Independent Multidisciplinary Science Team (IMST)

State of Oregon

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Dear Mike and Jim,

In response to your June 4, 2010 letter, the Independent Multidisciplinary Science Team (IMST) reviewed the Elliott State Forest draft Habitat Conservation Plan (HCP) and draft Environmental Impact Statement (DEIS). Your initial request also included the draft Elliott Forest Management Plan as part of the review, but in the interest of time and expediency the IMST did not review this document. The IMST focused the review on the scientific underpinnings of the draft HCP and DEIS regarding stream temperature, large wood recruitment, slope stability, and fine sediment delivery to streams via roads. The IMST did not consider social, legal, or management constraints related to management of riparian resources on the Elliott State Forest. These are policy issues that affect the application of scientific knowledge on the Forest, not the fundamental scientific basis of how management can impact riparian area functions, instream conditions, and salmonid populations. The IMST has no view, neither agreeing with nor disputing, on any of the proposed actions for the Elliott State Forest. IMST also does not assume that results and conclusions would have been different if a different or more rigorous analytical approach had been used.

The attached review addresses whether the DEIS's approach and analyses are credible and consistent with scientific standards and if the DEIS's assumptions are supported by best available science. In general, the IMST was unable to fully assess the scientific rigor and underpinnings of the DEIS analyses. The reasons for this are discussed in detail in the attached review.

IMST recognizes that research on riparian buffer management in the Pacific Northwest is still in its infancy and modeling is often used in environmental impact analyses. Until more empirical evidence is available for a wide range of forest conditions in Oregon, it is important that analytical assumptions based on professional opinion or limited case studies, and uncertainties related to model results are clearly stated and fully described in environmental impact analyses.

Please let us know if you have any questions or need clarification on the IMST's review. We would also be happy to discuss this review with you at an upcoming IMST meeting or with the Board of Forestry and/or the State Land Board at one of their meetings.

Sincerely,

Carl Schreck
IMST Co-Chair

Nancy Molina
IMST Co-Chair

cc: Louise Solliday, DSL
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IMST Review of the
Draft Elliott State Forest Habitat Conservation Plan
and
Draft Environmental Impact Statement: The Proposed Issuance of an Incidental Take Permit for the Elliott State Forest Habitat Conservation Plan
(August 2008 *drafts*)

Released on October 6, 2010

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Review Preparation: This review was prepared by the IMST based on an initial draft by an IMST subcommittee (Nancy Molina and Michael Harte with Kathy Maas-Hebner providing technical support). The subcommittee discussed the documents and review process at its March 12, 2010 public meeting. Nancy Hirsch (ODF) and Michael Cafferata (ODF) presented the agencies review request and discussed the draft documents at the IMST's January 27, 2010 public meeting. The IMST discussed the review at its March 31, July 26, and August 13, 2010 public meetings. The IMST discussed and adopted the final review at its September 20, 2010 public meeting. (Bob Hughes and Vic Kaczynski were absent from the vote to adopt.)

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Acronyms

BLM	Bureau of Land Management (US)
DEIS	Draft Environmental Impact Statement
DSL	Department of State Lands
HCP	Habitat Conservation Plan
IMST	Independent Multidisciplinary Science Team
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Agency
ODEQ	Oregon Department of Environmental Quality
ODF	Oregon Department of Forestry
ODFW	Oregon Department of Fish and Wildlife
OSU	Oregon State University
RAIS	Riparian Aquatic Interaction Simulator
RMA	Riparian management area
TMDL	Total maximum daily load
Type N	Non-fish-bearing streams
Type F	Fish-bearing Streams
USEPA	US Environmental Protection Agency
US	United State of America
VTS	View-to-Sky model
WDNR	Washington Department of Natural Resources
WFPB	Washington Forest Practices Board
WOPR	Western Oregon Plan Revision (Bureau of Land Management)

Introduction

The Independent Multidisciplinary Science Team (IMST) reviewed portions of the August 2008 draft documents titled *Draft Elliott State Forest Habitat Conservation Plan* (hereafter the draft HCP) and the *Draft Environmental Impact Statement: The Proposed Issuance of an Incidental Take Permit for the Elliott State Forest Habitat Conservation Plan, Volumes I and II* (hereafter the DEIS) in response to a request from the Oregon Department of Forestry (ODF) and the Department of State Lands (DSL; letter from Mike Cafferata (ODF) and Jim Paul (DSL) dated June 4, 2010)[1]. Our review focused on the question of whether the conclusions and assertions of likely affects of implementing the Proposed Action of the draft HCP were adequately supported by the DEIS analysis.

IMST's review considered whether best available science and methods were used, whether uncertainty and variation were adequately characterized, and whether the data and models used were relevant to ecosystems typical of the Elliott State Forest. Our review does not address how implementation of the Proposed Action might affect salmonids, whether a different management strategy might provide better protection, or how likely the Proposed Action is to result in achievement of the desired future conditions. We focused on the strengths and weaknesses of the analysis, and how they might affect the assertions made in the DEIS about the effects of the Proposed Action.

Specifically, the IMST reviewed the riparian area management guidelines of the Elliott State Forest Proposed Action (Alternative 2), on which the draft HCP management strategy is based with respect to four topic areas of concern discussed in federal agency correspondence to ODF about and reviews of the draft HCP and DEIS. A summary of these guidelines, along with those of several other federal and state land management agencies are shown in Appendix B. The topics reviewed by IMST were:

- Stream temperature,
- Large wood recruitment,
- Slope stability and risk of landslides/debris flows to streams, and
- Roads and fine sediment delivery to streams.

As preparation for the review IMST studied correspondence[2] provided by DSL. A subcommittee of the IMST met with staff from NOAA Fisheries, National Marine Fisheries Service (NMFS),

[1] The agencies also asked that IMST review the 2006 Draft Elliott Forest Management Plan, but in the interest of time and expediency, the IMST focused on the draft HCP and DEIS.
[2] Letter dated March 23, 2009 from Jim Young (ODF, Coos Bay, OR) to Ken Phippen (NMFS, Roseburg, OR)

and ODF on April 7, 2010 to clarify agency concerns about the draft HCP and DEIS. The subcommittee later met with NOAA Fisheries and NMFS staff on April 16, 2010 to follow up on their scientific concerns about the DEIS analysis. The subcommittee also met with ODF and DSL staff on June 2, 2010 to discuss the approach that was used to develop the draft HCP and the analyses used for the DEIS. While IMST consulted state and federal agency staff for further clarification of the issues, the IMST has approached the review from an impartial point of view and does not endorse any position(s) of the state or federal agencies with respect to management of riparian areas on the Elliott State Forest.

This review addresses whether the DEIS approach and analyses regarding the four topic areas listed above are credible and consistent with accepted scientific standards, whether draft HCP and DEIS assumptions are supported by best available science, and whether uncertainties are characterized adequately. IMST does not offer opinions or judgment on whether or not proposed actions, should they be implemented, would lead to protection or improvement of aquatic habitat or salmonid populations on the Elliott State Forest. IMST also does not intend to imply that alternative scientific analyses or explanations would necessarily lead to conclusion or actions different than to those proposed in the Plan.

This review presents IMST's key findings followed by several overarching issues that encompass all four topic areas. Next, detailed comments on each topic area are presented. Because of the approach taken by IMST on this review, the level of detailed review incorporated into each topic area varies. This approach was taken to expedite the review.

Key Findings

The general findings, followed by topic area findings, of the IMST are:

- We find that the basic framework of the HCP is consistent with recent science based approaches for sustaining ecological structure and function at a landscape scale, although the IMST did not review the science underpinnings of the overall forest management strategy for the HCP
- For the four topic areas reviewed by IMST (i.e., stream temperature, large wood recruitment, slope stability, and roads), we found that in some instances multi-scale analyses would have provided a better basis for understanding the effects of the Proposed Action. A landscape approach is by nature coarse-grained, and greater specificity at finer scales in some cases provides more robust information. We therefore suggest that a multi-scale approach, that more explicitly tiers finer-scale analyses to the overall landscape strategy would strengthen the confidence in the conclusions regarding the effects of the Proposed Action.

Letter dated July 21, 2009 from Dr. Kim Kratz (NMFS, Portland, OR) to Jim Young (ODF, Coos Bay, OR)
Letter dated July 27, 2009 from Jim Young (ODF, Coos Bay, OR) to Dr. Kim Kratz (NMFS, Portland, OR)

- At times, the effects discussion for the Proposed Action assumes, without sufficient supporting analysis, that small increments of change will have insignificant impacts. Depending on where and when they occur, small changes in stream temperature or landslide risk are not necessarily trivial.
- The DEIS does not clearly differentiate when conclusions are based on professional opinion or modeling rather than empirical evidence. In some cases this lack of description masked the fact that some of the models used may not be appropriate to the Oregon Coast Range.
- The documents reviewed lack sufficient discussion of uncertainty of conclusions, possible alternative outcomes, and variability in data and modeling results. Without this discussion, there is undue confidence in the conclusions of the analyses. Although there is provision for adaptive management, if the predicted results of the Proposed Action do not occur, there is no clear plan for monitoring trends, or for changing course if it found to be necessary to do so.
- A discussion of the lack of scientific consensus on management of riparian areas (e.g., buffer widths, desired conditions, and disturbance) at reach and watershed scales would provide needed context to the draft HCP riparian area management guidelines. The fact that various research studies have shown different results for effects from the manipulation of streamside vegetation is critical to understanding the uncertainty surrounding the effects of implementing the Proposed Action.
- The use of literature to assess the effects of the Proposed Action and alternatives could be improved. Additional relevant research has been published since the draft HCP and DEIS were written. In some cases, the documents cite literature that is not especially relevant to the Elliott State Forest. And many resources were cited that were difficult or impossible to find because they were either unpublished reports, conference abstracts, or lacked adequate citation information.

Stream Temperature

- There is little empirical data on the effects of riparian area thinning on stream temperature, especially at larger scales. While ongoing studies such as ODF's RipStream study and the Density Management Study on federal lands are beginning to provide useful information, a significant body of literature already available on this topic is not incorporated into the draft documents.
- The sparse documentation of the effects analysis methods for stream temperature made it difficult to evaluate. There are weaknesses in the approach used for modeling stream temperature in the DEIS, which undermine the confidence in the conclusions. The View-to-Sky model has potential problems for application in Oregon, and the overall structure of the analysis, relying on a logic train rather than an explicit analysis for determining the effects of the Proposed Action, also has weaknesses. Other models more widely used in Oregon such as the HeatSource model are available, may provide a greater degree of

rigor, and be more amenable to the use of local data. Where different models would produce different conclusions than those in the DEIS is unknown.

Large Wood Recruitment

- The analysis of potential large wood recruitment appears weak and has several possible flaws that should be examined at a closer level. The analysis relies on an unpublished paper examining wood recruitment in young, commercial forests in the Washington Cascade Mountains. Some modeling results were taken from the Elliott watershed analysis (Biosystems *et al.* 2003) and incorporated into the DEIS analysis which also appear to have several analytical flaws that were not disclosed in the DEIS.
- Several assumptions used in the large wood recruitment analysis (e.g., influence on thinning on windthrow rates) appear to be based on professional opinion rather than empirical evidence. The use of professional opinion was not disclosed in the DEIS.

Slope Stability:

- The aggregation of impacts at the extent of the Elliot State Forest as a whole may lead to an imprecise estimation of impacts of increased timber harvest on soil and slope stability for individual watersheds, basins and Type N and Type F streams.
- The creation of a landslide initiation risk index and its interpretation results in potentially misleading statements regarding the perceived small increase in risk of landslides and debris flows from increased timber harvests under Alternatives 1 through 3.
- Overall, limited quantitative analysis, use of limited literature, potentially inaccurate statements about the change in landslide risk, and use of a landscape level of analysis means that few scientific supported conclusions can be drawn about the effectiveness of proposed management measures to control the negative sediment related impacts of harvest on fish and their habitats under any of the alternatives presented.

Roads:

- Although the increase of roads on steep slopes over the next 50 years will be only four miles, the assumption that following best management practices in the draft HCP and the *Forest Roads* Manual will mean minimal impacts on fish and their habitats is not based on any primary analysis or scientific literature.

Overarching Issues

Need for Multi-scale Analysis

ODF has adopted a landscape level approach to managing state forests. The inclusion of such features as emulating natural forest vegetation patterns, diversity of structural elements in a dynamic mosaic, and biological refugia, all with the goal of creating ecosystem resiliency, are consistent with the principles and current "state of the science" of landscape ecology. We did not evaluate whether or not the specifics of the Proposed Action (e.g., the amounts and distribution of age classes and structural stages though time, placement of reserve areas) are consistent with the intrinsic ecology of the Elliott State Forest, nor did we assess the likelihood that implementing the Proposed Action will result in the desired future conditions. Nevertheless, we commend ODF for taking this forward-thinking approach to management state forest lands in Oregon.

The landscape level approach appears to rely on the agency's interpretation of IMST's earlier reports (see IMST 1999, 2002). The IMST still believes that maintaining the integrity of aquatic and riparian structures and processes across the landscape is an important management goal, and agrees that the overall draft HCP does attempt to do so; however, the analysis included in the DEIS (or at least how it was presented) is not sufficient to conclude with certainty that the goals of the draft HCP would actually be met, or that monitoring and adaptive management are sufficient to make course corrections when necessary. While a landscape level approach is desirable, the IMST cannot, without better documentation of effects at finer scales, determine whether or not that the specific approach that ODF is proposing will succeed in protecting and enhancing riparian conditions and processes or salmonids on the Elliott State Forest.

A landscape approach does not preclude the use of watershed or stream reach approaches. The landscape is not homogeneous and many environmental or ecological processes operate at a continuum of scales; therefore, both broad and local scale approaches can and should be used in concert. For example, Oregon Coast Range-specific literature on landslide initiation and debris flows suggests that spatial heterogeneity may make landscape level approaches not appropriate for developing of management measures to protect aquatic habitat. For examples of watershed level analyses see Benda *et al.* (2007) and Miller & Burnett (2007).

Presentation of Uncertainty

The IMST finds that there is significant uncertainty arising from both the state of the science and the analytical methods used in the analysis of effects of timber management on stream temperature, large wood recruitment, slope stability, and fine sediments from roads. These uncertainties are not fully discussed in either the DEIS or the draft HCP. The result of this is a portrayal of a greater level of assurance in the effects analysis than we believe is warranted. In general, the DEIS provides little information on the variation associated with the data or model predictions that are provided in the figures and tables. Without knowledge of variation, there is no way for the IMST to judge the scientific accuracy and precision of conclusions made by the authors from these data and model predictions. Additionally, the DEIS and draft HCP do not clearly identify when professional opinion is used rather than empirical evidence (see discussion on Liquori (2004) and Andrus & Froehlich (1988) on pages 19–20 of this review). Within the documents, opinion and research-based conclusions are not always sufficiently differentiated.

The documents as written leave the impression that authors of the DEIS are exceptionally confident in conclusions derived from professional opinion and modeling. This leaves the reader with an overly-optimistic impression that proposed management actions will be funded, implemented, monitored, and will result in achieving desired future conditions in aquatic and riparian ecosystems on the Elliott State Forest. The IMST believes that there are numerous uncertainties, of various degrees, associated with the contentions presented in the DEIS and draft HCP. These uncertainties may be statistical in nature (e.g., quantitatively determined 95% confidence bounds around an estimate of current abundance or productivity) or may simply reflect the confidence the authors have in parameter values determined by expert opinion or modeling efforts. Where practical, uncertainty should be documented

Adaptive Management Planning

The draft HCP (Section 11.2, page 11-12 and elsewhere) makes adaptive management a key forest management practice. For example on page 11-12 the HCP states:

> *Long-term, landscape-scale forest management is challenged by the dynamic, natural system within which it is conducted (the forest) and the limited scientific knowledge and modeling capabilities available to inform decision-making. These uncertainties can be addressed through the ongoing application of adaptive management. … In recognition of the uncertainties inherent in the proposed management strategies, the HCP will be implemented using an adaptive management approach; thereby allowing the ODF to evaluate and modify strategies to ensure the continued achievement of the HCP's conservation objectives."*

While we fully support the notion of adaptive management, it is difficult for the IMST to assess the strength of the case that the draft HCP will achieve stated objectives if the document only refers to adaptive management but does not provide an actual strategy for monitoring, evaluation, and implementation. In general, the Plan's adaptive management approach assumes that if and when a situation arises where alternative actions may be required an appropriate 'plan-B' will be formulated. This assumption and approach represent weak points in ODF's ability to make a strong case that the draft HCP will lead to improved riparian and aquatic ecosystem conditions. Additionally, the draft HCP and DEIS indicates that monitoring and evaluation will inform the adaptive management process, however, there is no mechanism or monitoring plan described to demonstrate if adequate monitoring will occur over the life of the final HCP. Nor do the documents indicate that there is adequate baseline data available for future assessments. Based on the Elliott watershed analysis (Biosystems *et al.* 2003) and the DEIS, we are not confident that an adequate baseline exists for ODF to be able to detect environmental changes in the forest. An explicit adaptive management plan should include a detailed description of how trends will be tracked by the agency, and the specific criteria and endpoints that the agency will use to determine when population or environmental trends have significantly diverged from desired status such that a new status assessment or suite of actions would be implemented, and specification of management actions given probably scenarios.

Citations and Studies Used in the Analysis

The body of literature on buffers, stream temperature, large wood recruitment, sediment delivery from landslides and debris flows associated with logging, road construction and buffer strip efficacy has become larger and more diverse since the draft HCP and DEIS were completed. For example, recent extensive peer-reviewed work by Burnett *et al.* (2006), Burnett & Miller (2007), and Miller & Burnett (2007) is specific to the Oregon Coast Range and therefore germane to the draft HCP. Importantly, this newer work (e.g. Benda *et al.* 2007; Frattini *et al.* 2010) provides an analytical basis for the analysis of slope stability at the basin and reach level that should inform the DEIS and draft HCP. Other recent references are cited in the body of this review.

IMST's first step in this review was to identify and locate references used in the draft HCP and DEIS to determine the applicability of the information to the documents and the impacts analyses. In several instances the draft HCP and DEIS authors cited references that were not available for review. Workshop abstracts were cited that did not include sufficient detail to determine the applicability of the research to DEIS analyses. Some were not listed in the reference list and their applicability to the DEIS could not be determined. Others reported on research from regions very dissimilar to the Oregon Coast Range and the applicability of these to the draft HCP or to the DEIS analyses was not established by the documents' authors. IMST did not have resources to check all references listed in the draft HCP or the DEIS, however, Appendix A lists references that we did check as part of the IMST's overall review and could not confirm.

Specific Comments

Stream Temperature

This review focuses on the analytical framework used to predict the effects of the Proposed Action on stream temperature, based on Sections 3.3.2.4, 4.3.2, and Appendices A-1 and A-2 of the DEIS, and Sections 8.4, D.3.3, D.4 and Appendix I of the draft HCP, along with additional information provided by R2 Resources Consultants, Inc.[3] who performed the analysis. Data quality and the validity of the desired future conditions for shade and temperature were not reviewed by IMST.

Relationship between Buffers and Stream Temperature

Presently, there is no scientific consensus regarding the "best" buffer widths or the relationship between buffer widths and stream temperatures, which is, in part, reflective of the variability across landscapes and management scenarios (e.g., IMST 2004; Moore *et al.* 2005; Gomi *et al.*

[3] June 17, 2010 Chapter 3 – Technical Memorandum (Project 1487.08) from Ron Campbell (R2 Resources Consultants, Inc., Redmond, WA) to Jim Young, Liz Dent, and John Runyon (12 pages plus spreadsheets).

July 2, 2010 Chapter 4 – Technical Memorandum (Project 1487.08) from Ron Campbell (R2 Resources Consultants, Inc., Redmond, WA) to Jim Young, Liz Dent, Mike Cafferata, and John Runyon (15 pages plus spreadsheets).

2006). NMFS has considered this issue sufficiently complex to propose a scientific panel be convened to advise land management and regulatory agencies on buffer/stream temperature relationships[4]. Using a combined "weight of evidence" and precautionary approach, most large land management agencies in the Pacific Northwest have adopted strategies of minimally disturbed buffers, often based in some way on site potential tree heights (see Appendix B). The BLM's Western Oregon Plan Revision (WOPR) Proposed Action is most similar to the Elliott State Forest Proposed Action. (The WOPR was withdrawn from further consideration by BLM. ODEQ[5], USEPA[6], and the interagency WOPR Science Team[7] expressed concerns about stream temperature under the WOPR Proposed Action). Most other Pacific Northwest strategies have either wider buffers, or less timber removal allowed in riparian management areas, or both. This is not to imply that IMST endorses or prefers any agency's specific riparian management strategy, but rather refer to them to highlight the current state of the science and that thinning in riparian areas are controversial.

The authors of the DEIS allude to this lack of consensus in Appendix A of the DEIS, but seem to give greater credence to studies that support narrower buffers. However these references are not applicable to forest conditions in the Oregon Coast Range:

- Barton *et al.* (1985) conclusions are drawn from studies in agricultural lands within the mixed-wood area of southern Ontario, Canada.
- Davies & Nelson (1994) conclusions are drawn from eucalypt forests in Tasmania, and relied on only single temperature readings. Even though the study showed stream temperature to be relatively unaffected with buffers greater than 10 meters wide, the authors recommend buffers of at least 30 meters to protect the full suite of riparian ecological functions and impacts to streams. These authors also noted the greater likelihood of windthrow in riparian buffers in the northwestern US in contrast to their Australian sites.
- Brazier & Brown (1973) is based on a small non-random sample, and lacks pre-treatment data; the comparisons of the shade/temperature relationships are in space, not in time. There was significant variability among the structural characteristic (and presumably ages) of stands studied, and in their results relating heat loading to canopy density, a high R^2 value was obtained by ignoring outlying data points.

Other authors have shown results at odds with the above cited studies, including Steinblums *et al.* (1984), Gomi *et al.* (2006), and Brosofske *et al.* (1997), and a summary of this issue in USEPA comments[8] to BLM's WOPR.

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[4] Memorandum dated July 23, 2010 from Dr. Kim Kratz (NMFS, Portland, OR) to Dr. Nancy Munn (Co-Chair Interagency Coordinating Subgroup, NMFS, Portland, OR) (85 pages).
[5] Michie, R (2007) Evaluation of the Western Oregon Plan Revision (WOPR) – Draft Environmental Impact Statement (DEIS) Alternatives for Stream Temperature. Water Quality Division. Oregon Department of Environmental Quality.
[6] http://www.blm.gov/or/plans/wopr/files/EPA_Comments.pdf (accessed Sept 10, 2010)
[7] http://www.bl m.gov/or/plans/wopr/files/Science_Team_Review_DEIS.pdf (accessed Sept. 10, 2010)
[8] http://www.blm.gov/or/plans/wopr/files/EPA_Comments.pdf (accessed Sept 10, 2010)

Applicable Research

In general, there is a lack of scientific data available to empirically evaluate the likely stream temperature effects of the Proposed Action (Alternative 2). There is also a lack of consensus among scientists regarding the relationships between buffers and stream temperature, and results among studies have not been consistent. Most field studies of buffers involve unmanaged buffers adjacent to clear-cuts (not thinnings), and have varying results (e.g., Allen & Dent 2001; Moore *et al.* 2005; Gomi *et al.* 2006). A small number of field studies are applicable to assessing ODF's Proposed Action:

- Pre-treatment results of the ODF RipStream study were published (Dent *et al.* 2008), and early post-treatment results, which are relevant to the Elliott State Forest and reflective of the current management on the Forest, will soon be published[9]. Two of the 15 state-managed sites (33 sites total in study) in the RipStream study are on the Elliott State Forest[10]. These early post-treatment results indicated that state forests harvested under Northwest Oregon State Forest Management Plan (ODF 2001) standards did not change the "Protecting Cold Water" criterion exceedence rate after harvest. (The Protecting Cold Water criterion of < 0.3º C increase above ambient temperature is used in waters that have summer seven-day-average maximum ambient temperatures that are colder than the biologically based numeric criteria[11]). Neither the draft HCP or DEIS present enough information to determine how many of the Elliott State Forest streams fall under the Protecting Cold Water criterion or how many would fall under more restrictive criteria such as those in the Umpqua TMDL (1º C increase), therefore we cannot determine how applicable the RipStream findings are across the Forest.

  Initially, the RipStream project measured reach-scale temperature effects. In the near future, the authors intend to include additional parameters (such as channel morphology) and to evaluate effects of multiple harvest entries in watersheds over time. This will greatly enhance the utility of the research for multi-scale evaluation.

- In the Density Management Study on federal lands in the Oregon Coast and Cascade Range forests (Anderson *et al.* 2007), a management strategy similar to the Proposed Action (9-meter unmanaged buffer, with the adjacent area of unknown width thinned to 80 trees per acre) resulted in similar microclimate readings among stream, buffer, and thinned upland (a fairly uniform gradient); in other words, the streamside environment became more similar to that of the adjacent thinning and upland. The measured amounts of visible sky and air temperature were higher than unthinned stands (visible sky was about 6% greater), and daily maximum air temperature and daily minimum relative humidity at stream center were considered to be "extreme" compared to other treatments. The authors of this study conclude: "*The effectiveness of narrow, streamside retention buffers in moderating stream microclimate from harvest effects is questionable*" (p. 265,

[9] Groom JD, Dent L, Madsen LJ (*in revision*) Stream temperature change detection for state and private forests in the Oregon Coast Range. Water Resources Research.
[10] Jeremy Groom (OSU). Personal communication. September 13, 2010.
[11] ODEQ Oregon Administrative Rules Protecting Cold Water (OAR 340-041-0028(11) and biological criteria referenced in the Protecting Cold Water standard OAR 340-04100028(4)).

Anderson *et al.* 2007). Wider streamside buffers in this study appeared more protective of the stream microclimate. It is uncertain how the observed differences in microclimate and visible sky would translate to stream temperature effects, because stream temperatures were not measured in this study[12]. However, the fact that stream temperatures can be affected by the microclimate of adjacent areas was noted by DEQ in the development of the Umpqua TMDL (ODEQ 2006).

- In a study of young Douglas-fir (30–33 years) stands in the upland areas of the Siuslaw National Forest, Chan *et al.* (2006) found that thinning to roughly the density prescribed by the Proposed Action resulted in an almost 30% increase in skylight that lasted almost 5 years before leveling off at about 20%. However, these thinnings were not adjacent to unmanaged riparian buffers, so effects to stream shading were not evaluated.

Stream Temperature Models

Because there is a lack of empirical studies on riparian buffer thinnings similar to those proposed in the draft HCP and stream temperature responses, the conclusions regarding the likely effects of the Proposed Action rest largely on assumptions, modeling, inferences, and extrapolations. Shade is assumed to be the dominant factor affecting stream temperature in the analysis of the Proposed Action

Temperature models use different variables and measurement methods, and therefore often result in different predicted temperature values, even where inputs are the same (see comparison of different temperature models in Sullivan *et al.* 1990). For this reason, such models are best used to make comparisons between alternatives, and are less reliable at predicting actual stream temperatures. If models are used, a good approach would be to use modeling methods commonly used in Oregon, such ODEQ's HeatSource model which is used in TMDL development. Because the modeling methods used for the Elliott State Forest do not appear as rigorous as HeatSource and are not commonly used in Oregon, it is difficult to place the results in context or evaluate them in light of other temperature results.

The analytical approach assumes that because Elliott streams are low in gravels, the hyporheic zone has little effect on temperature, and therefore shade is the dominant factor controlling stream temperatures. This assumption on the effects of low gravel amounts appears to be largely based on professional opinion stated in the Elliott State Forest Watershed Analysis conducted by Biosystems *et al.* (2003)[13] and does not account for streams dominated by bedrock channels (as on the Elliott) that are not expected to have hyporheic zones similar to gravel-dominated beds. This assumption is not a sufficient basis for dismissing other important influences on steam temperature and the effectiveness of riparian buffers on aquatic ecosystems. Riparian buffers

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[12] In recent years, the Density Management Study has begun measuring stream temperatures. Results have not been published as of this date (2010 personal communication, Dr. Paul Anderson, USDA Forest Service).

[13] Page 5-20 (Biosystems *et al.* 2003) "*The current scarcity of gravel in Forest streams (due in part to the removal of large wood) could be causing streams to be warmer than normal*" and Page 3.3-21 of draft EIS "T*he current scarcity of gravel in action area streams (due in part to the removal of large wood and a prevalence of channels scoured to bedrock) could be causing streams to be warmer than normal (Biosystems et al. 2003)*."

also affect large wood recruitment from windthrow, which can be substantial (e.g., Steinblums *et al*. 1984; Allen & Dent 2001); soil temperature changes resulting from canopy removal, both near-stream and basin-wide (e.g., Brosofske *et al.* 1997; Johnson & Jones 2000); and the potential for stream morphological changes with the loss of large instream wood (Bilby & Bisson 1998). The confidence in the stream temperature assessment would increase by addressing these and other parameters such as topography, stream geometry, discharge and, hyporheic flow, and by greater use of empirical data (see WOPR Science Review Team[14]) and simulations.

Analysis of the Proposed Action on Stream Temperature

The DEIS uses the View-to-Sky model (VTS[15]) to assess potential changes in stream temperatures under the Proposed Action. The model relies on a protocol developed in the 1990s for classifying streams in Washington State with regard to temperature relationships, and for predicting stream temperatures (Sullivan *et al.* 1990; WFPB 1997). A regression approach was used to develop a simple linear model from the Sullivan *et al.* (1990) data that predicts annual maximum temperature from changes in view-to-the-sky within different elevation bands (WFPB 1997). It appears the R^2 value of this relationship is 0.55 (WFBP 1997), which indicates a substantial amount of unexplained variation. For the Elliott State Forest, the first analytical step was to use this model to predict what stream temperatures would occur at reference and existing shade levels using ODFW's Aquatic Inventories Project shade data. Having the first step of the DEIS analysis of Alternative 1 (current management) and the Proposed Action rest on an analytical approach with a large amount of unexplained variation is problematic and introduces uncertainty which was not addressed in the either the draft HCP or the DEIS

ODF's Alternative 1 (which has 100-foot buffers on Type F streams) stream temperature effects were derived by calculating the amount of tree height growth needed to get to reference shade conditions from current conditions (the needed 3–5% increase in shade would be achieved by a 11 to 40 foot increase in tree height in 10–35 years). The effects of the Proposed Action were then derived by using a growth/harvest model to determine how long it would it would take for the average stand to increase in height by 11 to 40 feet (also 10–35 years), assuming 10% of stands between 35 and 80 years of age would be thinned (apparently to 50 trees per acre?) per decade. The thinning effect was apparently factored in by "gaming" the VTS model, reducing tree height (we could not tell by how much) to simulate the reduced (by 25%) stand opacity resulting from thinning (we could not determine the basis for 25% reduction in opacity) along streams with different channel widths. Reducing tree heights to simulate losses in opacity due to thinning could potentially be a problematic approach.

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[14] http://www.blm.gov/or/plans/wopr/files/Science_Team_Review_DEIS.pdf (accessed Sept. 10, 2010)
[15] Throughout this review, "VTS model" refers to the Washington State TFW Temperature Screen methods documented in Sullivan *et al.* 1990 and Doughty *et al.* 1991.

Distance from the Topographical Divide

The basis for separating the analysis of temperature effects by the distance from the topographic divide (using the VTS model within 10 miles from the divide, and the Biosystems *et al.* (2003) regression equation beyond 10 miles) is not well-documented and may be weak. The actual basis for the 10-mile cut-off was difficult to determine, but it appears to be from the basin-scale portion of the Sullivan *et al.* (1990) temperature study, which reports data from three streams in Washington, two in the western Cascades and one in the eastern Cascades, of questionable similarity to streams in the Elliott State Forest. The "threshold" proposed by Sullivan *et al.* (1990), beyond which stream temperature is increasingly a function of ambient air temperature, is between 30 and 40 km (18.7 and 25 miles) from the topographical divide. Only one stream included in Sullivan *et al.* (1990) had data points beyond 43 km (26.8 miles) from the divide, and one stream did not go beyond 30 km from the divide. The documents provided do not fully explain why the VTS model and a 10-mile distance were used, or if local data were used to validate the 10-mile cut-off. Neither the DEIS or Biosystems *et al.* (2003) clearly establish the basis for the use of elevation to predict stream temperatures on the Elliott State Forest. In ODF's RipStream study, Dent *et al.* (2008) concluded that models based on increased temperature as water moves downstream may oversimplify fine scale patterns in small streams.

Applicability of Analytical Methods

The analysis of the Proposed Action is not straightforward, and its conclusions are not rigorously developed or tested. At least some of the methods have not been widely used in Oregon. Because of this, the IMST was challenged in this review by the lack of clear explanation (even given the additional information kindly provided by the contractor) of how the effects to stream temperature were derived for streams within 10 miles of their topographic divide. We spent considerable time attempting to understand the basis for prediction of stream temperatures reported in the draft HCP and DEIS, yet there remain some areas of uncertainty as to the basis for some of the quantitative predictions. Stream temperatures less than 10 miles from the divide are predicted using an empirical model based on data reported for western Washington by Sullivan *et al.* (1990), using methods described in Appendix G of the Washington Forest Practices Board Watershed Analysis Manual (WFPB 1997), replicated as Appendix A-2 in the DEIS. Temperature effects for streams more than 10 miles from the divide are predicted using a regression equation developed in the Elliott State Forest watershed analysis (Biosystems *et al.* 2003) based on shade and distance-to-divide. The Proposed Action was not directly simulated or analyzed on its own. Instead, its effects were in part derived by making assumptions about similarities with Alternative 1. Specific weaknesses associated with this indirect approach are discussed below.

The analysis does not explicitly account for the areal extent of the Proposed Action's harvesting effects in riparian management areas, which may significantly influence stream temperature, nor does it evaluate the potential for downstream propagation of elevated temperatures. The rate of harvest predicted by the growth/harvest model (10% of stands 35–80 years along streams 53 feet or wider per decade; see page 14 of this review for rationale) appears to be simply assumed as sufficiently minor that temperature effects would be small and short-lived. A direct, spatially explicit simulation (such as that done for Fish Creek by USEPA[16]) would greatly strengthen the basis upon which the stream temperature conclusions rest.

There may be a mismatch between the assumptions of the effects analysis and the Riparian Area Management Standards listed in Table 5.5 of the DEIS. Most significantly, the draft HCP (page 8.8) states that where regeneration harvest is the silvicultural prescription for the adjacent upland, the Inner Zone will "commonly" not be harvested, in essence creating a 100-foot unmanaged buffer. Even given additional details of the analysis provided by the contractor, we were unable to understand how the Proposed Action would be implemented, whether the effects analysis truly simulates what will happen on the ground, and the relationship between the assumptions of the harvest model and the Riparian Area Management Standards.

Streams less than 10 miles from the divide

For non-fish-bearing streams (Type N), we were unable to locate any actual analysis or modeling of effects of the Proposed Action; the conclusions are based on two assertions:

- Any canopy cover in excess of 80% does not additionally protect stream temperature.);
- Leaving a buffer that provides 80% "shade" for a length of 500 feet from the confluence with a fish-bearing (Type F) stream will cool waters sufficiently that there would be no impact from upstream timber harvest to the Type F stream.

First, there is debate about the use of 80% canopy cover as a target for shade (e.g., WOPR Science Review Team[17]). Second, it is problematic to generalize that waters warmed by upstream exposure by harvest will cool simply by being shaded downstream (Johnson 2004; Story *et al.* 2003); cooler inflow from tributaries may be required for this to occur (Beschta *et al.* 1987); however, there is debate about this point (WDNR 2002, Moore *et al.* 2005). Sullivan *et al.* (1990), Moore *et al.* (2005), and Allen *et al.* (2007) all indicate that while temperature increases in headwaters may individually have little effect downstream, cumulatively they may be significant. Furthermore, by focusing solely on shade, the analysis appears to ignore potential temperature effects from increased sedimentation, altered surface and subsurface flows, and changes to channel morphology from timber harvest upstream from the 500-foot protected zone.

For Type F streams, it was difficult to obtain information that would allow IMST to verify the robustness of the modeling methods used (VTS model) for the Elliott State Forest. The VTS model has been primarily used on private forest lands in Washington State, and was apparently also used in the Upper Nehalem River watershed assessment in Oregon. We were unable to find any publications or rigorous documentation of these examples for this review; further exploration on the use of the VTS approach might be worthwhile, especially if follow-up monitoring of stream temperatures after harvest has occurred. Other approaches appear to have been used by Washington state agencies in recent years (for example, the use of the SHADE model by the Washington Department of Ecology in TMDL development (Cristea & Janisch 2007)),

[16] February 5, 2009 memo from Peter Leinenbach (USEPA, Seattle, WA) to Teresa Kubo (USEPA, Portland, OR)
[17] http://www.bl m.gov/or/plans/wopr/files/Science_Team_Review_DEIS.pdf (accessed Sept. 10, 2010)

The effects of the Proposed Action are framed as expected departure from those of Alternative 1. The result of this comparison is that there was no difference in shade (and thus predicted temperatures) between the Current Action (Alternative 1) and the Proposed Action for streams less than 53 feet wide. Thus, the potential for increased stream temperature for streams less than 10 miles from the divide was concluded to be only on streams greater than 53 feet wide, where thinning was likely to occur (10% of stands 35–80 years old per decade per watershed). The actual amount and duration of the effect do not appear to be reported.

This seems like a convoluted series of assumptions and inferences, potentially rendering the approach subject to compounded errors or weaknesses of induction. We believe a simple, straightforward, empirical, spatially-explicit simulation for a test watershed would be much more instructive. Some specific problems with the methods used are:

- Sullivan *et al.* (1990) and Doughty *et al.* (1991) emphatically and repeatedly assert that the VTS approach as embodied in the Washington state temperature screen documents should only be used in the State of Washington on type 1–3 streams, because the model is driven by regional climate/stream temperature relationships based on data from Washington only. Use of this model in Oregon (especially for smaller streams) seems questionable. Moreover, these authors strongly recommend sufficient follow-up monitoring to validate the reliability of the model estimates. It is unclear to what extent such model validation has occurred, if any.

- Since the VTS model predicts instantaneous daily maximum stream temperature, the results were subjected to an additional modeling step (regression based on data from the southwest Washington Cascades? – we were unable to determine the exact details of this modeling step) to derive 7-day moving average maximum temperature; this is a potential source of error compounding.

- Even though we were unable to reconstruct the exact sequence of modeling steps, it appears the information used in the analysis was based on regionalized climatic relationships from the western Washington Cascades to predict stream temperatures based on elevation ranges. If, as we believe, the relationships are from the Sullivan *et al.* (1990) “primary” sites, this data set appears to contain a relatively small number of sites (fewer than 20?), and the comparability to the southern Oregon Coast can be questioned, both on the basis of climate and stream characteristics. For example, the streams in the Elliot State Forest are described as typically less rich in gravel substrates than other streams (Biosystems *et al.* 2003); this could result in a different temperature profile (higher maxima) than streams with a greater proportion of alluvium (Johnson 2004). Furthermore, the assumption that stream temperatures within the Elliott State Forest have the same relationship to elevation as those in the Washington Cascades does not appear to have been validated.

- The time period over which stream temperatures were modeled is unclear from the information provided. Typically, such models calculate solar radiation for dates in late July or August, when air temperatures are at a maximum and cloud cover is least.

However, Johnson & Jones (2000), studying Oregon Cascade streams, observed maximum stream temperatures in June, when total daily solar radiation is greatest.

- The analysis of the potential effects of thinning in the Inner Zone assumes a 25% reduction of stand opacity (which in the VTS model is achieved by adjusting tree heights) with thinning, resulting in no significant temperature effects for streams less than 53 feet wide. It is not clear to what extent this actually simulates the likely canopy density or shade of thinned stands. (In an ODEQ analysis, Michie (2007) stated reducing canopy closure by 10–15% would still protect stream temperatures in the Canton Creek area of the Umpqua basin, but that 150-foot buffers would likely be needed in areas of sparse riparian vegetation.) The studies by Anderson *et al.* (2007) and Chan *et al.* (2006) cited above appear to have somewhat different results relating thinning density to post-harvest canopy cover (presumably because the stands studied are different ages, and trees per acre and canopy cover are not directly related). This is a point of uncertainty that should be explored further.
- Moreover, the distance along a stream over which the reduced canopy cover would occur, and the valley configuration and orientation, do not seem to be accounted for; only a non-spatially-explicit factor of "10% of stands 35–80 years old per decade) is assumed. The acceptance of 53 feet as the threshold stream width below which temperature effects from thinnings would not occur seems premature without further testing, especially in comparison with the "effective shade" values for stream widths reported in the Umpqua TMDL (ODEQ 2006). And in any case, the likely variation around the 53-foot threshold needs to be described

Streams more than 10 miles from the divide

The approach for these streams relies on the Biosystems *et al.* (2003) regression equation developed in the watershed analysis, based on 13 data points from the West Fork Millicoma River ($r^2 = 0.89$). In this equation, stream temperature is a function of distance from the divide and "shade" (which was either measured in the field (referred to as ODFW shade in the DEIS) or determined from aerial photographs and topographic maps (referred to as DEQ shade in the DEIS)). Use of this equation outside of the watershed from which samples were drawn, especially given the small size of the data set, is a potential point of weakness in the analysis. Also, the approach is based on the presumption of a linear downstream increase in stream temperatures (assuming equal shade) which is not supported by RipStream study pre-treatment data published by Dent *et al.* (2008), which found a high variation in longitudinal trends over short distances. Biosystems *et al.* (2003, p. 5.6) states that the regression equation developed for the West Fork Millicoma River is not applicable beyond 20 miles, but Tables 4.3-1 and 4.3-2 in the DEIS go up to 35 miles. This begs the question of the reliability of inferred temperature effects beyond 20 miles from the divide.

Again, the effects of the Proposed Action were not directly simulated or modeled but were based on presumed similarities with Alternative 1. It was assumed that the heights and growth rates of trees contributing effectively to shading streams between the two alternatives are the same, so therefore shade and stream temperature will be similarly affected. In other words, the effects of thinnings in the Inner Zone appear to have been simply "assumed away" with no supporting analysis. It is unclear whether this analysis made the same assumptions about extent of area or ages of stands affected (10% riparian management area acreage per decade on streams > 53 feet wide, stands 35–80 years old) as did the analysis for streams less than 10 miles from the divide.

Other Modeling Efforts

Other models have shown different results than the conclusions in the ESF DEIS effects analysis:

- ODEQ's HeatSource modeling exercise (Michie 2007) used as part of the agencies review of the BLM WOPR, showed exceedence of the applicable stream temperature standard under scenarios that appear similar to the Elliott State Forest Proposed Action, and in fact found that a 150-foot unmanaged buffer was required to have sufficient shade in the model. Since the goal of thinning under the WOPR was 80% effective shade (except where natural potential was less), ODEQ determined 80% shade to be not protective of stream temperatures. However, the temperature standard in the ODEQ analysis (0.1° C) is lower than Protecting Cold Water standard that ODF used in the RipStream study.
- USEPA's modeling results for Fish Creek within the Elliott State Forest found that shade levels in managed areas could remain below desired future conditions for decades[18]. The analysis demonstrated that there would likely be an initial 15%–25% reduction in riparian shade under the Proposed Action's riparian management guidelines which would diminish over time, but last at least 40 years with repeated harvest entries in the watershed. It is unclear to what extent the management regimes in this simulation are reflective of how the Proposed Action would be implemented, but the approach is very straightforward, transparent, and spatially explicit.

Large wood recruitment

The DEIS relies on Liquori (2004) and Biosystems *et al.* (2003) to determine large wood recruitment potential under the current and proposed actions. Both documents have scientific shortcomings and we illustrate these below. Sections of the DEIS reviewed were 3.5.3 and 4.5 and sections of the draft HCP reviewed were 5.6 and 8.5.3. Chapter 7 of Biosystems *et al.* (2003) was also reviewed.

Liquori (2004) is an unpublished published document not readily available to the scientific community. It therefore could not be obtained or evaluated by IMST. We also could not find any sources that have compared the findings in Liquori (2004) to other models used in the Pacific Northwest. Based on a peer-reviewed journal article with the

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[18] February 5, 2009 memo from Peter Leinenbach (USEPA, Seattle, WA) to Teresa Kubo (USEPA, Portland, OR)

same title (Liquori 2006), the work focuses on windthrow in young (40- to 70-years-old) conifer plantations in the Washington Cascades. The species composition is not described. The buffers are along streams in clear-cut stands and only buffers during the first three years after harvest were sampled and modeled. Ground disturbance within the buffers was minimized and "very modest thinning" was done in some units to meet wildlife objectives. Thinning in buffers was not a focus of the study. Liquori (2006) has not been evaluated and compared to other research in the Pacific Northwest and reported in peer-reviewed journal articles.

Significantly, the comparability of the results from Liquori (2004) to the Elliott State Forest was not established by the DEIS authors. The riparian forests on the Elliott are described as dominated by hardwoods within 100 feet of the stream for all stream size classes, and mixed conifer-hardwood stands from 100–200 feet from the stream. Liquori (2006) examined second-growth conifer-dominated riparian areas. The difference in forest types raises questions about the validity of the resulting calculations. Some instances where this may be important are:

- Page 4.5-42 (second paragraph):

  "*The percent of natural contribution from standard assessment widths are calculated based on likely RMA widths, conifer tree densities, and tree fall biases (Liquori 2004) for each alternative, as shown in Appendix A-3.*"

- Page 4.5-47 (third bullet): "*The estimate [potential large wood recruitment] is based on...the probability of trees hitting the channel, including differential factors for tree fall bias from each zone (Liquori 2004).*"

- Appendix A-3:

  "*After Liquori (2004) large wood integrated probability curves including differential tree fall bias as a function from the channel. Assumes:*

  - *Even distribution of trees per zone.*
  - *Tree mortality is 10% per decade without windthrow.*
  - *A total of 7.35 acres are available on both sides of the channel adjacent to 1,000 lineal feet of streams.*"

In addition to the reliance on Liquori (2004), the DEIS also relies on data from the Elliott Watershed Analysis (Biosystems *et al.* 2003). On Page 4.5-42 (second paragraph),

> "*The widths and potential large wood recruitment source area for the RMAs associated with each alternative are evaluated with respect to the McDade et al. (1990) source distance curve (Figure 4.5-2) and the wood recruitment modeling results for the action areas by Biosystems et al. (2003) (Figure 4.5-3).*"

The Watershed Analysis does not appear to have undergone scientific review before its results were incorporated into the DEIS. The IMST was neither requested nor had sufficient resources to do so as part of this review. This leads to the questions of whether or not the analysis and results from the watershed assessment are of adequate quality and scientific rigor to be used in the DEIS. Because an in-depth review of the Watershed Analysis is not feasible we only reviewed parts of Chapter 7 that pertain to large wood.

Biosystems *et al.* used results from an ODF inventory of selected streamside stand survey on nearby BLM riparian areas (Ursitti 1990) to assign stand characteristics (trees per acre, basal area per acre, and quadratic mean diameter) to the various combinations of stand age and conifer/hardwood compositions of the riparian stand. The riparian stand inventories were determined from aerial photographs. It is not possible to determine how accurate this method was because no measures of statistical confidence were reported. Biosystems *et al.* then use the stand characteristics in linear regressions to determine relationships between stand density and stand basal area with stand age. These relationships were then used in their modeling of streamside stands. They did report R^2 values for each linear equation, but those values except for one R^2=0.9 for a sample size of only 4) were low (ranging from 0.20 to 0.43 with most under 0.30). These low values indicate low predictive power. Biosystems *et al.* did acknowledge that the equations do not explain a large variance among plots but felt that they were adequate to address the type of management questions addressed by the watershed assessment. The IMST believes that there is insufficient evidence available to support this conclusion.

As part of the next step, Biosystems *et al.* …“ *adapted methods from the RAIS (Riparian Aquatic Interaction Simulator)model (Welty et al. 2002) to forecast wood inputs from streamside stands and the loss of wood in streams due to decay. However, this model was not used directly because it currently has several software bugs that make critical subroutines unusable. Instead, a spreadsheet version of the model was created and tailored to address various issues pursued in this analysis.*”

The authors do not specify how these modifications affected the outputs compared or how they may differ from what the original subroutines in RAIS would have produced. They also do not specify why a different model such as OSU’s STREAMWOOD (Meleason *et al.* 2003) or Washington’s Riparian-in-a-Box (Beechie *et al.* 2000), was not use instead nor do they compare their results to output from one of the other models. Additionally, Biosystems *et al.* uses two sources for wood decay rates for the modeling scenarios that are not applicable to instream wood on the Elliott State Forest: Lambert *et al.* (1980) reported balsam fir decay rates and Sollins (1982) reported for log decay rates in upslope conifer forests that do not account for patterns of submerging and wetting or instream physical abrasion (see Hassan *et al.* 2005b). The low R^2 values of the linear regressions done by Biosystems *et al.* coupled with adapted methods to a “buggy” version of the RAIS model, means there is no way for the IMST to determine how these results affected the analysis and final results in the DEIS, nor can it draw conclusions about the validity of the results.

Reliance on Professional Opinion

The DEIS uses professional opinion but the authors do not specify when professional opinion is being used rather than empirical evidence. One example is on pages 4.5-10 and 4.5-11 where the authors cite Liquori (2004) as a reference on how windthrow in buffers may be affected by thinning:

Page 4.5-10, first paragraph:

> *"Thinning in the inner and outer RMAs zones under Alternative 2 might expose trees that are not wind-firm to high velocity winds. However, the feathering approach of successive RMA zones under Alternative 2, rather than the abrupt vegetation edge prescribed under Alternative 1, would likely protect the inner, no-harvest streambank zone, and would result in less windthrow compared to Alternative 1 in that zone. The trees most vulnerable to windthrow in the RMAs would be located farthest from the stream channel under Alternative 2, where there would be less likely to contribute wood to stream channels (Liquori 2004). Given the tree retention on Type N streams would be compressed from 25 to 100 feet into a 25- to 50-foot zone, there would likely be little or no difference in windthrow potential on Type N streams under Alternative 2 to Alternative 1."*

And on page 4.5-11, first paragraph under Alternative 3:

> *"The RMAs with no-harvest buffers up to 160 feet wide along either side of Type F streams would protect core areas from wind throw, and would limit windthrow similar to Alternative 1 (Liquori 2004). Windthrow that might occur along the upland edges of RMAs under Alternative 3 would not be likely to deliver large wood to stream channels up to 160 feet away. The tree most vulnerable to windthrow would be farthest from the channels and less likely to contribute wood to channels compared to Alternative 1.*"

These conclusions are professional conjecture and not based on research, since thinning and windthrow in thinned buffers were not examined by Liquori (2004) and no studies were available at that time for Liquori to reference. We could only find one study, Drake (2008) a Master's thesis, on buffers adjacent to thinned stands who concluded that thinned stands did not provide any sheltering affect from wind damage in the riparian buffers. We could not find any applicable, published studies that examined windthrow of overstory trees in thinned riparian buffers.

In another instance, (page 4.5-56) the DEIS makes the following statement

> "*Under Alternative 1, large wood would be delivered to streams from RMAs through disease, landslides, bank erosion, beaver activity, and suppression mortality. The contribution of wood to channels from suppression mortality in the action area would occur rarely or at a low level, compared to other various sources of wood in the study area (Andrus and Froehlich 1988, Biosystems et al. 2003).*"

This conclusion in the quote above, does not account for the fact that causes and rates of mortality would be expected to vary by stand age and stand composition as well as location and other environmental factors. The DEIS authors do not include estimated rates for any of other types of mortality (disease, landslides, bank erosion, beaver activity, and suppression) mentioned in the passage above. Andrus & Froehlich (1988) is cited as a source for this section and is from a published symposium proceeding and focused on riparian forest development after logging, fire, or both. The work actually does not determine the cause of mortality. The authors compare the number of snags in the riparian areas to those determined by Cline *et al.* (1980) in upslope stands. Andrus & Froehlich suggest that the low number of snags was probably due to the initial low density of conifers in the riparian stands, because the number of hardwood snags was similar to the number reported by Cline *et al.* (1980). Biosystems *et al.* (2003) is also used as a reference to substantiate this conclusion but the statement by Biosystems *et al.* is based, solely, on Andrus & Froehlich (1988):

> "*The mortality of conifer trees next to streams seems to be rarely associated with competition among trees since initial tree density is rarely great enough for self-thinning to occur, and snags are scarce (Andrus and Froehlich 1988).*"
> (Biosystems *et al.* 2003, page 2-14).

This limits the confidence that can be put on the conclusion. The authors of the DEIS do not further substantiate the conclusion about competition mortality with any other sources, particularly ones that consider mortality in riparian buffer strips developing over a 50-year period, the amount of time covered by the HCP.

Soils and Slope Stability

The issue of soils and slope stability and impacts of the management alternatives on the aquatic environment with respect to turbidity and embeddedness were reviewed by the IMST. Sections of DEIS reviewed were 3.2, 4.0, 4.2, and 5.4.2 and sections of the draft HCP reviewed were 5.6 and 8.4.2.

Slope Stability Assessments

Reach- vs. Landscape-level Analysis

Ideally, the DEIS should describe in detail how it plans to evaluate the risk of landslide, debris flows and harvest induced soil erosion to fish and their habitat at the basin and reach level as well as at the landscape level. In particular, as presented in the DEIS and draft HCP, the IMST questions whether a faith in adaptive management with respect to the management of soils and slope stability is sufficiently justified based on the available literature. MacDonald & Coe (2007, page 148) write:

> *"The complexity and temporal variability of channel-hillslope interactions, in-channel processes, and downstream conditions makes it difficult to rigorously link upstream inputs and anthropogenic activities to the condition of downstream resources. These issues may preclude the use of adaptive management, particularly in*

larger basins, as adaptive management implicitly assumes that (1) downstream changes can rapidly be detected, (2) management will change rapidly in response to any adverse change, and (3) a management change will rapidly improve the affected resource. Since these assumptions may be difficult to satisfy—particularly in larger basins—the use of adaptive management must be carefully examined before it can be applied at the watershed scale."

The DEIS and draft HCP reference ODF (2003a, b) as the basis of when slope stability assessments will be done as part of management planning. However, both (ODF 2003a, b) deal with sites that put people and property at risk, there is no mention on when and how other sites will be assessed when neither people nor property are considered at risk. What other screening tools will ODF use and when will they be used during management planning? If models will be used, which models, and what are their accuracies and precision for Coast Range conditions? As an example of applicability of tools, Pyles & Kramer (2006) used SHALSTAB on central Oregon Coast Range forest lands and found that its predictive accuracy was not acceptable for slope stability assessments as part of forest management planning. Frattini *et al.* (2010) present a method for comparing accuracy for landslide susceptibility models that could inform ODF staff on determining appropriate models.

Risk of Landslide Initiation Index

Table 4.2-2 creates a landslide initiation risk index (table reproduced below). No citations were presented to support the use of this index and no reference to a similar approach could be found in the peer-reviewed literature by the IMST. We are unsure why work such as Hassan *et al.* (2005a) which estimates sediment yield from logged slopes was not referenced. Sediment yield increases from unharvested slopes are a more direct measure of changes in slope and soil stability that lead to turbidity and sediment related impacts on fish and their habitat.

Table 4.2-2 Relative Risk of Landslide Initiation among the Alternatives

	Average Acreage of Stands 0 to 10 Years Old				Landslide Initiation Risk Index			
	Umpqua	Tenmile	Coos	Overall	Umpqua	Tenmile	Coos	Overall
Current Condition (average between 1997 to 2006)	520	10	4,050	4,580	1.02	1.00	1.09	1.05
Alternative 1	1,100	480	4,020	5,600	1.04	1.02	1.09	1.06
Alternative 2	2,100	1,260	3,350	6,710	1.07	1.06	1.08	1.07
Alternative 3	1,880	1,820	2,480	6,180	1.07	1.08	1.06	1.07
Total area	28,196	21,562	43,524	93,282				

Source: Oregon Department of Forestry 2006b, 2006d, 2006e (acreage of stand structure)

Note: The risk index is based on the assumption that clearcutting doubles the risk of slope failure for a 10-year period, which is twice the risk rate cited from Biosystems et al. (2003). Therefore, acreage of 0 to10 year old stands is represented as ten times the average annual clearcut acreage (shown in table 4.1-1).

The landslide initiation risk index was based on the assumption that clear-cutting doubles the risk of slope failure 5 to 15 years after timber harvest and "is meant to estimate the maximum potential increase in landslides that might occur under each alternative" (DEIS page 4.2-8). A landslide initiation risk index of 1.0 indicates that no forest stands on the landscape are 5 to 15 years old; a landscape initiation risk of 2.0 indicates that all forest stands on the landscape are 5 to 15 years old (i.e., theoretically, all forest stands had been clear-cut in the last 10 years). In other words the index is really the proportion of the watershed or overall forest that has been harvested in the last ten years. These areas, according to the DEIS, have double the risk of landslide compared to older aged stands.

This index is then used to make the following claim (page 42.8-4.2.9):

> *"Table 4.2-2 shows that under Alternative 1, the landslide initiation risk for the entire action area would increase from an index of 1.05 to an index of 1.06 over the next 50 years, which would represent a less than 1 percent increase from current conditions. The slight increase in the index indicates that increases in harvest-induced landslides in the action area under Alternative 1 would be minor and probably would not be apparent among the natural temporal/spatial variation in landslide initiation."*

This numerical analysis could be potentially misleading. Table 4.2-2 is a risk index ranging in value from 1.0 to 2.0. By looking at index numbers in this table, one can see that the change from 1.05 to 1.06 in the risk index is not a 1% change in risk. It is a one unit change in the index. In fact the change in area at twice the risk of landslide is the percentage change from 1.05 to 1.06, i.e. (0.06-0.05)/0.05 = 20%. For Alternative 2 (Proposed Action) and Alternative 3 the percentage change in area at twice the risk of landslide is not 2% but 40%.

References to the change in the overall risk index for the Elliott State Forest throughout the DEIS may fail to demonstrate the significant variability in the changes in landslide risk in each of the three watersheds. The area subject to double the landslide risk is up to threefold greater than the area in the Tenmile River watershed, double the area in the Umpqua and one third the area in the Coos River watershed. In aggregate the large reduction in the Coos River watershed masks the larger percentage increases in the smaller Umpqua and Tenmile River watersheds.

This increase in area with double the risk of landslides is not directly translatable to environmental impacts on aquatic habitats and fish with respect to fine sediment transport, embeddedness or turbidity. To estimate the change in risk to fish and their habitats, finer scale analysis and sediment transport modeling at the watershed and reach scale for both Type N and Type F streams is necessary.

Size of Buffer zones

The DEIS discusses the important issue of the relationship between stream buffer width and sediment filtration at some length. For example page 4.5-76 states:

"Buffer widths needed for sediment filtration may vary from 25 to 300 feet or more depending on slope, parent rock type, and other factors. Studies of forested watersheds often recommend buffers along fish-bearing waters of approximately 100 feet for sediment filtration (Johnson and Ryba 1992)."

However, on pages 4.5-8 and 4.5-79, the DEIS goes on to suggest a 25-foot no harvest buffer zone:

> *"Perennial small Type N streams encompass 348 miles (45 percent of the channel network) in the action area. Given the steep side slopes of this channel type in the action area, the 25-foot no-harvest buffer prescribed for these stream reaches under Alternative 2 would filter a portion of the surface erosion occurring in or near these RMAs, but might not be effective in removing all of the sediment. Alternative 1 would provide a 50-foot no harvest buffer along these channel types and would offer greater, although not completely effective, filtration capacity to decrease the transport of fine sediment via surface erosion processes than Alternative 2."*

The IMST believes that given the cited differences in effective buffer zone width and the proposed 25-foot no harvest buffer, more analysis and/or support from the scientific literature is required. We can find little evidence to support DEIS conclusions such as (page 4.5-77): "*sediment and turbidity effects on fish habitat and populations under Alternative 1 are likely to be unchanged from current conditions*" and (page 4.5-79) "… *it is unlikely that differences between Alternatives 1 and 2 with respect to potential changes in suspended sediment and turbidity levels and channel scour would offer measureable changes in water quality at spatial scales larger than a stream reach*".

It is also noted that seasonal Type N streams receive less protection than perennial Type N streams, yet no analysis of the likely downstream sediment contribution from seasonal Type N streams is referenced.

Roads

Impacts on the fish and their habitat associated with increased road building under Alternatives 1 through 3 were reviewed by the IMST.

Overreliance on Best Management Practices Rather than Analysis

The IMST once again found a lack of hard data or analysis to support the findings of the DEIS. For example, the DEIS (page 4.5-14) states:

> *The actual sediment yield and delivery to the stream network from new roads would be small since all roads would be constructed in accordance using the best management practices within the Elliott State Forest Habitat Conservation Plan (Oregon Department of Forestry 2008) and the Forest Roads Manual (Oregon Department of Forestry 2000).*

> *Similar to Alternative 1, no new road construction would be allowed within 100 feet of perennial stream channels or other sensitive sites, where possible, and construction and erosion control practices, such as installing drainage relief culverts and cross drains, surfacing roads, and mulching soils to prevent delivery of ditch water to streams and reduce sediment yield, would be implemented*.

The IMST does not disagree or agree with this conclusion but observes that there are no data or characterization of the sediment inputs and hydrologic effects from new roads. This means we cannot determine the amount of mitigation needed to address any adverse effects on fish and their habitats and therefore we cannot judge whether or not existing best management practices are sufficient to mitigate impacts.

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- On page 4.5-41, the authors list Andrus & Lorensen (1992) as a source of information for wood recruited to channels and distance from streams.
- In Figure 4.5-2, the authors include a wood recruitment curve from McKinley (1997) but do not include it in the reference section.

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Appendix B. Buffer Widths in Pacific Northwest Managed Forests

Table B-1. Proposed and managed riparian buffer widths in the Pacific Northwest. Table is modified from: National Marine Fisheries Service. 2009. Untitled table comparing riparian management strategies. Oregon State Habitat Office, Portland, Oregon. 3 p.
Table B-1, *Continued*

Stream Type	*ODF Proposed Elliott State Forest HCP Strategies*	*Oregon Forest Practice Rules (Active Management Targets)*	*BLM's WOPR DEIS*	*Northwest Forest Plan*	*WA Dept. of Natural Resources HCP*	*WA Forests and Fish*
Fish-bearing streams	*•0-25 Feet - No harvest. •25-100 Feet - Thin to promote mature forest conditions (MFC). SDI greater than 25. Retain at least 50 trees per acre. •100-160 Feet - Retain 10 - 45 trees per acre depending on inner zone density. Favor those closest to streams.*	*•0-20 Feet - No harvest. •20-100 Feet (large streams) - Retain at least 74 sf of basal area, including 17 conifers/acre that are 11" dbh or larger. •20-70 Feet (medium streams) - Retain at least 56 sf of basal area[19], including 19 conifers/ acre that are 8" dbh or larger. •20-50 Feet (small streams) - Retain at least 18 sf of basal area.*	*•0-25 Feet - No harvest. •25-60 Feet – Thin to promote MFC. Maintain 80% effective shade or potential shade whichever is less. • 60-100 Feet – Maintain at least 50% canopy closure.*	*•2 SPT heights (300-440 feet) - Attain aquatic conservation strategy. Thinning allowed to create late-successional characteristics.*	*•0-25 Feet - No harvest. •25-100 Feet - Minimal harvest. Single trees with no appreciable reduction of shade or large wood. Additional 100 feet for wind buffer on windward side. •100-150 Feet - Low harvest. Thinning allowed that maintains or restores salmonid habitat.*	*•0-50 - No harvest. Roads and yarding corridor trees may be felled. •50-variable (usually 93-150) feet: Thinning only of basal area above and beyond DFC, and must leave 57 trees per acre. •Edge of inner zones out to 96-250 – Leave 20 trees per acre.*
Large and medium perennial non-fish-bearing streams	*•0-25 Feet - No harvest. •25-100 Feet - Thin to promote MFC. SDI greater than 25. Retain at least 50 trees per acre. •100-160 Feet - Retain at least 10 trees per acre. Favor those closest to streams.*	*•0-20 Feet - No harvest. •20-70 Feet (large streams) - Retain at least 56 sf of basal area, including 13 conifers/acre that are 11"dbh or larger. •20-50 Feet (medium streams) - Retain at least 45 sf of basal area, including 6 conifers/acre that are 8" dbh or larger.*	*Same as above.*	*•1 SPT height (150-220 feet) - Attain aquatic conservation strategy. Thinning allowed to create late-successional characteristics.*	*•0-25 Feet - No harvest. •25-100 Feet - Minimal harvest. Single trees with no appreciable reduction of shade or large wood.*	*•0-30 Feet – No equipment. •0-50 Feet – 50-foot no harvest circles to protect sensitive areas (non-fish tributary junctions, seeps, springs). •0-50 Feet – At least 50% of non-fish-bearing stream length must be included in no harvest buffers.*

Stream Type	*ODF Proposed Elliott State Forest HCP Strategies*	*Oregon Forest Practice Rules (Active Management Targets)*	*BLM's WOPR DEIS*	*Northwest Forest Plan*	*WA Dept. of Natural Resources HCP*	*WA Forests and Fish*
Small perennial non-fish-bearing streams	•Applied to 75%. •0-25 Feet - No harvest. •25-100 Feet - Retain at least 15-25 trees per acre. Favor those closest to streams. Most stands would result in a 50 foot buffer. Retain 80% shade within 500 feet of fish-bearing streams. •100-160 Feet - If retention not met in inner zone, retain 0-10 trees per acre. Most stands would be no retention.	•No retention required.	Same as above.	•1 SPT height (150-220 feet) - Attain aquatic conservation strategy. Thinning allowed to create late-successional characteristics.	•0-25 Feet - No harvest. •25-100 Feet - Minimal harvest. Single trees with no appreciable reduction of shade or large wood.	•0-30 Feet – No equipment. •0-50 Feet – 50-foot no harvest circles to protect sensitive areas (non-fish tributary junctions, seeps, springs). •0-50 Feet – At least 50% of non-fish-bearing stream length must be included in no harvest buffers.
Small intermittent high energy non-fish-bearing streams (greater than 5 feet and 15%)	•Applied to 75%. •0-25 Feet - No harvest. •25-100 Feet - Retain at least 15-25 trees per acre. Favor those closest to streams. Most stands would result in a 50 foot buffer. •100-160 Feet - If retention not met in inner zone, retain 0-10 trees per acre. Most stands would be no retention.	•No retention required.	•0-25 Feet – Retain 12 conifer trees per acre.	•1 SPT height (100-220 feet) - Attain aquatic conservation strategy. Thinning allowed to create late-successional characteristics.	Strategy for first 10 years until final strategy is approved: •0-25 Feet - No harvest •25-100 Feet - Minimal harvest. Single trees with no appreciable reduction of shade or large wood.	•0-30 Feet – No equipment. •0-50 Feet – 50-foot no harvest circles to protect sensitive areas (non-fish tributary junctions, seeps, springs). •0-50 Feet – At least 50% of non-fish-bearing stream length must be included in no harvest buffers.

Table B-1, *Continued*

Stream Type	***ODF Proposed Elliott State Forest HCP Strategies***	***Oregon Forest Practice Rules (Active Management Targets)***	***BLM's WOPR DEIS***	***Northwest Forest Plan***	***WA Dept. of Natural Resources HCP***	***WA Forests and Fish***
Small intermittent **debris flow** non-fish-bearing streams (likely to deliver wood to fish-bearing stream)	•Applied to 75%. •0-25 Feet - No harvest •25-100 Feet - Retain at least 10 trees per acre. Favor those closest to streams.	•First 500 feet upstream of fish stream: Retain 2 trees per acre where directed by State Forester.	•0-25 Feet - No harvest. •25-100 Feet - No harvest where mature or structurally complex forest stands already exist, except for safety or operational reasons.	•1 SPT height (100-220 feet) - Attain aquatic conservation strategy. Thinning allowed to create late-successional characteristics.	Strategy for first 10 years until final strategy is approved: •0-25 Feet - No harvest •25-100 Feet - Minimal harvest. Single trees with no appreciable reduction of shade or large wood.	•0-30 Feet – No equipment. •0-50 Feet – 50-foot no harvest circles to protect sensitive areas (non-fish tributary junctions, seeps, springs). •0-50 Feet – At least 50% of non-fish-bearing stream length must be included in no harvest buffers.
Other small intermittent non-fish-bearing streams (greater than 15%)	•Applied to 75%. •0-25 Feet - Maintain integrity of stream channel. •25-100 Feet - Retain at least 10 trees per acre. Favor those closest to streams.	No retention required.	•0-25 Feet – Retain 12 conifer trees per acre.	•1 SPT height (100-220 feet) - Attain aquatic conservation strategy. Thinning allowed to create late-successional characteristics.	Strategy for first 10 years until final strategy is approved: •Protected "when necessary" •0-25 Feet - No harvest •25-100 Feet - Minimal harvest. Single trees with no appreciable reduction of shade or large wood.	•0-30 Feet – No equipment. •0-50 Feet – 50-foot no harvest circles to protect sensitive areas (non-fish tributary junctions, seeps, springs). •0-50 Feet – At least 50% of non-fish-bearing stream length must be included in no harvest buffers.

[1] Basal area conversion: A 14" dbh tree = approx. 1 sf of basal area
A 24" dbh tree = approx. 3 sf of basal area
A 36" dbh tree = approx. 7 sf of basal area
A 48" dbh tree = approx. 13 sf of basal area