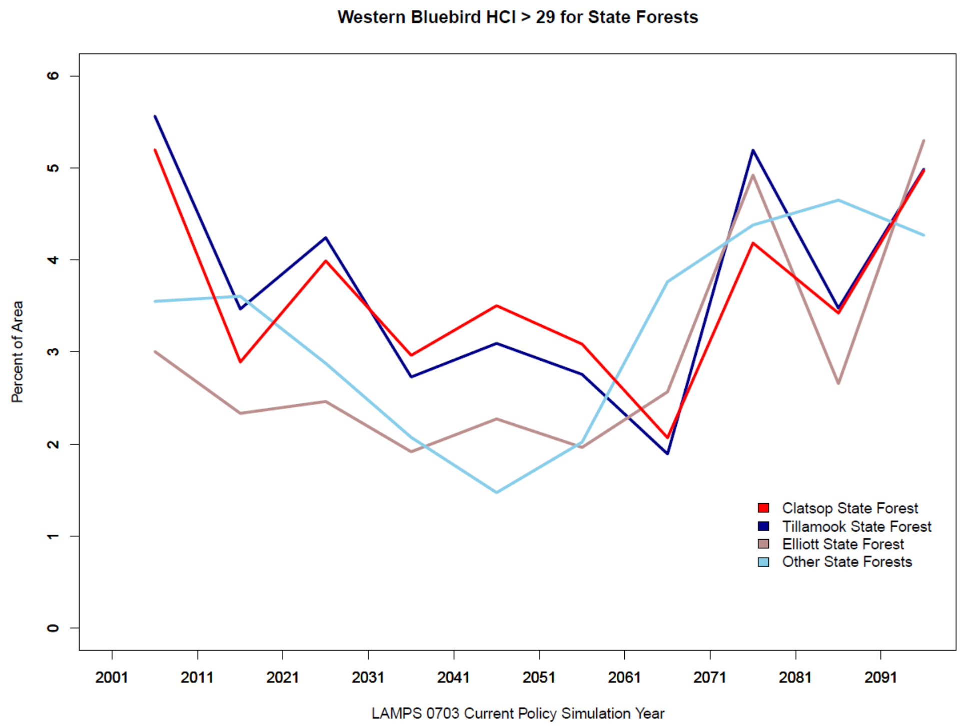

Figure 6. CLAMS assessment of Western Bluebird HCI > 29 for state forests.

In summary, the base case projections were reasonably consistent between ODF projections and the CLAMS projections, lending confidence that the ODF projections are indeed reasonable representations of stand structural conditions likely to be seen in the future under both scenarios. It is unclear how species of late successional associations, such as spotted owls, marten, marbled murrelet, and red tree voles, may respond under increased levels of risk. CLAMS projections indicate that under the base case projections spotted owl habitat could increase to 40% of the state forests, but clearly there would be less habitat available under the PM + SOC scenario. Unless these habitat projections are used as habitat change input in regional population viability analysis models, it is unclear what levels of risk this species might face based on a change to the PM + SOC policy.

Steelhead and coho intrinsic potential

The CLAMS modeling of intrinsic habitat potential for steelhead and coho salmon demonstrates the importance of spatial pattern, habitat characteristics, and fish distributions to assess the consequences of land use on fish populations. The model estimates the intrinsic potential of the habitat to support populations of coho salmon and steelhead trout. The CLAMS project provided the model output for the streams within the Clatsop, Tillamook, and Elliott state forests (data provided by Kelly Burnett, Kelly Christiansen, and Gordon Reeves, US Forest Service Pacific Northwest Research Station, 2010). The model provides estimates of relative habitat quality ranging for 0 – 1. For this summary, values from 0 – 0.25 are categorized as low potential, 0.25-0.75 as medium potential, and -.75 – 1.0 as high potential.

The CLAMS output could result in major implications for the modeling of fish response to management scenarios for state forests (Table 3). Eighty to ninety percent (80-90%) of the stream networks in all three forests are unlikely to support fish. This reflects the considerable amount of small headwater streams that do support fish populations. These streams still provide important functions for fish bearing streams, including delivery of food, delivery of large wood and sediment, and maintaining lower water temperatures. The three state forests differ greatly in habitat quality and quantity for coho salmon and steelhead trout. The Tillamook State Forest is substantially larger than the other state forests and provides more stream length to support salmon and steelhead. However, habitat potential in the Tillamook State Forest is lower than the other forests, with more than 50% of the reaches with habitat potential being ranked as low. The Clatsop State Forest has the highest proportion ranked as high potential (26%) and the Elliott State Forest has the highest proportion of medium potential (48%). These model projections clearly indicate that these forests are not homogeneous and there are substantial differences in current habitat conditions.

Table 3. Intrinsic potential of stream habitat for coho salmon and steelhead trout in the Clatsop, Tillamook, and Elliott state forests based on models from the CLAMS Project*,**

Coho	Clatsop Length (km)	Clatsop Percent	Tillamook Length (km)	Tillamook Percent	Elliott Length (km)	Elliott Percent
Low	155.2	45.4	368.7	51.1	102.4	40.3
Medium	98.3	28.7	297.6	41.2	120.6	47.5
High	88.7	25.9	55.7	7.7	31.0	12.2
None	1390.4	80.2	6184.1	89.5	1511.0	85.6
Steelhead						
Low	217.3	46.4	294.2	29.4	107.5	32.9
Medium	137.2	29.3	176.7	17.6	72.1	22.0
High	114.1	24.3	531.3	53.0	147.5	45.1
None	1264.2	73.0	5903.9	85.5	1438.0	81.5

*Percentages reported for streams with no habitat potential are based on percent of total stream miles.
**Percentages reported for streams with low, medium, and high potential are based on the proportion of the miles of stream with habitat potential.

The CLAMS analysis also demonstrates that the spatial distributions of habitat potential differ greatly within and among these three state forests (Figures 7 and 8). Habitat potential for coho salmon and steelhead trout varies greatly along individual stream networks. The patterns and overall quality differ greatly across the coastal region. Projections of the consequences of any management scenario must account for the distributions of habitat types and quality. Steelhead trout generally occupy stream reaches with higher gradients than coho salmon do. This is reflected in the greater length of stream habitat for steelhead in all three state forests. The reaches also differ substantially in their relative potential for steelhead and coho, demonstrating that broad generic surrogates without consideration of spatial patterns cannot adequately represent fish responses to alternative management strategies.

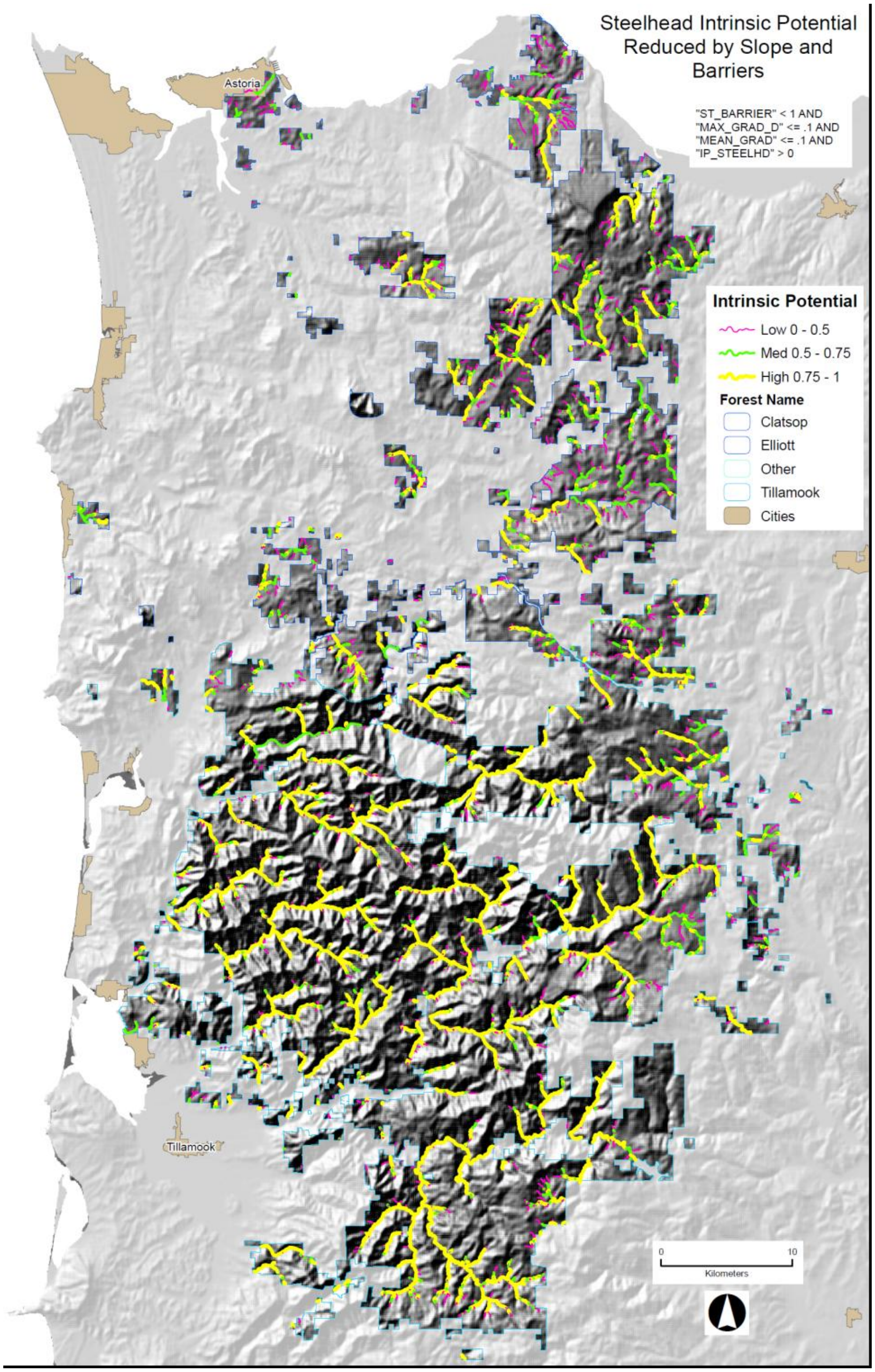

Figure 7. CLAMS assessment of steelhead intrinsic potential reduced by slope and barrier.

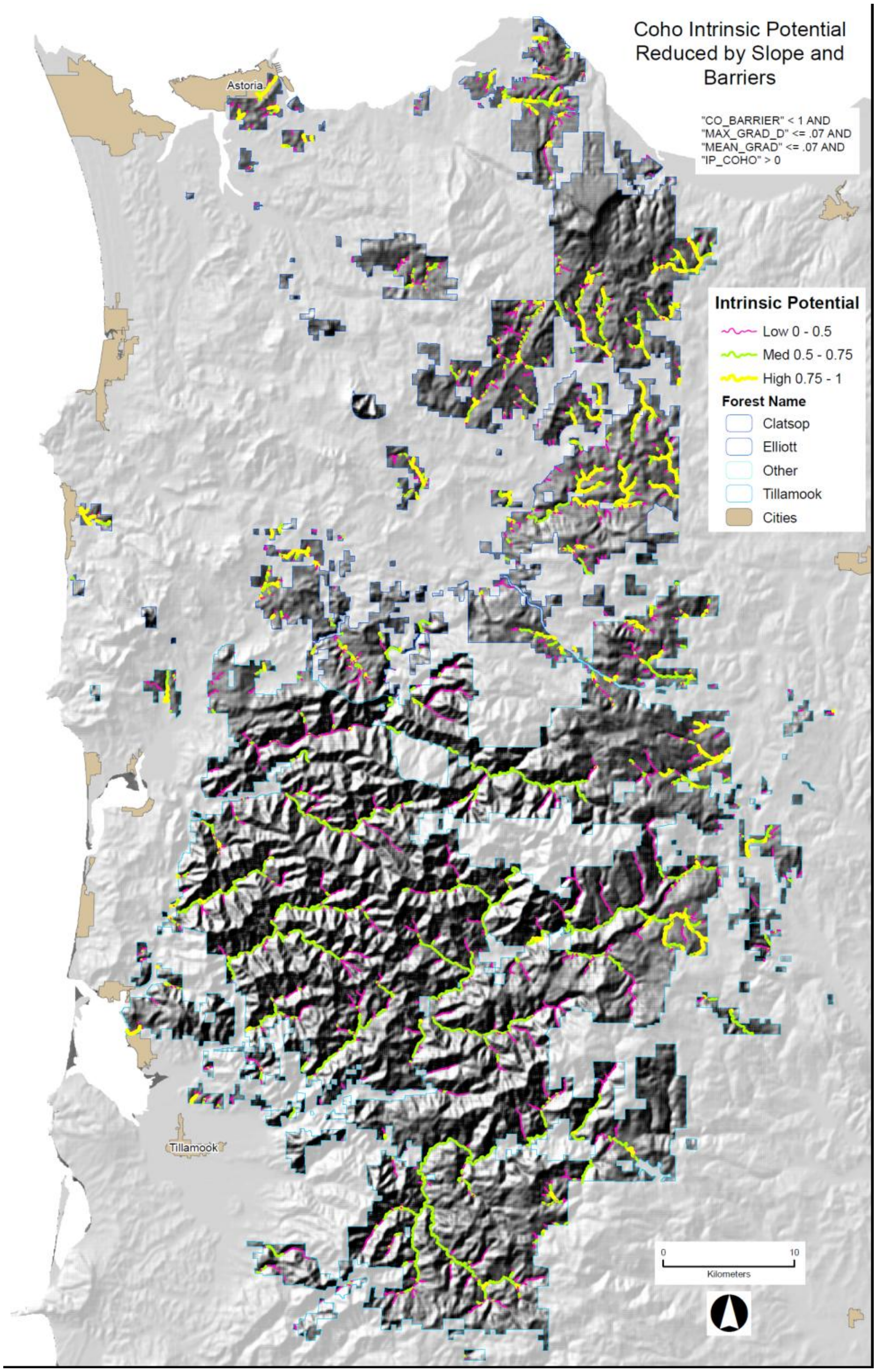

Figure 8. CLAMS assessment of Coho intrinsic potential reduced by slope and barriers.

Review of the State Forests Performance Measures

Introduction

Overview of the performance measures document

In 2009, ODF published the report, the *Board of Forestry State Forests Performance Measures* (ODF, 2009b). The report discusses the expected achievement of the nine Board of Forestry performance measures (Table 4) under two management approaches and the relative difference between the approaches. Management approach comparisons were based on two model scenarios that characterized: 1) the current 2001 Forest Management Plan implemented with draft Habitat Conservation Plan strategies (Base Case); and 2) a modified 2001 management plan implemented with proposed draft species of concern strategies (Performance Measure with SOC) (ODF, 2009b:2). For each of the performance measures, the metrics reported are those that had data available or, alternatively, surrogate data sources were used. The area covered by this analysis includes the Astoria, Forest Grove, and Tillamook Districts.

Table 4. Board of Forestry state forests performance measures

Performance Measure 1: Net return on asset value
Performance Measure 2: Financial contributions to communities
Performance Measure 3: Financial contributions to government services
Performance Measure 4: Forest health
Performance Measure 5: Forest road risks and fish habitat
Performance Measure 6: Wildlife habitat by stand structure type
Performance Measure 7: Recreation and education
Performance Measure 8: Public and stakeholder involvement
Performance Measure 9: Oregonians awareness and support

Indicators criteria

The development of performance measures – or indicators – is the operationalization of "targets" and "objectives" into something that can be observed and measured. Although there is a large and growing body of literature on developing effective indicators (e.g., Pencheon, 2008), a consistent message has emerged. Indicators must be:

- **Relevant** – each indicator shows you something about the system that you ***need*** to know;
- **Easy to understand** – each indicator is clear and transparently ***associated*** with what you are trying to measure;

- **Reliable and Valid**– each indicator collects information that is ***consistently correct***; and
- **Accessible** – each indicator uses information that is ***easily and regularly collected***.

These four characteristics point toward indicators that have significance to people and can be collected without extensive expense or time. When indicators lack these characteristics, they are likely to be ignored or forgotten over time – especially as budgets and priorities change. The characteristics also hint at how difficult it is to develop suitable indicators that can be used to routinely monitor change over time. It may be possible to increase the relevance of an indicator, for example, only at the expense of accessibility or reliability. The degree to which the use of the nine indicators (or performance measures) used to evaluate the forest plan modifications meet these criteria varies, with some indicators potentially more successful than others. We highlight these in the following discussion of each of the indicators.

Conceptual Clarity

Before commenting on the performance measures outlined in Table 4 of this review, we would like to emphasize the need for a clearly articulated, logically coherent, and contemporary conceptual framework to support the Board of Forestry's performance evaluation efforts. Our impression is that several aspects of the existing framework lack conceptual clarity or rigor. Four examples illustrate our observation:

1. There appears to be confusion in terminology; for example, among the terms "metrics", "targets" and "performance measures." This confusion is not simply a grammatical issue; it suggests the need to more carefully think through and articulate Board goals and objectives.
2. Throughout the evaluation, an assumption is made that increasing timber harvests will generate revenue, which will enable ODF to make progress toward meeting various performance metrics. While this may be true for some metrics, significant tradeoffs associated with other performance measures would be expected. For example, while increased harvesting might produce revenue enabling trail expansion and greater maintenance, it might also result in decreased or displaced trail use. Anticipating such tradeoffs is essential to a rigorous evaluation.
3. The frame of reference for the evaluation, with respect to its social and economic dimensions, appears to be lagging significantly behind the times. That is, the performance measures selected imply a view of society's relationship to the forest that was dominant a half century ago, but does not accurately reflect contemporary relationships. For example, limiting analysis of community impacts—both social and economic—to harvest and its associated employment levels and financial contributions suggests a static view of communities that were once entirely timber-dependent. Few, if any communities in the state still fit that description and some communities are developing new social and economic relationships to the public forests that surround them.
4. Lastly, the conceptual separation of the social and economic aspects of the evaluation from its biophysical (or ecological) aspects hinders considering the many other ways that potential biophysical changes resulting from proposed forest plan modifications will be perceived by

people beyond timber harvests and recreation. Conceivably, future plan modifications could affect water quality, fish and wildlife populations, carbon storage, aesthetics, and other attributes, all of which depend on biophysical conditions but nonetheless directly and indirectly affect people. Potential biophysical effects are addressed in the SOC analysis; however, findings presented in the analysis report are not incorporated in the performance measure documents which are the subject of our social and economic review.

Existing Performance Measures

Performance Measure 1: Net return on asset value

Net return on return on asset value (ROAV) on Board of Forestry Lands and Common School Fund land calculated across all state forestlands and for each forest

Key variables in this analysis include timber management costs, stumpage prices, and timber volume harvested. As shown in Figure 9, log and stumpage prices are highly correlated with housing starts, which is an indicator of the demand for wood and wood products. ODF's assumptions regarding housing starts, log and stumpage prices, and timber volume harvested are within expected parameters for the best available science (Adams, 2010 pers. comm.). In terms of relevance, understandability, reliability, and accessibility, Performance Measure 1 is an appropriate indicator.

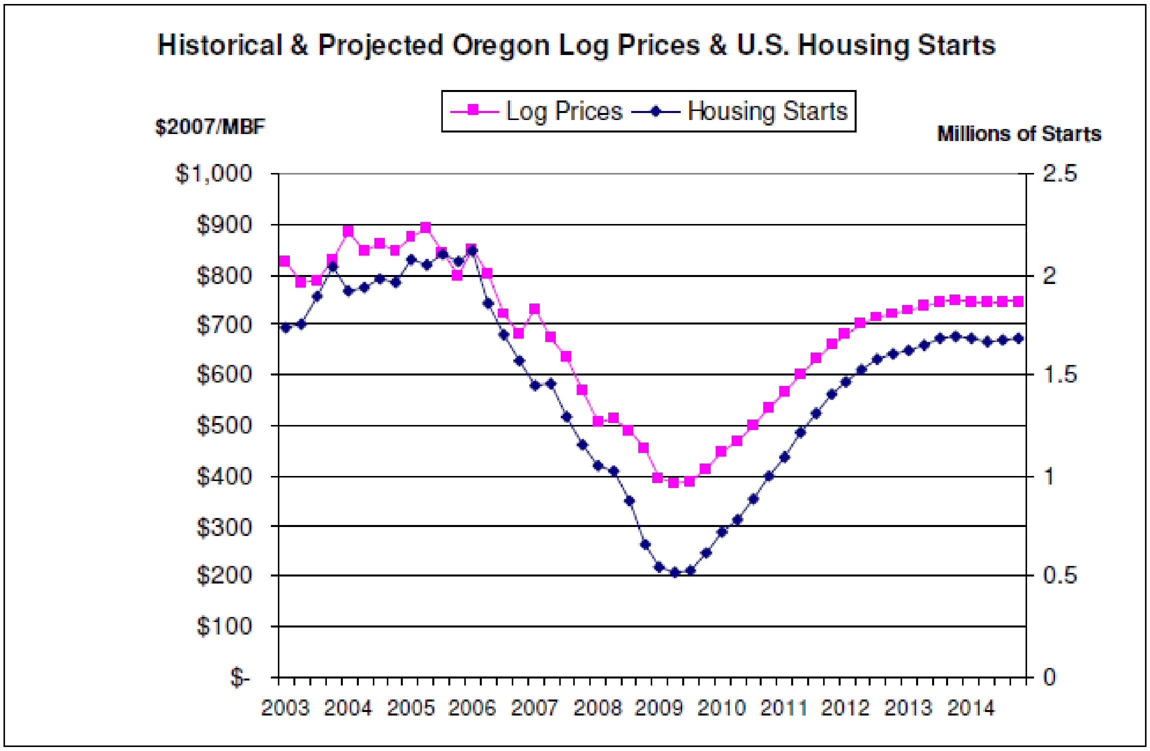

Figure 9. Historical and projected Oregon log prices and U.S. housing starts.

Figure reproduced from *ODF (2009b) Board of Forestry State Forests Performance Measures: An evaluation of the achievement of all nine performance measures for two management approaches on the Tillamook and Clatsop State Forest* (Board of Forestry meeting 3 June 2009, Agenda Item 3, Attachment 1)

Performance Measure 2: Financial contributions to communities

Direct and indirect financial contributions from the State Forests Division to support communities

Key variables in this analysis include timber volume harvested, distribution of harvested timber to mills in rural areas, and direct (jobs and income supported from harvested timber), indirect (jobs and income supported through backward linkages of mills and harvest activities), and induced (jobs and income supported through expenditures of direct incomes) effects of volume flows to mills to western Oregon, including its rural areas. Key assumptions regarding timber harvest volumes are based on the best available science as noted above. The multipliers (direct, indirect, and induced effects) assumed in the calculation of employment and income effects are conservative measures based on previously used multipliers for other Oregon economic impact analyses (ODF, 2010). However, historical evidence of jobs created from increased timber harvests in a subset of state forests appears to indicate the possibility of more modest increases in employment per additional million board feet harvested (see Ruder 2010). The multipliers used in the ODF analysis assume constant marginal changes in employment and income associated with one million board feet harvested. As such, they do not necessarily capture potential nonlinearities associated with mill capacities, technological changes, and linkages with other businesses/industries in Oregon. Short of developing a new model of Oregon's timber-related economy, an effort that is likely not warranted given the value of information gained, the direct effects of increased timber harvesting could be tempered with historical changes per million board feet harvested. All secondary effects (indirect and induced) are estimates conditioned by the economic models they are derived from and are based on the best available science. In terms of relevance, understandability, reliability, and accessibility, Performance Measure 2 for timber harvest-related economic impacts is an appropriate indicator. However, the analysis might have also considered a range of multiplier assumptions to account for existing uncertainties regarding the true relationship between timber harvesting and jobs.

The discussion and summary estimates presented in the subsection *Recreation* (ODF, 2009b) is more problematic. One problem is that two very different types of economic analyses are discussed: (1) benefit-cost analysis, and (2) economic impact analysis. The *Recreation* subsection seems to mix these two concepts by noting an economic value as "$170 for each user per visit" and an economic impact estimate of "two to five jobs per 1,000 visits." In economic analysis, it is important to clearly distinguish between benefits and economic impacts (e.g. job creation), because they are not the same (e.g. Kline, 2004:12-14).

Benefit-cost analysis evaluates social net benefits by measuring total benefit or value net of costs. This approach measures the contribution to societal welfare and can include the values of market as well as nonmarket goods, tangible as well as intangible outcomes, and benefits to individuals both currently and in the future. Non-market values, such as recreation benefits and ecosystem services values, are commonly estimated using techniques such as the travel cost method and the contingent valuation method. Measures of economic values for recreation would best be captured under Performance Measure 7 as a measure of societal welfare and quality of recreational experiences.

The second type of economic analysis being discussed is economic impact analysis, which traces the flows of spending associated with an activity (like recreation and tourism) in a region. It is used to identify the changes in sales, tax revenues, income and jobs due to this activity and is more akin to the analysis of harvest-related economic activity, also examined under this performance measure. The principal methods of economic impact analyses are economic base or input-output models that describe the interactions of different private and public sectors in a regional economy for a particular year. These measures of regional economic activity do not allow for consideration of non-market values or intangible outcomes. Measures from these two types of analyses (economic value and economic impacts) cannot be aggregated as an estimate of total value.

A second problem with the *Recreation* subsection (ODF, 2009b) is the seeming lack of information pertaining to the potential role of recreation in financial contributions to communities. An analysis similar to that conducted for timber harvests could be done for recreation if three key components are known: (1) a measure of total visits to state forests; (2) a measure of average recreational expenditure per visit (usually within 50 miles of state forest); and (3) multipliers (e.g., number of jobs and income generated from direct expenditures, and indirect and induced effects). Some disaggregation of the above key components would increase the rigor of projected estimates, such as separating by local vs. non-local visitors, by recreation activity type (overnight visitors such as campers who typically spend more locally than day visitors), and by economic sectors (e.g., lodging, restaurants).

It would seem that for many formerly timber-dependent communities, forest-based recreation could be an important source of economic activity and therefore indirect financial contributions supporting communities. For this reason, it is important to include analysis of the economic impacts of potential changes in recreation resulting from forest plan modifications. Potential recreation-related economic impacts should be included as part of Performance Measure 2 to ensure all relevant components have been incorporated.

Performance Measure 3: Financial contributions to government services

Direct and indirect State Forests Division financial contributions to local and state government

Key variables in this analysis include total timber volume harvested, stumpage and log prices, various tax rates, and allocations of tax revenue to the State, Trust Land counties, and local governments. Assumptions on volume harvested and prices have been discussed above. The tax revenue distributions are regulated, but are potentially subject to change over time (an unknown). This analysis is based on the best available science and, strictly from a harvest perspective, would meet criteria for relevance, understandability, reliability, and accessibility.

Similar to the situation with Performance Measure 2, however, parallel Performance Measure 3 analysis could be undertaken for recreation expenditures, whereby total recreation-related expenditures allocated across different sectors and linked with tax revenue generation could be estimated using similar assumptions and tools as noted above. For example, lodging tax revenue generated from overnight stays associated with recreation and tourism within regions surrounding a state forest could be reported along with tax revenues derived from timber harvests. For this reason, Performance

Measure 3, although conceptually relevant and potentially understandable and reliable, arguably lacks accessibility unless the barriers to analyzing forest-related recreation expenditures can be overcome.

Performance Measure 4: Forest health

State forest area affected by or at risk of invasive species, pests, disease and fire

The main argument in ODF (2009b) is that both management strategies will move the forest to more diverse conditions over time, thereby reducing or maintaining the risk of invasive species, pests, disease and/or fire. Both strategies would employ a full range of silvicultural approaches to create and maintain diversity, and stands could adapt to smaller-scale stochastic and cyclical disturbances over time. Large-scale disturbances would need to be considered differently.

Recent literature holds that for many systems increased diversity can lead to an improvement in forest health/conditions. However, diversity in species or structure is not always the basis of forest health. For example, mixed species and mixed canopy positions can pose a fire hazard, be challenging for fuel complexes and can spread of some diseases like dwarf mistletoe.

The difference between the two strategies is based on the amount of timber harvest and the number of times a landscape is entered. Increased access and intensity of impact will increase the risk of introducing exotic, invasive plants species and insect pest species. The risk of moving diseases around can also be increased. It also increases the opportunities to notice and regulate these agents through management practices. Depending on the aggressiveness of the species in question, that trade-off point moves. Details about the assumptions should be included so that the phrase “likely to be similar” can be determined to be a sound conclusion.

Fire hazard can be reduced by harvest intensity, number of entries (through fuels treatment), maintained road systems for pro-active management and/or fire suppression, and a greater presence in the woods for monitoring. However, entries can create problematic fuel complexes and consistently increase risk of ignition. More information is needed to evaluate whether it is a sound conclusion.

Performance Measure 4 is clearly relevant to the long-term productivity of many ecosystem goods and services, and is potentially understandable. The degree to which metrics are reliable and accessible depends on the consistency and rigor of the monitoring needed to understand occurrences and changes in distributions of diseases, especially invasive species in these forests.

Performance Measure 5: Forest road risks and fish habitat

Forest road risks to water quality and fish habitat

Performance Measure 5 calls for reducing the miles of hydrologically connected roads to less than 15 percent of the road network within the next ten years and reducing the number of road crossings that are barriers to fish passage to less than 2%. As stated in ODF 2009b, the base case and the alternative do not differ for this performance measure. When this performance measure is met for both roads hydrologically connected to streams and fish passage related to road crossings and culverts, the performance measure is dependent on the timber market. In the case of fish passage, there is no indication of how long the target may be delayed (depending on the base year being used for the measure) if markets remain low, nor is there discussion of options for meeting the objective if markets remain depressed for a significant amount of time. Performance Measure 5 is relevant to the long-term productivity of aquatic-associated resources. Metrics of water quality are readily available, reliable and accessible; the degree to which these metrics are used to trigger management changes and policy decisions should be clearly articulated.

Performance Measure 6: Wildlife habitat by stand structure type

> ***Quantities of habitat by FMP stand-structure type and habitat components, and the use of those areas by native fish and wildlife***

The main argument in ODF 2009b is built on Table 5. Although there is more cutting planned over two decades, it does not drop the amount of complex structure across the landscape below 20% after 20 years. The SOC scenario replaces “regeneration structure” – early seral conditions – for some of the complex structure. Despite this change, both approaches are likely to maintain and/or enhance habitat for some species of fish and wildlife.

ODF does not present any data, trends, or conclusions on live tree and snag retention in harvest units at different times. These can be generated based on modeling assumptions. This is not crucial information for evaluation (since it is just an assumption) but should be included for critically evaluating impacts on fish and wildlife habitat. The current body of science shows that sound silvicultural practices can enhance various habitat characteristics at the stand and landscape levels relative to current conditions; however, the relationship between silvicultural practices and habitat condition on the state forests was vaguely presented in the analysis and not presented in a way that would allow the SAT to conduct a more thorough review.

Table 5. Quantities of forest habitat (metrics a, b, c; d and f surrogates).

Table reproduced from *ODF (2009b) Board of Forestry State Forests Performance Measures: An evaluation of the achievement of all nine performance measures for two management approaches on the Tillamook and Clatsop State Forest* (Board of Forestry meeting 3 June 2009, Agenda Item 3, Attachment 1).

Metric	Base Case	Performance Measure with SOC
a. Live tree and snag retention and downed wood in harvest units	Data are not available; however, no differences are expected between the two approaches because the standards and strategies remains the same.	
b. Stand structure percent c. Acres of SF by FMP structure type	Results in 26% complex structure after 20 years. Achieves the 2001 Forest Management Plan's long range goals for all structure classes; for complex structure 40 to 60%, and 5 to 15% for regeneration.	Results in 22% complex structure after 20 years. Achieves a long range balance of structure classes different from the 2001 Forest Management Plan's; achieves 32% complex structure, and climbs to 20% regeneration structure.
d. Landscape averages of the number of snags and amount of downed wood (Amount of Older Forest Structure used as a surrogate)	There is a high probability to maintain and enhance snag and downed wood habitat as the percent of older forest structure increases.	There is a high probability to maintain and enhance snag and downed wood habitat as the percent of older forest structure increases; the achievement of improved quantities would be slower.
f. Use of stand structure types and habitat components by wildlife- data not available for habitat "use"; report on probability that the model will maintain and enhance habitat - several surrogates were evaluated for 40 species	FISH: There is a high probability to maintain and a moderate probability to enhance habitat for fish species of concern. Some variability exists when evaluated by individual species.	FISH: There is a moderate probability to maintain and enhance habitat for fish species of concern. In general lower probabilities are associated with younger forest structure and greater amounts of clearcutting. Some variability exists when evaluated by individual species.
	WILDLIFE: There is a high probability to maintain and enhance habitat for wildlife species of concern. Some variability exists when evaluated by individual species.	WILDLIFE: There is a high probability to maintain and enhance habitat for all but two wildlife species of concern. Some variability exists when evaluated by individual species.

See our review of the SOC analysis (ODF 2009b) for a more thorough analysis of the approaches taken and risks associated with those approaches. These performance measures should be reported by ODF staff for each state forest given the differences in initial conditions among them.

Metric a. Live tree and snag retention and downed wood in harvest units – It is not clear why this was not analyzed. Although standards remain the same between approaches, the sizes, interconnectedness, and edges associated with early seral patches with snags will influence the likelihood that a patch may be used by a species. Locations of harvest units also can have an influence on factors such as snag fall rates. Finally, it is not clear why DecAID was not used to develop guidelines that could be tailored to landscapes. This could ensure that dead wood levels over large areas are strategically allocated with appropriate levels in some places at all times and in all seral stages across a watershed or landscape.

Metrics b and c. Stand structure percent and acres of SF by FMP structure type – With spatial display this information could be linked to a wildlife habitat relationships model that helps to understand 'habitat types' over time. The coarse filter analysis would be limited over the next 80 years but it would not represent the fine-filter analysis that would seem to be required for SOC.

Metric d. Landscape averages of the number of snags and amount of down wood – The amount of older forest was used as a surrogate for this metric; however, if conservation of early seral species is a priority, early successional forests should also be considered. DecAID can provide guidance. Habitat elements in diverse early successional conditions should include snags, logs, and shrubs all of which are dependent on legacy retention from the previous stand and early stand management practices. Using the area of older forest does not address the species reliant on these habitat elements.

Metric f (note text refers to metric e, but we could not find that in the table or elsewhere) Use of stand structure types and habitat components by wildlife – The use of stand types as surrogates for habitat for each of the SOC is inherently flawed. As we stated in the review of the SOC analysis, habitat is the set of resources necessary to support a population over space and through time. Every species has its own habitat needs. Garshelis (2000) made the point that quite often foresters and wildlife biologists both will refer to vegetation types, or other discrete classes of the environment, as habitats. More accurately, these are stand conditions or habitat types in that some species can be associated with some vegetation types and not with others. But these associations occur only because some or all of the resources needed by the species occur in those types. As stated earlier, the distributions of fish species and their different habitat requirements are not considered in the model. Stand structure is an important influence on fish habitat but does not adequately represent the potential abundance of fish as a single factor. Given the significance of the SOC in the comparative analyses conducted by ODF, habitat should be defined for each species and should include the structural and compositional elements of habitat necessary to support populations over space and through time. Stand conditions or habitat types are useful classifications for understanding coarse filter goals but are inadequate for fine filter analyses that should be used the SOC. Performance Measure 6 is clearly relevant to the long-term productivity of habitat for a site of species considered politically or legally significant. Since habitat is a species-specific concept the proposed approach is not understandable or reliable, though the data are accessible and easily extracted from available data bases. The relationships between these data and the function of the habitat to support populations of each focal species are not supportable.

Performance Measure 7: Recreation and education

Availability, quality and public use of recreational opportunities and educational programs

A primary assumption in this performance measure's analyses is that increased timber revenue, which currently subsidizes recreation and educational opportunities, will directly lead to increases in the availability, quality, and use of these resources. While recreation on public lands oftentimes does not directly cover its costs, it is typically subsidized through general federal, state and local tax revenue allocations and other sources of revenue (e.g., timber revenue). Although there are ways to generate revenue from recreation, such as through user and concessionaire fees, they typically are insufficient to cover the full costs of providing recreation infrastructure, management, and programming (exceptions being for private recreation opportunities such as golf courses and campgrounds). One justification for subsidizing recreation owes to its myriad of other social benefits, including individual, community, public health, education, and general wellbeing. Providing for recreation opportunities is not costless and typically includes, construction, maintenance, management, monitoring, and enforcement costs. These factors might arguably be included as part of Performance Measure 7, provided that data are available for assessment.

The metrics that are noted, but unmeasured, in Table 6 generally cover the supply of and demand for recreation opportunities. The supply of recreation opportunities can be quantified through the number, size (capacity), diversity, and location of recreation sites, and through quality indicators such as signage, accessibility, and crowding. The demand for recreation opportunities can be quantified through visitor or user counts in various types of recreation activities on state forests. None of these potential data would seem "out of reach," though their collection would entail some level of cost and effort.

Table 6. Recreational opportunities and education programs metrics under Performance Measure 7.

Table reproduced from *ODF (2009a) Board of Forestry State Forests Performance Measures: An evaluation of the achievement of all nine performance measures for two management approaches on the Tillamook and Clatsop State Forest* (Board of Forestry meeting 3 June 2009, Agenda Item 3, Attachment 1)

<table>
<tr><th>Metric</th><th>Base Case</th><th>Performance Measure with SOC</th></tr>
<tr><td>a. Number of facilities and trails developed and maintained for interpretation, education, and recreation</td><td>The Division is functioning at capacity under this approach, but continues to struggle with achieving these targets, particularly as it relates to facility and trail development and maintenance. Implementing recent modeling results of the Base Case would mean a reduction in investments in this benefit area.</td><td>The additional revenue generated by this approach would enable this metric to perform at higher levels. Some additional adjustments may be necessary regarding trail protection or realignment to minimize conflict with harvest operations.</td></tr>
<tr><td>b. Annual visitation to the TFC compared to five- and ten-year averages</td><td rowspan="2">The Division is functioning at capacity under this approach, and is on track to meet these targets. Implementing recent modeling results of the Base Case would mean a reduction in investments in this benefit area.</td><td rowspan="3">The additional revenue generated by this approach would enable this metric to perform at higher levels.</td></tr>
<tr><td>c. Annual participation in formal educational programs compared to five- and ten-year averages</td></tr>
<tr><td>d. Annual user days for the various types of recreational use on SF</td><td>The Division is functioning at capacity under this approach. Due to increasing public use of State Forest recreation facilities, this metric is generally on the increase.</td></tr>
</table>

Another indicator of the demand for recreation is derived from measures of economic values, such as net willingness to pay or consumer surplus—the amount users would be willing to pay beyond the costs they have to pay to participate in recreation activities. These economic measures require information on the total number of visits and an estimate of economic value per visit. Common valuation tools include travel cost methods, contingent valuation methods, and benefit transfer (Champ et al., 2003; www.ecosystemvaluation.org). These economic valuation tools require information derived from visitors that is commonly gathered through surveys or derived from prior estimates from the literature or other sources. Their implementation to routinely support Performance Measure 7 may be beyond the resources available to ODF. Aggregating the value per visit times the total number of visits provides a measure of the total value of recreation. This could then be compared with the costs of provisions in a benefit-cost analysis, or some other type of welfare analysis. To the best of our knowledge, data on the supply of and demand for recreation opportunities in state forests is lacking, but data is available in varying degrees of specificity for other, complementary public lands in Oregon (e.g., national forests and state parks). We thus conclude that this performance measure does not use the best available science. Although it potentially meets criteria for relevance, understandability, and reliability, the performance measure lacks accessibility in this analytical context because the data needed to use the performance measure are lacking.

Performance Measure 8: Public and stakeholder involvement

Degree of public and stakeholder involvement in state forestland activities and processes

According to the ODF website, public involvement is characterized as "participation on departmental and Board-appointed advisory committees, formal public hearings and comment periods on agency rulemaking, comment opportunities at Board of Forestry and advisory committee meetings, and forest tours and volunteer opportunities on state forest lands" (http://www.oregon.gov/ODF/STATE_FORESTS/Public_Involvement.shtml).

The first set of activities (formal hearings and comment periods), are traditional modes of public involvement for state and federal agencies. Tracking attendance at these meetings meets three of the characteristics of good indicators described above. Because these meetings are mandated and regularly held, the data could be collected and reviewed regularly to track attendance. However, attendance alone may not provide information on the importance (or relevance) of why people are and are not attending hearings and comment periods. It may be worth tracking the types of questions and comments people make at the meetings. Because comments and questions would need to be analyzed this would likely increase the relevance as well as the cost.

It appears as if forest tours and volunteer activities are the second primary source of public involvement activities. It is not clear from the website how data about these efforts are collected or compiled for the state. If districts are tracking and reporting numbers of participants/hours volunteered, it may be relatively easy to track changes over time in these activities, though it does require a centralized reporting ability. While the claim is made in ODF 2009b:13 that "volunteers provide an important level of service to the public and to ongoing trail maintenance," there does not appear to be a metric that measures miles of trail maintained. This metric may be as easy to collect as hours of volunteer time.

The metric "report on progress on specific volunteer projects" is difficult to assess as no additional information is provided. It is unlikely, however, that data on this metric are collected in ways that can be used to compare across projects or across time.

More importantly, these types of public involvement have been called "procedural" (Creighton, 2005) and tend to "inform and educate, presuming that the expert decision-maker simply needs to impart knowledge to a passive, receptive audience" (Wondolleck, 1988 cited in Daniels and Walker 1996, p. 75). Once the information is provided in a public meeting, the agency's accountability to the public has been met. Procedural involvement tends to be ineffective; some people call it the *DAD model*: Decide, Announce, Defend. DAD efforts tend to make people angry and increasingly cynical about agency efforts (e.g., Creighton, 2005).

The second metric for Performance Measure 8 is “Annual Survey of SFAC and FTLAC[1] members.” Technically this is not a metric, but rather a way to collect information. It is not clear from this description what is collected through the survey or how the information is used. It is also not clear how representative SFAC or FTLAC members are of the general public and/or people not affiliated with either group.

While Performance Measure 8 and the ODF website suggest that public and stakeholder involvement is important to ODF, there is nothing in this performance measure that can help them assess the level or even type of difference public involvement is making to ODF. While focused primarily on instrumental involvement (i.e., providing opportunities for input, seeking volunteer assistance), there is no indication that information or assistance from the public is considered seriously in ODF decision processes. According to the report, even these minimal efforts are likely to be constrained due to the “planned elimination of the Division’s public involvement and communication resources” (ODF 2009b: 13).

Performance Measure 9: Oregonians’ awareness and support

Customer awareness and support of the management of state lands

There is a bit of confusion in describing the impact of changes to the FMP on Performance Measure 9. The suggestion is that the “ability to administer, analyze, and track response to survey questions is probably not greatly affected one way or the other by either of these models” (ODF, 2009b: 13). The real question for this metric should be how changes in the FMP will affect customer awareness and support of state lands. The survey is only the *method* for collecting data, though there is also concern, however, about the difficulty of surveying to adequately capture the input of an “informed selection of the public familiar with State Forests.”

The extensive literature on customer awareness, satisfaction, and loyalty in the private sector is not matched by a similar body of literature regarding the public sector; we know very little about the relationship between these variables in agencies like ODF. While there is a general recognition in the literature that public sector organizations have a multitude of purposes that extend beyond that of being a more or less acceptable provider of goods and services, there is still the expectation that “effective agencies stay close to their constituents. They have developed a marketing orientation . . . using a variety of means to listen to their constituents to better understand their desires and develop programs that address them” (McMullin, 1993: 207). Most of the limited literature draws lessons from the private sector and suggests what should be successful in the public sector, with little empirical research to back up the claims.

[1] State Forests Advisory Committee and Forest Trust Land Advisory Committee

ODF should track “customer awareness and support” through a biennial survey; however, it is critical that ODF define “customers”. Given the concern raised in the discussion of performance measures, it appears as if customers are those citizens directly involved with ODF in some way. User/customer perceptions of performance may be better assessed through point of service assessments like satisfaction surveys regarding specific activities. This could provide ODF with the type of listening described by McMullin (1993) above. Customers may also see a direct response to their concerns as programs are modified.

If ODF sees all Oregon residents as their potential customers, it may make sense to conduct a random sample survey of residents and begin tracking levels of awareness across the general population. Though there are different perceptions and expectations for ODF in timber counties and urban areas, most of the “power” to make policy change comes from the urban areas of the state. There is a need to find out what kind of information is required from both segments of the population to ensure that ODF communicates Board policies and practices in ways that are understood and supported across the entire population. It is also important to find out what kind of information is needed to know that ODF policies and practices are supported by the general population or specific sectors of the population. This information may be fruitfully collected through a regular state-wide survey. Questions that are focused on actionable items can also be included in any survey to increase the value of survey information. For example, ODF may be able to collect information on recreation preferences, and/or expectations about state forests and revenues for contribution to local and state projects, all of which can help formulate strategies and/or test the acceptability of state forest practices and policies.

Suggested Performance Measures

Community wellbeing

One important objective of the Board is to contribute to the wellbeing of communities in and near state forest lands. Existing performance measures for this objective include financial contributions to communities and to government services. While these are very important and appropriate measures, they do not adequately capture the contemporary relationships that communities have with state forests. The relatively simple historical relationship of timber harvest feeding mills, which then creates employment, which supports community life, is no longer the sole or even the dominant prevailing relationship in rural communities. The performance measures currently utilized may be very important indicators in some communities and irrelevant as measures of community wellbeing in other communities.

If the Board desires realistic measures of how well local communities are faring, or how they will likely respond to alternative forest management schemes, it must expand the performance measures it uses. Any reasonable evaluation of community wellbeing must ask such questions as:

- Is the community growing or shrinking in population?
- What is the age structure of residents?

- How are employment, household income, education, and health indicators trending?
- How diverse is the local economic base, and what is constraining or facilitating diversification?

An abundance of current, readily available, free data exists on all of these and many more measures of community wellbeing. The U.S. Census (http://2010.census.gov/2010census/) has an abundance of community-level data available online. The Rural Communities Explorer (http://oregonexplorer.info/rural/), a natural resources digital library developed at OSU, makes it extremely easy to develop socioeconomic profiles of communities throughout the state. An accurate, up-to-date profile of communities of interest should inform and provide context for the Board's evaluation process.

Ecosystem services

As noted in the *Board of Forestry State Forests Performance Measures* (ODF, 2009b) on page 4 under "Performance Measure 2", state forests provide ecosystem services and products in addition to timber and recreation opportunities. Ecosystem services is a conceptual framework intended to directly link social and economic analysis with biophysical analysis to evaluate how people perceive and value changes in biophysical conditions and processes. Ecosystem goods and services may be defined as "the aspects of ecosystems utilized (actively or passively) to produce human well-being" (Boyd and Bonzhaf, 2007; Fisher and Turner, 2008: 1186; Fisher et al., 2008: 2051). Fisher and Turner (2008) further clarify this definition by noting that:

1. Services are not benefits (i.e., benefits are those aspects that affect human welfare);
2. Ecosystem services are ecological in nature (i.e., ecosystem functions and processes are ecological components that may be ecosystem services so long as they have human beneficiaries); and,
3. Ecosystem services do not have to be utilized directly (i.e., many ecosystem services affect humans outside of the boundaries of a forest, such as climate regulation, water filtration, and pollination, or are necessary inputs into other valued products such as food, housing, and recreation).

The structure and function of forests as ecosystems are directly and indirectly affected by management decisions and actions and therefore are an important part of any forest policy assessment (Kline, 2006). Beyond this recognition, consideration of ecosystem services is not included in the performance measures reported. This exclusion could be from a perceived lack of data on the stocks and flows of ecosystem goods and services, and their measured linkages to people. As noted at the beginning of our assessment, it would seem that the SOC analysis summarizes biophysical data and analysis which could be used to support greater consideration of ecosystem services effects potentially resulting from forest management plan modifications.

Kline (2006) provides an outline of information needed to begin developing ecosystem services indicators beyond timber and recreation which already are addressed in varying degrees by the performance measures examined. These steps include (1) defining a typology of ecosystem services for state forests; (2) describing and measuring these ecosystem services units or outputs; and, (3) describing and measuring these ecosystem services per unit of values or social weights (Kline, 2006). Data needed to address the three steps listed above may be lacking, especially in specificity to state forests, and would require substantial effort on behalf of ODF to derive them(in particular for step 2 which requires biophysical assessments and step 3 which may require primary data collection via public surveys). In the absence of unit values or social weights, it is often useful to at least describe anticipated changes in the outputs of ecosystem services, similar to some of the biophysical measures mentioned in the companion report.

State forest ecosystem services need to be identified, their biophysical components measured (metrics that can be used to establish a trend in the distribution, quantity, and quality of ecosystems), and their social/economic components measured using tools and concepts consistent with social and economic theory and methods. Without accounting for potential changes in ecosystem services and the associated tradeoffs among them under different management plans, any assessment of proposed modifications to state forest management plans will be missing important information and may not fully account for potential impacts on people over the long term.

Conclusions

Our review of scientific information considered in developing and evaluating the forest management plan strategies suggests to us that current analyses have not utilized the full breadth of methods and information potentially available. The analysis has focused on examining several performance measures intended to address socioeconomic and environmental factors. We evaluated each of these performance measures according to how well they meet indicator effectiveness criteria ensuring relevance, understandability, reliability, and accessibility.

In our opinion, only Performance Measure 1 fully meets these criteria and might be considered a successful application of available science information. Other performance measures provide only partial information pertaining to the environmental and socioeconomic factors they are intended to address. Performance Measures 2 and 3 lack information describing the potential impacts of forest management changes on the direct and indirect financial contributions to communities and to local and state government. Performance Measures 4, 5, and 6 – while relevant to the long-term productivity of many ecosystem goods and services, aquatic-associated resources, and habitat for a site of politically or legally significant species – lack information on the monitoring needed to understand occurrences and changes in distributions of diseases, and especially invasive species, in these forests and lack clear articulation as to how the metrics trigger management changes and policy decisions. In the case of Performance Measure 6, the relationships between the data and the function of the habitat to sustain populations of each focal species are not supportable.

Performance Measure 7 lacks information characterizing potential changes in the supply and demand for recreation in state forests. Similarly, Performance Measures 8 and 9 could include additional information addressing public and stakeholder involvement and Oregonians' awareness and support of management changes under consideration. Additional performance measures characterizing potential influences on community wellbeing and ecosystem services also might have been considered.

There is a reasonable chance that the incompleteness of the performance measures examined may be sufficient to mischaracterize the anticipated impacts of proposed forest management alternatives. ODF (2009b) rationalizes the absence of key information by stating the unavailability of needed data to fully implement the performance measures outlined. We do not feel that the absence of key data owes to any shortcoming in existing scientific method necessary to develop or procure needed data. Rather, we feel the lack of data owes largely to a disinclination to invest in developing and procuring complete data necessary to fully implement the performance measures outlined.

We recognize that funding and other constraints may obligate state agencies to do more with less. However, if this is the case, perhaps a different set of performance measures, ones for which complete data are already available, might be considered by the Board. This might necessarily entail acknowledging that some potential effects are left unmeasured. Alternatively, the Board might consider investing in the mobilization of resources necessary to conduct the type of comprehensive analysis they envision. Either way, given that information, process and science will never be perfect or complete, moving forward with elements common to the existing plan and the proposed SOC guidelines should only proceed using landscape ecology and adaptive management frameworks and with full recognition and acknowledgement of potential shortcomings of existing data and analysis.

Conclusions

The SAT had been tasked with providing a scientific review of recent ODF management decisions. Scientific findings will likely never produce a degree of certainty great enough to satisfy all stakeholders in contentious policy making (Bradshaw and Borchers, 2000). A fundamental problem with natural resource decision making is the lack of an overarching, widely agreed upon set of values and criteria for interpreting scientific research. What often appear to be debates about scientific evidence are really differences of values, opinion, or preferences as to what outcomes are most important and what actions are appropriate in the face of imperfect evidence. Science cannot resolve these differences. The only long-term solution for integrating scientific knowledge into decision making is the development of social learning frameworks that foster shared understanding between diverse stakeholders. A transparent and credible public process for integrating scientific findings into management is as important as rigorous scientific research and review. Decision making requires an ultimate decision maker who weighs the science and the revealed values of stakeholders and moves forward in the face of imperfect and incomplete knowledge.

Even where there is clarity about scientific findings and agreement among stakeholders, natural resource management is extremely rule-bound, with decision space tightly constrained by highly durable and inflexible regulatory frameworks (Brunner et al., 2002). Of particular importance to ODF in the context of managing for SOC are the requirements of the federal Endangered Species Act (ESA).

In conclusion we offer several recommendations to address key issues and offer suggestions of new performance measures that should be doable within ODF's current staff and fiscal capacity:

- **Distinguishing conclusions from information**
  - RECOMMENDATION: Use existing landscape ecology tools and models (described in this report) to allow inferences about effects to SOC.
- **Uncertainty**
  - RECOMMENDATION: Plans should address uncertainties and have the flexibility to adapt to changing social views about biodiversity protection, economic goods and services, and other values.
- **Combining information among state forests**
  - RECOMMENDATION: Impacts of changing policy should be approached separately on each forest as initial conditions vary among forests and the context for the forests (the surrounding forest conditions) also varies.
- **Lack of use of habitat models**
  - RECOMMENDATION: Consider the use of spatially explicit models of habitat availability for species that include some of the SOC considered in this report.
- **Coarse-, meso-, and fine-filter approaches to ensuring protection of species**
  - RECOMMENDATION: Coarse-, meso- and fine-filter approaches should be used to allow a more comprehensive analysis of risks to biodiversity than simply SOC.

- RECOMMENDATION: Species specific habitat models, population viability analysis models, or other approaches that are widely available can be used to ensure that the SOC are likely to persist under each of the management scenarios on each state forest.
- **Lack of spatial considerations**
    - RECOMMENDATION: ODF needs to conduct spatially explicit analyses.
- **Comparisons to appropriate baseline conditions**
    - RECOMMENDATION: Consider using the historical range of variability (HRV) as a reference condition in each region in which each state forest is located.
- **Using stand types as surrogates for habitat**
    - RECOMMENDATION: Given the significance of the SOC in the comparative analyses conducted by ODF, habitat should be defined for each species and should include the structural and compositional elements of habitat necessary to support populations over space and through time.
- **Use of other GIS data that could inform habitat availability**
    - RECOMMENDATION: Combining information from other data layers with information on overlain stand conditions, or more ideally included within species specific habitat models, would allow a more complete understanding of habitat trends over time.
- **Considerations of dispersal habitat especially for species with limited mobility**
    - RECOMMENDATION: Take into consideration dispersal habitat. Without a more complete understanding of the risks associated with changes in landscape connectivity, it is not clear how much confidence we can place in projections that simply show changes in a surrogate for habitat availability.
- **Considerations of thresholds and tipping points in achieving anticipated results**
    - RECOMMENDATION: Take into consideration thresholds and tipping points. We need to ask if synergies among these stressors and uncertainties ***could*** lead to a tipping point for any of the species.
- **Lack of social, economic, and legal "limiting factors"**
    - RECOMMENDATION: Consider social, economic, and legal factors as "limiting factors".
- **Suggested performance measures**
    - RECOMMENDATION: Use ***community wellbeing*** as a more realistic measure of how well local communities are faring, or how they will likely respond to alternative forest management schemes.
    - RECOMMENDATION: Use ***ecosystem services*** to directly link social and economic analysis with biophysical analysis to evaluate how people perceive and value changes in biophysical conditions and processes.

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Appendix A

Group 1 through 3 documents

Group 1 documents

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Group 2 documents (ODF documents requested by the SAT)

Responsive Management. 2006. *Oregon Residents' Knowledge of Values Regarding and Attitudes Toward Natural Resources Management in Oregon State Forests: A Nonparametric Analysis*. Conducted for the Oregon Department of Forestry.

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A series of documents from ODF:

This folder contains 10 documents. There are three basic groups of information as requested by INR.

1. Harvest and Habitat modeling information, including the peer review of the modeling work and the ODF response.
2. April 2009 staff report that outlines different possible alternatives from the forests – including outputs expected under a range of alternatives including Forest Practices.
3. Modeling outputs used as underlying data for the species of concern analysis.

The Division has develop eight model alternatives that follow the same basic structure, but represent different management scenarios and are comprised of specific rules, data and executable programs. There is an alternative for the Forest Management Plan (FMP) with HCP management scenario and an alternative for the FMP with Species of Concern (SOC) management scenario. In addition, there a number of settings for running the models (input parameters) that allows different runs of a model alternative to represent different management scenarios, such as the FMP with Species of Concern (SOC) with a 30 percent or 40 goal for complex structure.

Documents 01 through 03 are specific to Alternatives 1 through 4, which were developed under the Harvest and Habitat Model Project. The SOC analysis used the outputs from Alternatives 7 and 8:

Alternative 7 – Base Case Model assumes management under the NW and the draft Western Oregon Habitat Conservation Plan (this alternative is an update of Alternative 1)

Alternative 8 – SOC Model assumes management under the NW Forest Management Plan and the SOC Strategies (new alternative)

<u>01 H-H FinalReport – Appendices A and B.pdf</u>

- These two appendices were extracted from the Harvest and Habitat Model final report to the Board of Forestry
- They describe the purpose of the models and their basic construction
- The full report can be found at the following link: http://egov.oregon.gov/ODF/STATE_FORESTS/Harvest_and_Habitat_Model_Project.shtml

<u>02 H-H Peer Review Report Aug 31 2006.pdf</u>

- "A peer review of the H&H models was conducted by a team of seven scientists (the authors of this report). The specific objectives of the model peer review were to assess the strengths and weaknesses of the models, including level of confidence in model results; assess model credibility for decision-making and help determine appropriate model application, and suggest model improvements." (from the Executive Summary of the Peer Review)

<u>03 H-H Peer Review Staff Response.pdf</u>

- The staff response to the peer review identifies areas of agreement, disagreement, and points of clarification. Where there was agreement, the report identifies how improvements may be made to the models.

<u>04 April09_StaffReport_onModeling.pdf</u>

- A staff report and attachment that describes the results of modeling six management scenarios that was presented to the Board of Forestry in April 2009

<u>05 Model Rule Linkages_Alt_7.pdf (Base Case Model)</u>

- This document describes the assumptions made in this model. It identifies the modeling issues and links ODF Policy/Guidance to the rules used in the model.

<u>06 FMP-HCP_Alt7_DataDictionary.pdf (Base Case Model)</u>

- Describes the fields used in the model spatial data

07 Model Rule Linkages_Alt_8.pdf (SOC Model)

- This document describes the assumptions made in this model. It identifies the modeling issues and links ODF Policy/Guidance to the rules used in the model.

08 FMP-SOC_Alt8_DataDictionary.pdf (SOC Model)

- Describes the fields used in the model spatial data.

09 Combined_Base_Reports.pdf (Alt 7)

- A series of tables and charts that display the harvest volume, stand structure, and other forest characteristics over an 80 horizon in 5 year periods.

10 Combinded_SOC_Reports.pdf (Alt 8)

- A series of tables and charts that display the harvest volume, stand structure, and other forest characteristics over an 80 horizon in 5 year periods.

Documents 09 and 10 contain much of the data used for the SOC analysis.

Group 3 documents

Patterson, Craig. 2003. National report on sustainable forests–2003: A perspective from the ground up. In *Perspectives on America's Forests: Multiple Perspectives on the National Report on Sustainable Forests–2003.*

Wild Salmon Center. 2010. Science Review Comments. 29 October 2010.

- Attachment A: State Forester Report for Board GPV and Planning Rule Determination.
- Attachment B: Petition for reconsideration: IN THE MATTER OF State Forests Work Plan 2, IBI-6, Changes to the NW Forest Management, Plan made by the Oregon Board of Forestry (18 June 2010).
- Attachment C: Declaration of H. Thomas Davis, Hydrologist (16 June 2010).
- Attachment D: Decadence Management Strategies within Tillamook District (23 December 2008).
- Attachment E: Power, T.M., and P.J. Ruder. 2003. *Economic Realities in the Tillamook and Clatsop State Forests: Possibilities for Economic Expansion and Diversification*. A report prepared for The Tillamook Rainforest Coalition. Portland, Oregon.
- Attachment F: Testimony to the Board of Forestry Greatest Permanent Value, Phil Ruder, Pacific University, March 3, 2010.

Appendix B

Compilation of secondary reviewers' comments and SAT response

Purpose of the Secondary Review

Role of the secondary reviewers involved reading the below mentioned documents with the aim of:

1. commenting on whether we adequately answered the broad questions that were asked of us;
2. commenting on whether we supported our responses based on expert opinion and the state of current science; and,
3. providing us with any comments/ questions/ suggestions about the SAT review report in writing.

Secondary reviewers were provided:

- A Project Overview Document (a short 1-2 page summary of the project). This document includes the questions we were asked, and has hyperlinks to the original 2 ODF documents.
- The Draft Report ODF 5 Jan secondary review (6-page Exec Summary; 53-page main document). The SAT's review of the 2 ODF documents, which did not include the appendices.
- The Group 2 documents: A list of references of some of the representational literature (some of these are not cited in the review report, but are listed for reference to ODF and Board) that the SAT provided.

Secondary Reviewer #1

The role of a secondary reviewer is to "read a 1-page overview of the project and then read the Science Advisory Team report" and to answer three questions. As requested, I have done this.

Below are my comments grouped under the three questions asked in your original memo to me.

Has SAT adequately answered the broad questions that were asked?

The report seems thorough and well prepared. It makes many recommendations, and all the questions asked of SAT have answers contained in the SAT report. The basic conclusions SAT reached seem to me to be, 1) with regard to the SOC modeling, stand structure has been adequately modeled, but species response to differences in structure have not, but could have been; 2)not all relevant information available regarding the state lands in question that should have been used in the analysis was used; and 3) the SAT conclusion that "There is a reasonable chance that the incompleteness of the performance measures examined may be sufficient to mischaracterize the anticipated impacts of proposed forest management alternatives" seems to me to be a completely devastating criticism of the performance measure analysis.

To some degree, with any limited time and budget exercise (here we apparently have two, the ODF reports and the SAT report), the charge can be made that more information should have been gathered and used. Whether this is a relevant charge depends on the possible consequences of incompleteness. In this instance, the SAT report says that the consequences could be major, and that the reliability of the SOC analysis and performance measures could be materially increased "within the resources available". This makes it imperative that the SAT report be taken seriously, and not dismissed as yet another call for "more science", in my view.

Are SAT responses supported based on expert opinion and the state of current science?

The listed SAT team includes an impressive array of scientific credentials and experience. I suspect it would be difficult to assemble a group better qualified to answer the questions asked, particularly in the severely limited time and budget environment described. But an important caveat is contained in the first paragraph of the "Conclusions" section of the body of the report. I think it is worth restating here, since it contains the seeds of what might be done "next time":

> *"Scientific findings will likely never produce a degree of certainty great enough to satisfy all stakeholders in contentious policy-making (Bradshaw and Borchers, 2000). A fundamental problem with natural resource decision making in Oregon is the lack of an overarching, widely agreed upon set of values and criteria for interpreting scientific research. What often appear to be debates about scientific evidence are really differences of values, opinion, or preferences as to what outcomes are most important and what actions are appropriate in the face of imperfect evidence. Science cannot resolve these differences. The only long-term solution for integrating scientific knowledge into decision-making is the development of social learning frameworks that foster shared understanding between diverse stakeholders. A transparent and credible public process for integrating scientific findings into management is as important as rigorous scientific research and review."*

I believe it is fair to add to this that in addition to this important process point, decision-making requires and an ultimate decision-maker that weighs the science and the revealed values of stakeholders and moves forward in the face of imperfect and incomplete knowledge.

> **SAT RESPONSE TO SECONDARY REVIEW**
> **This point was added to the conclusions.**

Comments/ questions/ suggestions

Because the Executive Summary is somewhat disconcertingly labeled as the "consensus" part of the report, I have appended some comments on it along with this memo. Several additional things might be considered:

- The SAC report has the flavor of advocating a species by species approach, as opposed to an ecosystem one. Although the ESA is interpreted in as "species" law, it does talk about ecosystems, and, given the abundance of species that might be found in any system, it seems to me that a species by species approach will ultimately lead to infinite regress. Thus, I would suggest that SAC write a bit more about this dilemma and how to handle it in a practical, time and resource limited world.

    SAT RESPONSE TO SECONDARY REVIEW
    The SAT agrees. Taking an ecosystems structure and function approach is more likely to result in consideration of species and processes. To a certain degree that is what the coarse-, meso- and fine-filter approach does.

- The charge that not all information "from state lands" has been used is a devastating one, but I can't find exactly which information has been missed. I assume it is cited or quoted in the appendices that weren't provided with the report. If not, it should be.

    SAT RESPONSE TO SECONDARY REVIEW
    There are GIS layers that were not used such as stream layers, roads, etc.

- I personally am not a big fan of HRV and am doubtful that it is a good basis for much of anything in the face of modern society, climate change and a country that will soon contain 400 million people.

    SAT RESPONSE TO SECONDARY REVIEW
    We acknowledge HRV as a starting point that must be considered in the context of the current and likely future ecosystem states and processes, as well as social variability in acceptance of future conditions.

- The SAC report calls for a more thorough analysis based on "landscape ecology" and I agree that it would be a good thing to do, but are the applied tools available to do this with a specific and quantitative confidence level?

    SAT RESPONSE TO SECONDARY REVIEW
    Applied tools are available. See:

    Gordon, S. 2006. *Decision Support systems for forest biodiversity management: A review of tools and an analytical-deliberative framework for understanding their successful application*. Ph.D. Dissertation. Corvallis, OR: Oregon State University. June 9, 2006.

Secondary Reviewer #2

I reviewed the January 5th version of the INR report from a science advisory team (SAT) on the ODF's species of concern strategy (SOC) and the BOF performance measures (PM) for state forests. Given the short notice I had to do the review and my busy schedule I was not able to conduct a very detailed review of the report. However, I read through the report once.

Here are my conclusions:

The SAT report is well written and the conclusions are consistent with the latest science in conservation biology, forest ecology and landscape ecology.

The conclusions are supported by the analyses and applications of the previous CLAMS analyses. I support all of the recommendations of the SAT.

In particular, I thought the following recommendations of the SAT were valuable

- Provide separate reports for the individual State Forests. These forests have very different forest conditions and ecological potentials. Combining information about could mask important trends.

- Characterize the social, economic and legal limiting factors. While the ecological science is important, I agree that these non-biophysical factors are typically more important when decisions are made about management of State Forests. It is particularly important to avoid the appearance that the ecological analyses in the SOC and PM are just a cover for decisions made on other socio-economic grounds.

One final comment, I was somewhat surprised that the PMs did not explicitly mention carbon storage in forests and forest products. Perhaps this is being dealt with in another area of state government? Carbon storage and forests are a critical issue both ecologically and economically. Performance measures for forests that do not explicitly include carbon are not scientifically defendable.

SAT RESPONSE TO SECONDARY REVIEW
Though the SAT was not tasked with analyzing carbon storage, this is an excellent point that we acknowledge and agree should be recommended.

Secondary Reviewer #3

Essentially my responses to questions 1 and 2 are "yes", while my response to the third question is "how good is good enough?"

Review

1. Adequacy of review and basis in science

The SAT has carried out a comprehensive review of the overall strategy employed by ODF, even though the SAT states (p2) that "Given the time and resource constraints we faced, it was not possible to review in detail every one of the assumptions and outcomes that informed the development of limiting factors, surrogates and performance measures plus species of concern (PM + SOC) trends. Our

SAT review report addresses some of the more important gaps in assumptions and application of scientific research in order to illustrate the advantages of adopting more robust analytical methods."

I believe that the conclusions of the SAT are robust and apply generally to the ODF strategy, even though the SAT only focused on some major issues and critical species.

Here are my comments on the main conclusions and recommendations:

Distinguishing conclusions from information

- SAT COMMENT: The ODF does not provide conclusions per se for the SAT to review. Instead, the ODF makes statements about the quantitative difference in conditions that result from implementation of the PM + SOC strategy. This information may be important, but does not necessarily allow conclusions ("a reasoned judgment") about how species will be affected by adopting a different management strategy. Species may respond non-linearly to changes to surrogates (a threshold may trigger cascading change, for example), or changes to surrogates may interact with other ecological patterns and processes at different temporal and spatial scales to create results not predicted by measurement of surrogates.
- SAT RECOMMENDATION: Use existing landscape ecology tools and models (described in this report) to allow inferences about effects to species of concern.

    <u>Reviewer:</u> The basic criticism, that statements about difference in conditions do not allow a leap to conclusions, is important. The ODF approach would be better supported by a stronger narrative linking management of surrogates to species. As the SAT points out, there are tools to do this readily available. However it is important to assess how much would be gained by improving the quality of the analysis (see comments below).

- SAT COMMENT: ODF could have mentioned that information about species is incomplete and effects to species are uncertain.
- SAT RECOMMENDATION: Plans should address uncertainties and have the flexibility to adapt to changing social views about biodiversity protection, economic goods and services, and other values.

    <u>Reviewer:</u> This criticism is on two points. I agree strongly with the first point, that addressing uncertainties is a key step in any scientific analysis that will be applied to management. I also agree that the ODF reports have not made such uncertainties explicit, and hence that their proposed approaches are harder to assess for likely success. On the second point, I wonder whether the SAT exceeds its' mandate, in terms of suggesting the need for flexibility about future social views.

    <u>SAT RESPONSE TO SECONDARY REVIEW</u>
    On the second point, flexibility to accommodate future social expectations is almost pro forma. We probably should have been more specific about what flexibility looks like, i.e., what are reasonably foreseeable future social expectations and how could management be flexible to accommodate new circumstances?

Combining information among state forests

- SAT COMMENT: Based on our knowledge of the current age class distribution of the Tillamook and Clatsop State Forests it would seem that projections of future conditions could vary considerably among these forests, and that benefits or risks to species could also vary considerably with a forest and from one forest to another.
- SAT RECOMMENDATION: Impacts of changing policy should be approached separately on each forest because initial conditions vary among forests and the context for the forests (the surrounding forest conditions) also varies.

Reviewer: I agree

- SAT COMMENT: The information provided to illustrate likely changes in habitat availability for SOC is based on using forest stand classes as surrogates for habitat for many of the SOC. Since habitat is a species-specific concept, lumping species into stand classes is a crude estimate of habitat availability.
- SAT RECOMMENDATION: Consider the use of spatially explicit models of habitat availability for species that include some of the SOC considered in this report.

Reviewer: I believe that the SAT is here suggesting a 'mixed approach'. Clearly, for many species, we lack enough data to carry out the proposed spatially explicit models. In such a situation then, we can only carry out analyses for some but not all target species. Should we 'weight' such species more heavily in a final management strategy? Clearly there are some serious problems with doing so. On the other hand, failing to use appropriate techniques when these are available for some species, is also a problem. I think the SAT might consider elaborating on just how the ODF could approach a cost-effective and time-efficient process that combines approaches for different species with contrasting levels of available information.

SAT RESPONSE TO SECONDARY REVIEW
The coarse-, meso-, and fine-filter approach is a good one that addresses this concern. Further for any SOC we use the best tools available recognizing that some analyses will be more robust (less uncertain) than others.

Coarse-, meso-, and fine-filter approaches to ensuring protection of species

- SAT COMMENT: Though many species are listed as SOC and listed as being represented by the models, the aggregations of species into stand structural conditions ignore major differences in their individual distributions, life histories, and ecological requirements. In addition, there are many other species that could be influenced by management activities that were not considered. A question remains regarding the potential for either positive or adverse effects on other species not selected for analyses.

- SAT COMMENT: The ODF analyses assumed a direct relationship between a biophysical class and habitat for each of the SOC, rather than using the biophysical classes as surrogates for other species that could occur on these forests as is typically done in this type of analysis.
- SAT COMMENT: Since model projections are based on stand inventory information and growth models it seems that the ODF analysis could have explicitly considered the likely changes in snag and log abundances, tree size distributions, and tree species composition over time.
- SAT RECOMMENDATION: Coarse-, meso- and fine-filter approaches should be used to allow a more comprehensive analysis of risks to biodiversity than simply SOC.
- SAT RECOMMENDATION: Use of species specific habitat models, population viability analysis models, or other approaches that are widely available can be used to ensure that the SOC are likely to persist under each of the management scenarios on each state forest.

> **Reviewer:** See previous comment. In addition, I question whether PVA would be accurate enough to usefully inform management decisions for many of the species. Notably, for species such as Northern Spotted Owl, this would require embedding the ODF strategy within larger landscapes under various projected conditions, which might be beyond the scope and capabilities of ODF. Generally I support the SAT's statement that more could usefully be done; however it is simply impossible at this point to determine how much is necessary. Perhaps the federal FEMAT approach of convening panels of experts for each species, and then rapidly assessing each species separately (using whatever tools are appropriate for each species) might be a model for how to proceed.
>
> However 1. the SAT is correct in stating that there are other approaches, not used by ODF, and 2. the existing approach is certainly not comprehensive and could be improved simply by incorporating additional readily available.

Lack of spatial considerations

- SAT COMMENT: ODF's analysis was not spatially explicit. They say how surrogates change, but do not relate that change to specific spatial and temporal relationships.
- SAT COMMENT: Based on our interpretation of the models used in projecting future forest conditions, assessment of the sizes and spatial arrangement of species-specific habitat patches or distributions along the stream reaches would seem to be possible, but there is little evidence of that in the documents provided.
- SAT RECOMMENDATION: The ODF needs to conduct spatially explicit analysis.

> **Reviewer:** Spatially explicit data are certainly available, and may be useful for some species. Again, whether or not to use these data would require an analysis, species by species, on the likely value to be gained.

Comparisons to appropriate baseline conditions

- SAT COMMENT: The ODF projections and summaries of relative differences in acres of habitat between management plans may allow for a comparison of plans, but does not provide a comparison to a reference condition that reflects the ecological capacity of the system to meet the needs for each species or for ecosystems processes.

- SAT RECOMMENDATION: Consider using the historical range of variability (HRV) as a reference condition in each region in which each state forest is located.

Reviewer: No comment

Using stand types as surrogates for habitat

- SAT RECOMMENDATION: Given the significance of the SOC in the comparative analyses conducted by ODF, habitat should be defined for each species and should include the structural and compositional elements of habitat necessary to support populations over space and through time.

Reviewer: This criticism is really about whether the ODF has made its case, using the scientific literature, as to whether stand types are adequate surrogates. I agree that this is a critical issue; practically I suspect that this is not a major problem - but the steps need to be better laid out in order for any regulatory agency, the public, or a decision-maker to have confidence moving forward.

SAT RESPONSE TO SECONDARY REVIEW
See the paper by Cushman et al that challenges use of stand types as surrogates for habitat.

Use of other GIS data that could inform habitat availability

- SAT COMMENT: Several of the SOC identified as important components of these ecosystems were not analyzed apparently because of lack of information.
- SAT RECOMMENDATION: Combining information from other data layers with information on overlain stand conditions, or more ideally included within species specific habitat models, would allow a more complete understanding of habitat trends over time.

Reviewer: See final comment below

Considerations of dispersal habitat especially for species with limited mobility

- SAT COMMENT: Without a more complete understanding of the risks associated with changes in landscape connectivity it is not clear how much confidence we can place in projections that simply show changes in a surrogate for habitat availability.

Reviewer: See final comment below

Considerations of thresholds and tipping points in achieving anticipated results

- SAT COMMENT: We need to ask if synergies among these stressors and uncertainties could lead to a tipping point for any of the species.

Reviewer: See final comment below. Exactly how would such an assessment be made? Are there any tools available? Certainly I know of no PVA analysis (even geographically explicit) that would allow realistic modeling of species embedded in a larger federal/private landscape.

SAT RESPONSE TO SECONDARY REVIEW

We agree that there are not good models available for evaluating most viability thresholds. We are not calling for that sort of analysis so much as asking the agency to acknowledge that effects to species as a result of changed management practices are likely to be non-linear. Also, we recommend spatially explicit analysis to be able to understand how changes in management might affect species viability with respect to the pattern of habitat on the landscape.

Limited use of available literature to not only support statements made

- SAT COMMENT: Although we are sure that ODF staff are aware of literature beyond what was cited in the two documents that we were asked to review, the literature cited sections are indeed very sparse and some of the highly relevant information collected on state forest land was not included.

Reviewer: I agree

Lack of social, economic, and legal "limiting factors"

- SAT COMMENT: Social, economic, or legal factors are not considered limiting factors in the SOC analysis. The lack of analysis of these factors may lead to ineffectual choices and decisions as the Board of Forestry moves forward with policy decisions, regardless of how sound the biophysical analysis.
- SAT RECOMMENDATION: Consider social, economic, and legal factors as "limiting factors"

Reviewer: Overall, I agree that such limiting factors might be useful approaches to modeling. However I strongly recommend that, if such an approach is used, such factors need to be defined by decision-makers, and not by the scientists carrying out the analyses.

Final comment

It is always possible to improve any body of science; indeed the very basis of the scientific method is to criticize and then modify. In a management scenario, this leads to a potential conflict between the underlying philosophy of scientists ("is this as good as it could be?") and that of managers ("is it good enough?"). I believe that the SAT's review answers the first question directly: the ODF strategy is not as comprehensive as it could be, does not use all available techniques, is inadequately supported by the literature cited, and can be easily improved by readily available techniques. To that extent, I believe that the SAT review has fulfilled its mandate, and is a fine review.

However I also think that the SAT review could help managers and decision-makers assess the ODF strategy by also reconsidering both ODF's plans and their own review in terms of the second question "is it good enough?" Yes, it is possible to do a PVA for marbled murrelets (for instance) but realistically the ODF lands are of minor importance to the survival of that species, and hence a PVA is unlikely to be very informative or useful in assessing alternative management scenarios. I am not here criticizing any of the conclusions or recommendations of the SAT - simply suggesting that a decision-maker would be helped by an assessment of how much better his or her decision would be if PVAs, dispersal habitat, snag densities etc, are incorporated into the ODF approach. I suspect that for some of the SAT's recommendations the answer would be "quite a lot", but for others it might be "not much". Hence I strongly recommend that the SAT look over its review from such a perspective, and highlight those issues that are truly likely to result in better decision-making (as opposed to simply better-documented science).

SAT RESPONSE TO SECONDARY REVIEW

Point well taken. There really are two issues here, though they are confounded with one another. One deals with the current science used (which theoretically deuces uncertainty) and the other deals with better decisions making (which theoretically is better with less uncertainty).

Secondary Review #4

Overall Comments

I found the report to be well written and conceived as well as grounded in the relevant scientific literature. Overall, I concur with the reviewers' assessment that ODF did not draw very heavily on the scientific literature for SOC. The SAT does a thorough job of highlighting some of the most pertinent issues and missing literature. The recommendation that ODF consider individual species responses rather than just aspatial habitat structure as a proxy (surrogate) is particularly pertinent. Other highly relevant SAT comments included the consideration of (1) modern landscape ecological approaches, (2) many species that are currently missing from the strategy but might fall through the rather large cracks in the coarse filter approach currently used.

The comparison between CLAMS models and ODF models was a good idea. It is reassuring to know that for most species surrogates, the trends are in a similar direction. It will be important to put more emphasis on the fact that in this case the CLAMS models are also structure based (i.e., not based in models of species' demography). It would have been interesting (though time prohibitive) to implement a PVA or species distribution model (SDM) as a third 'validation' of these two former methods.

One weakness of the report was the ambiguity around how to revise or formulate new performance criteria. I found the concluding section of the report a bit difficult to interpret and possibly contradictory. The first point made by SAT is that ODF's apparent reluctance to invest to obtain more data should be addressed by adopting different (less ambitious?) performance measures (i.e., ones WITH data). However, the next paragraph acknowledges (correctly) that the science required for decision making "will never be complete". So, what degree of certainty is necessary before one considers a performance measure to be appropriate for evaluation? I agree that the current performance measures are difficult to test, but there seems to be considerable risk in down-grading/simplifying performance criteria until it is deemed that sufficient information already exist. Indeed, it is likely to conflict with the first criterion for a good indicator – in the words of the SAT report: "relevant: each indicator shows you something about the system that you ***need*** to know".

SAT RESPONSE TO SECONDARY REVIEW
The SAT was not explicitly instructed not to construct new performance measures, but simply evaluate the ODF's evaluation of the performance measures.

All of this might be clarified/ remedied with some examples from SAT for useful performance measures where "complete data are already available". Alternatively, the SAT could put more emphasis on the necessity to simply do a better job with the current performance measures. ("Alternatively, the Board might consider investing in the mobilization of resources necessary to conduct the type of comprehensive analysis they envision." This will obviously involve providing ODF with a stronger mandate to conduct more in-depth scientific research as it applied to management.

SAT RESPONSE TO SECONDARY REVIEW
The SAT was not explicitly instructed not to construct new performance measures, but simply evaluate the ODF's evaluation of the performance measures.

This raises the final point that many of the mismatches and weaknesses mentioned by SAT are most likely due to a lack of investment by Oregon State in the scientific capacity of ODF, rather than a 'poor job' by existing ODF employees. Though this point is made early on in the report, I think it could be emphasized more in throughout the report and in the conclusion.

Review of Key Recommendations

Given that one of the most important aspects of the SAT report is the list of recommendations, I have highlighted several of the most relevant of these below and commented on whether each of these is well founded based on logic and the existing scientific literature.

- SAT RECOMMENDATION: Use existing landscape ecology tools and models (described in this report) to allow inferences about effects to species of concern.

  Reviewer: This recommendation is well founded and is quite critical to effective forest management planning. However, it should be noted that implementing Population Viability Analyses (PVA) and Species Distribution Models are not trivial tasks and will require substantial investment even if data on demography and distributions of SOC species are already available. The reviewers recommend the use of multi-species simulation models as a major contribution from the field of Landscape Ecology, but it is important to state the caveat that often such models are short on high-quality empirical data needed to support robust predictions. Using such models will also require the investment in the collection of *actual data* on animals and their demographic responses to various forest management treatments. For many of the SOC species, the demographic data necessary for a PVA (e.g., age-specific survival, natal & breeding dispersal in different landscape contexts) are not available. These data would need to be collected for most priority species (except perhaps spotted owl). Such data-intensive models may only be applied to species for which extensive information on habitat associations, demography and life history exists or is obtainable.

- SAT RECOMMENDATION: Plans should address uncertainties and have the flexibility to adapt to changing social views about biodiversity protection, economic goods and services, and other values.

  Reviewer: The use of deterministic models by ODF given the high degree of uncertainty is somewhat surprising. This is a strong recommendation, though the details of how to do this will need to be worked out.

- SAT RECOMMENDATION: Impacts of changing policy should be approached separately on each forest because initial conditions vary among forests and the context for the forests (the surrounding forest conditions) also varies.

  Reviewer: Agreed

- *SAT RECOMMENDATION: Consider the use of spatially explicit models of habitat availability for species that include some of the SOC considered in this report.*

  Reviewer: The reviewers raise an important point that using vegetation/ forest conditions as surrogates for wildlife populations reflects an untested hypothesis that there are strong links between vegetation conditions and the populations themselves. Stating that this approach "is not supported by current science" may be a bit strong unless scientific references are provided indicating that changes in structure are poor predictors of demography (some refs are available). The reviewers DO provide a few good examples (e.g., thresholds etc.) where surrogates may not function as intended. Overall, this is a very important point. The challenge will be in its implementation.

  SAT RESPONSE TO SECONDARY REVIEW
  The SAT provided the Cushman et al paper.

- SAT RECOMMENDATION: Coarse-, meso- and fine-filter approaches should be used to allow a more comprehensive analysis of risks to biodiversity than simply SOC.

  Reviewer: The approach recommended by the SAT has become fairly common practice for forest biodiversity planning in many jurisdictions. It will be critical for ODF to consider coarse, meso and fine-filter strategies – particularly given the opportunity for various silvicultural treatments to influence within-stand structures in a variety of ways (that might be beneficial or hazardous to the range of species considered).

- SAT RECOMMENDATION: The ODF needs to conduct spatially explicit analysis.

  Reviewer: I agree with SAT that this is an absolute necessity.

- SAT RECOMMENDATION: Consider using the historical range of variability (HRV) as a reference condition in each region in which each state forest is located.

  Reviewer: This is a commonly used approach, though one with considerable technical and philosophical problems. The SAT could briefly state some of the controversies that have emerged in the scientific literature over use of HRV.

  SAT RESPONSE TO SECONDARY REVIEW
  Point well taken. Two critiques of HRV include:

  Millar CI, Woolfenden WB. 1999. The role of climate change in interpreting historical variability. *Ecological Applications* 9(4):1207–1216.

  Kimmins JP. 2004. Emulating natural forest disturbance, what does this mean? In: *Emulating Natural Forest Landscape Disturbances*, (eds.) Perera, A.H., L.J. Buse, and M.G. Weber. New York: Columbia University Press.

- SAT RECOMMENDATION: Given the significance of the SOC in the comparative analyses conducted by ODF, habitat should be defined for each species and should include the structural and compositional elements of habitat necessary to support populations over space and through time.

  Reviewer: It will be critical to have species-specific definitions of habitat, however, as noted above, this will require considerable investment.

- SAT RECOMMENDATION: Combining information from other data layers with information on overlain stand conditions, or more ideally included within species specific habitat models, would allow a more complete understanding of habitat trends over time.

  Reviewer: This is certainly the least expensive approach to developing species-specific projections, but will require data on individual species distributions. Also associated with this approach is that the relationship between vegetation conditions and species stay constant over time.

- SAT RECOMMENDATION: Take into consideration dispersal habitat. Without a more complete understanding of the risks associated with changes in landscape connectivity it is not clear how much confidence we can place in projections that simply show changes in a surrogate for habitat availability.

<u>Reviewer</u>: Though there is little scientific evidence on the influence of connectivity on animal demography, this is more due to the difficulties designing landscape-scale studies that address this question. I agree that a 'precautionary approach' would adopt species-specific definitions of dispersal habitat.

- SAT RECOMMENDATION: Take into consideration thresholds and tipping points. We need to ask if synergies among these stressors and uncertainties **could** lead to a tipping point for any of the species.

<u>Reviewer:</u> This is a good recommendation and has ties to earlier SAT recommendations on the need for incorporating uncertainty into projections. Spatially explicit PVA is the most effective way to do this on the wildlife side (but see cautions above).

Minor Points

- How strong is the evidence that forest fragmentation is a major driver of RTV distributions? The authors provide a Carey 1991 reference, but to my knowledge, this paper did not go into detail on fragmentation effects.
- The criterion that indicators be "easily and regularly collected" seems a challenging one to meet given the data and labor-intensive recommendations provided by the SAT.
- I found Table 2 to be a particularly useful part of the report as it summarizes for each SOC group the degree to which the ODF effort is internally consistent and is supported by the current science. I agree with the reviewers' conclusion that though ODF measures tended to be internally consistent (i.e., conclusions were supported by the analysis), there were fairly major weaknesses in relation to the best available science. The largest of these weaknesses is that animal response does not necessarily correspond to habitat structure response. Some very good recommendations are provided in the "Other Ways to Conduct Analysis" column.
- The only small criticism I have of these recommendations concerns the one on using "Fragstats" to analyze landscape pattern. Though some of the metrics in this program are interpretable on ecological grounds, there is the danger that a myriad of metrics could be applied with a "so what?" outcome. This point is especially relevant for internal consistency of the report; the reviewers stress earlier that surrogates need to be tied to the responses of animal populations. The risk of mismatches between fragmentation metrics and biological responses is high. I suggest that a caution be applied that only those metrics that are known to have biological relevancy to SOC should be considered.

<u>SAT RESPONSE TO SECONDARY REVIEW</u>
A good point – FRAGSTATS metrics that have been identified as important drivers of habitat quality or ecological processes should be used.

- The reviewers make an excellent point about the flaws associated with deterministic projections.

Secondary Review #5

Thank you for the opportunity to provide feedback on "Scientific Review of Oregon Department of Forestry's Proposed Species of Concern Strategy and the Board of Forestry's State Forest Performance Measures." This report represents a significant undertaking and clearly involved considerable careful comparison of the ODF reports to current scientific literature. It's clearly written and well organized. Given my background in socioeconomic issues of forest management, I focused of my review around those issues.

I agree with the SAT that there is a need to consider social, economic, and legal limiting factors in the analysis along with biophysical limitations. I also largely agree with the review of performance measures, especially the overall weakness of social and economic measures. However, I have a few suggestions here that might strengthen the SAT's recommendations.

PM 2. Financial contributions to communities. The review of this performance measure raises critical issues that need attention. But, I think the review needs to be revised to include also economic benefits created through ODF spending on forest management, restoration, and other activities on state forests. There is a growing body of literature that has been focusing on the economic activity of public land restoration and maintenance, which suggests that this too create important local economic activity. Reviewers do not appear to have considered this literature or its consequences. I would recommend revising this recommendation to include direct and indirect economic and jobs impacts from forest restoration and maintenance along with the impacts of timber harvest and recreation.

SAT RESPONSE TO SECONDARY REVIEW
This can be addressed verbally at the April Board of Forestry meeting.

PM 8. Public and stakeholder involvement. This recommendation reflects the current literature about the significant limitations of ODF measurement of public and stakeholder involvement. As the reviewers suggest, the public involvement and collaboration literature has made clear that richer types of engagement in public decision-making processes are critical. I would go further than this recommendation does to suggest that the measurement of public and stakeholder involvement needs to include some measurement of collaboration, including at the forest level.

SAT RESPONSE TO SECONDARY REVIEW
Excellent point.

PM 9. Oregonian's awareness and support. I agree with this recommendation, but feel that it could be edited to be more accessible to ODF and public audience.

Suggested performance measures: Community wellbeing. The SAT is right to recommend creating a performance measure around community well-being. As this recommendation suggests, there is a long-standing and clear literature that suggests that 'logs to the mills' does not equate to community wellbeing in forest communities. Community wellbeing is more complex and needs to be measured separately of timber harvest levels; timber harvest is not a proxy for community-well being. However, the recommended measurements that the reviewers suggest are not all that directly linked to ODF management, especially in increasingly complex (though rural) economies. Although they are easy to gather from existing data sources, ODF performance/management may not actually be reflected in these sorts of broad measures; it's too course scale. Instead of recommending overarching community-well being measures, I would recommend developing well-being measures for specific sectors of the economy such as forest products, forest and watershed restoration, recreation and tourism, and other related sectors that the state forests affect. Similarly, I would recommend social wellbeing measures that are more closely related to state forests and their management.

Thank you again for the opportunity to review this document. Please feel free to contact me if you have any additional questions.

Appendix C

Compilation of Public Comments

Public Comment #1

We need another way to manage our forests.

Unfortunately Oregon State University, industry, the Oregon Board of Forestry and some management agencies — doesn't seem to take into account some basic facts and contradictions. More of the same will only make things worse after a very short-lived boom, followed by another long-term bust.

There is nothing sustainable about industrial clear-cut forestry — not environmentally, not economically and not socially. It represents the ultimate short boom, then results in generations of busted environments, economics and society — the greatest good for fewest numbers for the shortest time.

Here are some facts:

Environmentally, the industrial model takes a highly interdependent and diverse ecosystem and converts it into a plantation of uniform structure and age class. The rationale is to speed up the growth in Douglas fir. Yet the litany of unintended consequences (invasive species, disease and insect infestations, soil erosion, overcrowded fire-prone stands, boom-and-bust cycles, etc.) all follow our industrial "management" practices. They sacrifice forest quality and structural integrity for fast growth without understanding the consequences.

There are many serious liabilities regarding man-made products, from out-gassing (which affects indoor air quality) to failing in less than 10 minutes in a house fire (oriented strandboard floor joists and rafters), which all point to the lessons we must learn regarding the industrial model.

Historically we have simply passed such externalities as forest restoration on to future generations with impunity. Now these costs are demanding our attention and accounting. Ignoring these costs and liabilities contributes significantly to our inability to pay for them.

This is a structural disconnect embedded in incomplete analysis and our singular focus on short-term profits. This disconnect drives us further away from holistic and life-cycle cost analysis — thus our problems magnify.

In a matter of days we can level a stand of ancient trees that took hundreds of years to evolve into the dynamic and interdependent ecosystems that an intact forest embodies.

Then our forest scientists ask, "How do we create structural diversity in a plantation?" without noticing that diversity was destroyed in converting a forest to a plantation in the first place.

If this represents science, then morality, social relevance, ethics and common sense have been thrown out the window.

Socially, the implications become even more insidious as unemployment soars in timber-dependent communities, our social contract is strained to its limits and future generations wonder what their future holds.

If we, our scientists and our land managers were smart enough to understand all these restoration costs and hold funds in escrow to cover their eventual costs, we might learn the lessons of past management. However, when we disconnect these costs and liabilities from past choices, the restoration costs soar, the environment, our economics and our society suffers, and future generations will curse us.

To be fair, the Forest Service and Bureau of Land Management have responded to the science of endangered and threatened species and the overcutting prior to 1990, and have dramatically lowered their cut. The Oregon Board of Forestry runs counter to that trend, clear-cutting an average of six or seven times what the federal agencies combined cut between 2001 and 2007. To give context, the Forest Service and BLM represent 60 percent of Oregon's forests; the state forests 3 percent.

State officials say they work under the mandate of providing the "greatest permanent value" from state lands, which for them means increased liquidation of the forests. They don't seem to understand the concept of short-term boom and long-term bust, even when the evidence is overwhelming.

On private lands, the Forest Practices Act is marginal at best. It uses many of the right words, but actions speak louder. Last year I gathered information regarding the decade of clear- cutting up Quartz Creek off the McKenzie River. Between 400 and 500 designations of high risk areas, high risk sites and northern spotted owl sites were identified in their Forest Activity Computerized Tracking System, or FACTS, program. Those designations meant nothing to the loggers and timber companies. Take a look at Quartz Creek due south of Finn Rock on Google Earth and you can see for yourself the Forest Practices Act at work.

There is one alternative voice on the Board of Forestry, Peter Hayes. It's time to support his voice and redefine "greatest permanent value" that includes future generations and not just short-term profits.

Past forestry management isn't a model to emulate if we have concern for the environment or for our kids and grand kids. The jury is in if our eyes see holistically.

Public Comment #2

Thanks, Lisa, for sending the document (ODF) for Public Comment.

One thing that we rural forest dwellers notice whenever ODF (or BLM etc) makes references to economic conditions in "logging communities" they fail to note that the number of rural logging communities that have a mill is a tiny percentage compared to the many rural communities -- like mine -

- that get heavily logged and have no local mill. The majority of rural people living in areas where there is heavy logging do not have a local mill for economic gain.

Rather, we suffer from the non-stop logging trucks dominating our roads, suffer the noise of the logging that typically begins between 3 am and 4 am and wakes us up, suffer through the aerial spraying of herbicides that sicken us and pollute our water... and get absolutely no economic benefit because there are no mills within a reasonable commute for work.

Not once have I ever read an EIS that even remotely accurately described the real impact to most of us who live in heavily logged forests. Never have I read any sort of acknowledgement that there are two very different rural logging community types: 1) The small minority that have a local mill and, 2) the vast majority that have no mill but are located in a heavily logged forest region. We are like a third world country: they come in and take our natural resources and the wealth thereof, and give us nothing in return.

Public Comment #3

Please accept the following comments from [omitted] regarding the Draft Science Review of the ODF Proposed Species of Concern Strategy.
http://oregonstate.edu/inr/sites/default/files/project_odf_sr/DRAFT_Report_ODF_31_Jan_public_comment.pdf

1. It is unclear how this report will be used to calibrate policy. ODF seems to try to increase timber harvest even when the ecological evidence indicates otherwise. The Science Review indicates and we agree there is limited scientific support connecting the limiting factors to the species of concern. Does this mean that ODF will develop a new set of strategies with better scientific support?

2. There are risks when using superficial measures of forest structure and a proxy habitat. For instance, we agree with Table 2 which criticizes the use of older forest as a surrogate for snags and dead wood. When "Layered Older Forest Structure" is the result of multiple forest entries involving wood removal, it will almost certainly lack sufficient snags and dead wood to function as suitable habitat for late successional wildlife that depend on dead wood habitat.

3. There are risks when using habitat as a proxy for wildlife populations, because habitat and populations can be decoupled by disease, invasive species, etc. The barred owl is a good example. Much suitable habitat for the spotted owl is not available to support spotted owl populations because it is occupied and defended by invading barred owls.

4. The Species of Concern listed for "snags and down wood" includes lots of bats but no birds. There are a variety of primary cavity excavator sand secondary cavity users that could be included as SOC associated with snags and down wood.

5. The “hydrology” limiting factor needs to be clarified. It probably has multiple components, including avoiding cumulative watershed effects and peak and low flows. Other indicators should be considered, including, road density, road-stream crossing density, and landscape-level coverage of complex or unmanaged forest.

6. Table 5 says there is a “high probability to maintain and enhance snag and down wood habitat as the percent of older forest structure increases.” This is not necessarily so. If the old forest structure is a product of commercial timber sales that remove trees that would otherwise be recruited as snags. Dead wood recruitment requires restoration of not just large tree *structure* but also restoration of the *process* of tree mortality. Thinning captures mortality and reduces recruitment of dead wood structure. See this online slideshow which shows the modeled effects of thinning on dead wood habitat. http://www.slideshare.net/dougoh/effects-of-logging-on-dead-wood-habitat Mortality is still an under-appreciated ecological process. As forest density approaches mortality thresholds, professional foresters always seem to want to intervene to reduce stand density and avoid mortality.

7. The document cites favorably the DecAID Advisor, and we agree that it represents a collection of useful information about wildlife use of snag and dead wood habitat. However, DecAID does not provide management recommendations and it has several caveats and short-comings that need to be considered. For instance, DecAID snag levels for “unharvested” stands represent snags levels from a world where disturbances (e.g. fire, insects, disease) are artificially suppressed. “DecAID is NOT: … a snag and down wood decay simulator or recruitment model [or] a wildlife population simulator or analysis of wildlife population viability. … Because DecAID is not a time-dynamic simulator … it does not account for potential temporal changes in vegetation and other environmental conditions, … DecAID could be consulted to review potential conditions at specific time intervals and for a specific set of conditions, but dynamic changes in forest and landscape conditions would have to be modeled or evaluated outside the confines of the DecAID Advisor.” Marcot, B. G., K. Mellen, J. L. Ohmann, K. L. Waddell, E. A. Willhite, B. B. Hostetler, S. A. Livingston, C. Ogden, and T. Dreisbach. In prep. “DecAID -- work in progress on a decayed wood advisor for Washington and Oregon forests.” Research Note PNW-RN-XXX. USDA Forest Service, Pacific Northwest Region, Portland OR. (pre-print) http://wwwnotes.fs.fed.us:81/pnw/DecAID/DecAID.nsf/HomePageLinks/44C813BC574BDFCC88256B3E006C63DF. The “unharvested” inventory data used in DecAID may represent but a snapshot in time, and fail to capture the variability of dead wood over time, including the pulses of abundant dead wood that follow disturbances and may prove essential for many wildlife species. The tolerance levels from DecAID may be too low to support viable populations of wildlife associated with dead wood, because anthropogenic factors that tend to reduce snags (e.g., firewood cutting, hazard tree felling, fire suppression, and salvage logging) may have biased the baseline data that DecAID relies upon to describe “natural” conditions. See Kim Mellen, Bruce G. Marcot, Janet L. Ohmann, Karen L. Waddell, Elizabeth A. Willhite, Bruce B. Hostetler, Susan A. Livingston, and Cay Ogden. DecAID: A Decaying Wood Advisory Model for Oregon and Washington in PNW-GTR-181, citing Harrod, Richy J.; Gaines, William L.; Hartl,

William E.; Camp, Ann. 1998. Estimating historical snag density in dry forests east of the Cascade Range. PNW-GTR-428. http://www.fs.fed.us/pnw/pubs/gtr_428.pdf DecAID is still an untested new tool. The agencies must conduct effectiveness monitoring to determine whether the snag and down wood retention recommendations in the DecAID advisor will meet management objectives for wildlife and other resource values.

Public Comment #4

The [omitted] Watershed Council thanks you for the opportunity to review and comment on science reviews that INR has conducted on the body of science that the Oregon Department of Forestry considered in developing forest management plans – and in particular species of concern – and the Board of Forestry State Forests Performance Measures.

We are not able to offer any substantive comments on the panel's comments and recommendations; our expertise is not sufficient to add to the panel's valuable report.

That said, we have examined the report, and recommended our members read the report. Our Council frequently relies on scientific data and analyses in order to make choices affecting protection and restoration activities in the [omitted]. We are appreciative of the work that the INR panel has done in identifying and evaluating key issues related to the quality and reliability of scientific data and analyses. The questions raised by the panel are instructive for all those who rely on a sound scientific basis for their decisions. We see this panel's report as an important educational tool for us to use in future science-reliant choices **and believe that it will provide guidance for forestry managers in gathering the types of information needed to make good decisions**

Public Comment #5

On behalf of the [omitted] Executive Committee, we are writing in regards to the Oregon Department of Forestry Science Review Project. The [omitted] Executive Committee would like to recognize the importance of the Institute for Natural Resources' Science Advisory Team's independent review of ODF's "The Influence of Modeled Management Scenarios on Habitat for Species of Concern" and "The Board of Forestry's State Forests Performance Measures" reports. The [omitted] Executive Committee feels that the application of the best available science and scientific models provide the most efficient and effective efforts towards endangered species recovery and the restoration of watershed health in general.

Appendix D
Table 2 of the SOC Analysis

Limiting Factor	Surrogate for Limiting Factor	Assumptions	SOC
Amount Late-successional forest (1)	**Amount of landscape in Complex Structure** (percent LYR + OFS)	Complex structure stands will provide habitat components (e.g., large trees, snags, downed wood, closed canopy, canopy layering, etc.) needed for suitable habitat for the affected species.	American Marten Hoary Bat Red Tree Vole Spotted Owl Olive-sided Flycatcher
Amount Late-successional forest (2) Amount of large nesting trees	**Percent of Landscape in older forest** (> 100 years old) **Evaluated within 35 miles of the ocean for Marbled Murrelet	Complex stands need to be present on the landscape for an extended period of time to develop large diameter and large branch structure required for nesting by marbled murrelets and bald eagles. This metric provides an indicator of acres in this older condition.	Marbled Murrelet** Bald Eagle Osprey
Amount of snags and downed logs	**Amount of Landscape in Older Forest Structure** (percent OFS)	Targets for amounts of snags and downed wood are higher for OFS than for other structural stages in the FMP. Using only OFS to model snags and logs will underestimate overall habitat (snags and logs will occur in other structural classes), but the amount of OFS will reflect differences between models for areas with expected high abundance of snags and downed logs.	California Myotis Fringed Myotis Long-legged Myotis Silver-haired Bat Clouded Salamander
Fragmentation/ Patch Size	**Number of Complex Structure Patches** (> 120, 200, 520, or 2180 acres)	Larger patches provide more interior habitat. Larger patches are less susceptible to edge effects (microclimate, nest depredation). For red tree vole, larger patches are more likely to provide for self-sustaining populations.	American Marten Red Tree Vole Marbled Murrelet Spotted Owl
Fragmentation/ Limited Dispersal Ability	**Acres < 20 years old**	Stands < 20 years old represent a barrier to movement and/or dispersal	American Marten Red Tree Vole
Limited Dispersal Ability (aquatic environments)	No model surrogate	Not Analyzed	Coastal Tailed Frog, Columbia Torrent Salamander
Availability of cavities (in forest openings)	No model surrogate	Not Analyzed	Western Bluebird Purple Martin
Amount of shrub habitat	No model surrogate	Not Analyzed	Little Willow Flycatcher

Limiting Factor	Surrogate for Limiting Factor	Assumptions	SOC
Disturbance at nest/roost sites	No model surrogate	Not Analyzed	Peregrine Falcon, Townsend's Big-eared Bat
Reductions in quality and quantity of mineral springs	No model surrogate	Not Analyzed	Band-tailed Pigeon
Changes in water level (ponds, etc.), road kill, recreational impacts	No model surrogate	Not Analyzed	Western Toad
Watershed Function (1): Hydrology, Water Quality, Wood Recruitment	**Complex Forest Structure** at the landscape level and in AAWs; at current, 20, 40, and 80 years.	Watersheds with greater percent of complex structure are beneficial for watershed functions such as large wood recruitment and stream temperature.	Coho, Chum, Fall Chinook, Spring Chinook, Coastal Cutthroat, Winter Steelhead, Western Brook, and Pacific Lamprey
Complex Fish Habitat	**Complex Forest Structure** at the landscape level and in AAWs; at current, 20, 40, and 80 years. **Current Condition**	Increasing complex forest structure in watersheds will increase probability to provide large trees for instream complex habitat. Data from watershed analyses, Coho Assessment, OCCP on current habitat condition	Coho, Fall Chinook (especially in larger rivers)
Watershed Function (2): Water Quality (stream temperature), Wood Recruitment	**Cumulative Clearcut** harvest in two 40-year time frames in AAWs.	Watersheds with a range of cumulative clearcut acreage present a range of risks to watershed function -based on Pollock et al. (2009) and Reeves et al. (1993)	Same as above
Hydrology	**Stand less than 20 years** in AAWs; at current, 20, 40, and 80 years.	If stands less than 20-years exceeds 30% of the watershed area there is a risk to increasing small peak flows (<5 year return period) based on Grant et al (2008).	Fall Chinook, Spring Chinook, Coastal Cutthroat, Winter Steelhead,
Riparian Function: Large Conifer trees in riparian areas, wood recruitment, shade	**Amount of clearcut and thinning harvest in riparian areas** for AAWs and Management Basins; at 5, 20, 40 and 80 years.	Greater harvesting within 100 feet of streams risks a reduction in overall wood recruitment in small streams and increases in stream temperature. Risk ranking of High, Moderate, and Low based on Pollock (2009)	Coho, Fall Chinook, Spring Chinook, Coastal Cutthroat, Winter Steelhead, Western Brook and Pacific Lamprey.

Limiting Factor	**Surrogate for Limiting Factor**	**Assumptions**	**SOC**
Water Quality: Summer stream temperature	**Amount of clearcut and thinning harvest in riparian areas** for AAWs and Management Basins; at 5, 20, 40 and 80 years.	Greater harvesting within 100 feet of streams may increase stream temperature. Risk ranking of High, Moderate, and Low based on Pollock (2009). Wider buffers maintain amphibian species richness and higher abundance for some stream amphibians (Stoddard and Hayes 2005, Vesely and McComb 2002).	Coho, Fall Chinook, Spring Chinook, Coastal Cutthroat, Winter Steelhead, Western Brook and Pacific Lamprey, Cope's Giant and Columbia Torrent Salamander, Tailed Frog
Water Quality: Sediment, delivery and retention of large clean spawning gravels	**Hydrologic Connectivity:** Current Condition Only, no model surrogate	Data from watershed analyses on road connection to streams (hydrologic connectivity). Assume greater connectivity between roads and streams equates to greater sediment delivery to streams.	Coho, Fall Chinook, Spring Chinook, Coastal Cutthroat, Winter Steelhead, Western Brook and Pacific Lamprey, Cope's Giant Salamander, Tailed Frog
Habitat: Resting holes	No model surrogate	Not Analyzed	Coastal Spring Chinook
Fish Passage	**Percent of crossings that don't pass fish:** Current condition only, no model surrogate –	Data from watershed analyses on current barriers	Coho, Chum, Fall Chinook, Spring Chinook, Coastal Cutthroat, Winter Steelhead, Western Brook Lamprey, Pacific Lamprey, and Cope's Giant Salamander
Stream Habitat Fragmentation	No model surrogate	Not Analyzed	Same as above
Population Isolation	No model surrogate	Not Analyzed	Same as above
Estuarine and Marine Conditions	No model surrogate for estuaries, forest management has little influence on marine conditions	Not Analyzed	Coho, Chum, Fall Chinook Spring, Chinook Coastal, Cutthroat, Western Brook and Pacific Lamprey
Hatchery and Fish Harvest Interactions	No model surrogate, forest management has little influence	Not Analyzed – Under the Oregon Plan, changes in hatchery management that influences listed species is reviewed by NMFS. OCCP	Coastal Spring Chinook
Dredging Rapid Water Withdrawals	No model surrogate, forest management has little influence	Not Analyzed	Western Brook and Pacific Lamprey