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February 28, 2001

Dick Pedersen
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Department of Environmental Quality
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Portland, OR 97204

Ted Lorensen
Forest Practices Program Director
Department of Forestry
2600 State Street
Salem, OR 97310

Dear Mr. Pedersen and Mr. Lorensen:

The Environmental Protection Agency (EPA), and the National Marine Fisheries Service and U.S. Fish and Wildlife Service (Services) appreciate the opportunity to review and comment on the December 2000 draft report titled *ODF/DEQ Sufficiency Analysis: Stream Temperature* (SAST) by the Oregon Departments of Forestry and Environmental Quality (ODF and DEQ). The agencies have completed this review (Attachment 1) in order to provide technical assistance to the state of Oregon, and to provide guidance about the adequacy of the state's Forest Practices Act (FPA) for meeting the goals of the Clean Water Act (CWA) with respect to water temperature, particularly as they relate to providing functional freshwater habitat for salmonid fishes listed under the Endangered Species Act (ESA).

The SAST is an "[e]valuation of the adequacy of ...[Oregon's] forest practices act in the achievement and maintenance of water quality standards." The SAST is clearly the product of a great deal of work and presents a significant amount of data. Determining whether the FPA is sufficient to meet the Oregon water quality standards (WQS) for temperature requires examination of the effects of forest practices on stream temperatures to determine if numeric and narrative criteria are being attained, designated beneficial uses (e.g., salmonid spawning and rearing) are being protected, and antidegradation provisions are being met. Since the "best management practices" under the FPA are used as the legal mechanism for meeting all three components of WQS (attainment of criteria, protection of designated beneficial uses, and antidegradation), our review looks at the SAST data and conclusions within the context of these three components.

Our review of the SAST and the body of scientific literature related to forestry effects on factors affecting water temperature (see Attachment 1) confirms, with a high degree of confidence, that practices under the FPA adversely affect temperature-related factors such as shade levels, surface erosion, landslide rates, stream morphology and substrate, and landscape-scale conditions. Therefore, we concur with ODF and DEQ that "there are water quality impairments due to forest management activities even with FPA rules and BMPs" (SAST, p. 58 and Table 9). Scientific research and temperature assessments completed in Oregon and the Pacific Northwest also indicate that these adverse effects affect water quality and fisheries on small, medium and large streams.

While it is not clear how the stream temperature effects determinations for forest practices were made in the SAST (Tables 5, 6, 7, 8, and 9), shade appears to be the only factor considered. We agree that shade is an important factor for stream temperature, and that the FPA will result in reduced shade and increased stream temperatures in Oregon's streams. However, the SAST also needs to consider the cumulative effects of other temperature-related factors in determining whether the FPA meets the three components of WQS. The SAST also needs to clearly describe the rule set, criteria, or logic used to arrive at the effects determinations in Tables 5, 6, 7, 8, and 9. For example, the determination that FPA basal area targets in riparian areas, which range from zero to less than one third of the basal area found in mature forest, pose a very low to moderate risk of not meeting temperature standards (SAST Table 8) needs to be better explained. Our submittal includes a comparison of riparian protection strategies proposed or in effect under several categories of land ownership in Oregon (see Attachment 2).

The sections related to equilibrium temperature would significantly benefit from a re-examination of the two studies that appear to form the basis for the SAST conclusions regarding forest activity effects on downstream temperature. In addition, the importance of cold water refugia to salmonids and the existing impaired conditions of watersheds should be factored in to any conclusions reached about the significance of downstream effects from forestry activities. The SAST discounts the importance of both site-specific and cumulative effects from forest practices, which is contrary to the scientific literature and extensive temperature assessment efforts completed as part of DEQ's total maximum daily loads (TMDLs) (see Attachment 3).

We realize that it is not possible to determine the exact magnitude of forest practice effects to stream temperature for specific stream reaches in a statewide sufficiency analysis. The evidence is, however, overwhelming that forest practices on private lands in Oregon contribute to widespread stream temperature problems and degraded salmonid habitat conditions. These effects of forest practices do not meet the goals of the CWA or ESA. EPA and the Services are committed to working with ODF and DEQ to ensure that the best available science is used to support the changes to forest practices that are necessary to protect water quality and fisheries. To this end, we would welcome an opportunity to work with you during the Board of Forestry's review of the proposals from the Forest Practices Advisory Committee. Also, the FPA rules include a provision for basin-specific rule changes that can address water quality issues in a particular watershed, subbasin, or georegion. Based on the substantial body of scientific literature demonstrating that Oregon forest practices likely adversely affect water quality and threatened species of salmonids, we recommend initiation of the basin-specific rule change process.

Please feel free to contact us if you have questions regarding our comments or would like to set up a meeting. We would appreciate your sending us the final version of the SAST.

Sincerely,

Dan Opalski, Director
Environmental Protection Agency
Oregon Operations Office

Kemper McMaster, State Supervisor
U.S. Fish and Wildlife Service
Oregon Fish and Wildlife Office

Michael Tehan, Chief
National Marine Fisheries Service
Oregon Branch, Habitat Conservation Division

Attachments:
Attachment 1: Review of the December 2001 Draft Sufficiency Analysis
Attachment 2: Comparison of Riparian Protection Measures
Attachment 3: TMDL Shade Comparison
cc:
Stephanie Hallock, Director, Oregon Department of Environmental Quality
Melinda Eden, Chair, Environmental Quality Commission
James E. Brown, State Forester
David E. Gilbert, Chair, Oregon Board of Forestry
Peter Green, Governor's Natural Resources Office
Chuck Findley, Acting Regional Administrator, Environmental Protection Agency, Region X
Donna Darm, Acting Regional Administrator, National Marine Fisheries Service, Northwest Region
Anne Badgley, Regional Director, U.S. Fish and Wildlife Service, Region 1

Attachment 1

Review of the December 2001 Draft Sufficiency Analysis: Stream Temperature (Oregon Departments of Forestry and Environmental Quality)

by the

Environmental Protection Agency, National Marine Fisheries Service, and U.S. Fish and Wildlife Service

February 2001

GENERAL COMMENTS

Introduction

The Environmental Protection Agency (EPA) and the National Marine Fisheries Service and U.S. Fish and Wildlife Service (Services) have reviewed the December, 2000 draft report titled *ODF/DEQ Sufficiency Analysis: Stream Temperature* (SAST) by the Oregon Departments of Forestry and Environmental Quality (ODF and DEQ). The SAST is an "[e]valuation of the adequacy of ...[Oregon's] forest practices act in the achievement and maintenance of water quality standards." Under the Federal Clean Water Act (CWA), state water quality standards (WQS) define the water quality goals of a waterbody by designating the beneficial use or uses to be made of the water, by setting numeric or narrative criteria necessary to protect the uses, and by preventing or limiting degradation of water quality through antidegradation provisions. Determining whether the Forest Practices Act (FPA) is sufficient to meet the Oregon WQS for temperature requires examination of the effects of forest practices on stream temperatures to determine if numeric and narrative criteria are being attained, designated beneficial uses (e.g., salmonid spawning and rearing, and public water supply) are being protected, and the antidegradation provisions are being met. Since the "best management practices" under the FPA are used as the legal mechanism in Oregon for meeting all three components of WQS (attainment of criteria, protection of designated beneficial uses, and antidegradation), our review looks at the SAST data and conclusions within the context of these three components. The agencies have completed this review in order to provide technical assistance to the state of Oregon, and to provide guidance about the adequacy of the FPA for meeting the goals of the Clean Water Act and Endangered Species Act (ESA) related to water temperature.

Portions of the draft are well written and provide useful information related to stream temperature. However, many conclusions and statements in the SAST are not consistent with the general background information provided, related supporting literature, or other available literature. The SAST analysis contains conflicting statements and findings regarding the relative importance of shade and other potential factors (such as erosion and sedimentation, channel widening, loss of large wood, reduction in upwelling, disturbance or alteration of groundwater, and microclimate). Throughout most of this analysis, shade appears to be generally assumed as the only important factor concerning stream temperatures and attaining WQS. The SAST considered only shade, stream temperatures, and attainment of numeric, fixed temperature targets, rather than how forest practices affect the suite of temperature-related factors relevant to riparian and stream channel functions that are critical to supporting designated beneficial uses such as salmonid spawning and rearing. While several sections in the SAST recognize the importance of factors other than shade, these sections do not appear to be considered in the final findings and effects determinations. For example, shade alone is analyzed with respect to basal area and is the only temperature-related factor substantively discussed in the context of FPA buffer widths. Therefore, it appears that many of the SAST conclusions regarding risk of temperature changes from forest practices for all stream designations may be understated, due to this analytical approach.

It is very difficult to interpret some of the data and figures in the SAST (e.g., p. 38 - 53). The conclusions and risk ratings (p. 57-58) do not appear to flow directly from the data that are presented in the draft analysis (Figures 14-18). For example, there are no data presented in the analysis to support the contention that large streams would not experience temperature increases or that large streams are "likely to be influenced only by legacy effects" from past management practices. However, based on the full body of science we reviewed, we concur with the SAST finding that there are water quality impairments due to forest management activities, even with FPA rules and best management practices (SAST Table 9, p. 58). We also support ODF and DEQ use of the basin rule change process to create watershed specific protection rules to ensure that forest management activities do not impair water quality (SAST Table 9, p. 58).

Statewide Forest Practice Analyses

The SAST appears to rely almost exclusively on data from 28 monitoring sites along 7 streams in western Oregon in its sufficiency findings. While data from these sites do confirm that forestry activities increase stream temperatures, the FPA sufficiency determinations should also utilize other scientific reports that evaluate the adequacy of forest practices in Oregon and California. These reports: 1) were developed by individuals with forestry, riparian, water quality, and fisheries expertise; 2) are based on a review of a broad range of several hundred research and monitoring efforts; and 3) are directly relevant to forest practices on private lands. Relevant reports include IMST (1999), Ligon et al. (1999), Beschta et al. (1995), Botkin et al. (1995), and Murphy (1995).

Based on the collective body of the best available science, the above reports make specific recommendations regarding riparian protection and landscape scale needs for the respective states' forest practices. These reports identify the need for increased riparian management area protection for salmon and water quality. The IMST report (IMST 1999), which evaluated how well the FPA is meeting the goals of the Oregon Plan for Salmon and Watersheds, specifically looked at FPA adequacy for salmon recovery. It recommended a number of changes to the FPA as necessary to ensure salmonid recovery. The Oregon Forest Practices Advisory Committee (FPAC) developed recommendations that, while not based on meeting CWA and ESA requirements, would improve water quality and fishery protection through voluntary measures and FPA rule changes. The State of Washington recently adopted forest practice rules that increase protection for water quality and fisheries substantially beyond the level provided by the FPA.

Some of the SAST determinations are misleading, leaving the reviewer with the impression that there really is not "conclusive" evidence regarding whether the FPA rules and BMPs increase stream temperatures or fully protect designated beneficial uses at the statewide level. Part of the problem is the SAST's reliance on incomplete data from a limited number of specific monitoring sites to make a statewide determination. Data from individual sites may or may not show significant shade and temperature changes from forestry activities. This is especially true where factors such as changes in ground water inputs, yearly temperature variation, forest conditions in the upper watershed, changed channel morphology, and various other site-specific conditions are not considered in the studies. Questionable site-specific measurements may also be misleading (e.g., short-term shade level increases after harvesting, Figure 19). At the broad scale, the preponderance of existing scientific knowledge and evidence indicates that forest practices under the FPA are likely to adversely affect the factors that elevate stream temperatures, contributing to WQS violations and adverse effects to beneficial uses such as salmonid spawning and rearing.

Landscape Scale and Cumulative Effects

The FPA lacks a landscape scale/cumulative effects framework that would ensure consideration of critical broader-scale water quality and fisheries effects related to the timing, location, and intensity of harvest and road related activities. The Oregon Board of Forestry (OBF) and Oregon Department of Forestry (ODF) 1995 Forestry Program Report for Oregon states that "[T]imber management policy has often been considered on a site-specific basis, without making links to the effects of such management on the forest as a whole—without a "big-picture" or landscape view... Truly "fixing the problem," however, requires a broader approach—an approach that considers forests as ecosystems that can be carefully managed to achieve a variety of objectives, rather than a collection of resources that can be managed in isolation" (OBF & ODF 1995). This conclusion is reinforced by numerous other studies and assessments (FEMAT 1993, Botkin et al. 1995, Murphy 1995, National Research Council 1996, Spence et al. 1996, Quigley and Arbelbide 1997, IMST 1999, Ligon et al. 1999.)

Because of their proximity to streams, riparian activities have a high potential to adversely affect salmonids and water quality. However, upslope forestry activities affect surface erosion, mass wasting, hydrologic processes, and nutrient dynamics and therefore need to be considered in determining fish habitat and water quality effects (Spence et. al. 1996). Further, the IMST (1999) pointed out that:

> Since streams are tightly linked to the terrestrial landscape they flow through, when reviewing land use practices and their effects on salmonid habitat, it is necessary to analyze impacts on both adjacent and distant components of the landscape. Analysis and adjustment of management practices in riparian forests has received a lot of attention. However, considering the interrelated components of the entire landscape, a similar analysis and adjustment in management practices must occur in upslope forests throughout the watershed (p.13).

The IMST report also states that "[t]he historic range of ecological conditions in the Pacific Northwest, both of habitat and salmonid stocks, is important because it provides a framework for developing policy and management plans for the future." The IMST report concludes "that the goal of management and policy should be to emulate (not duplicate) natural processes within their historic range." The SAST (p. 28) suggests that riparian buffers designed to maintain physical habitat may result in average shade levels that exceed historic shade levels and result in less productive salmon habitat. While this could be true for a single or several specific sites, the SAST discussion on disturbance is misleading if the landscape scale is considered. Natural disturbance across the region played a significant role in shaping forest structure, seral class distribution, and the species composition of riparian and upslope stands. However, at the landscape scale, forest practices have substantially modified vegetation species and age class composition, including within riparian areas (Bisson et al. 1987, Botkin et al. 1995, National Research Council 1996, Oregon Coastal Salmon Restoration Initiative [OCSRI] 1997, Quigley and Arbelbide 1997).

The Riparian Issue Paper developed as part of the FPAC process estimated that mature forests (older than 100 years of age) covered 50-70% of the region between 1850 and 1940, and that on average 15-25% of the forest in the Central Oregon Coast Range would have been in early successional stages due to fire disturbance. Private lands where the FPA is applied have been largely cut over, resulting in many watersheds having a very small component of mature forest (Lorensen et al. 1994, FEMAT 1993). The FPA tree retention requirements within riparian management areas (RMAs) represent the only substantial opportunity for mature forest regeneration on private lands at the landscape scale. Depending on stream density and fish presence, RMAs under the FPA constitute approximately 2% to 9% of the total acreage within a watershed. Depending on the stream type and size, the FPA rules for regeneration harvest allow the removal of two-thirds to essentially all of the existing mature riparian forest (basal area) within RMAs, provided minimal tree retention requirements are met. The basal area retention targets are far below the level expected in mature forest. In the Coast Range, for example, 100 $ft^2 ac^{-1}$ is the standard basal area target for large fish bearing streams while mature forest would generally contain at least 332 $ft^2 ac^{-1}$. Standard basal area targets are substantially lower for medium and small stream RMAs, ranging from zero to 75 $ft^2 ac^{-1}$. Outside of RMAs (> 90% of the total acreage in a typical watershed) even lower amounts of mature forest would be retained under the FPA.

A 1995 temperature study on the Olympic Peninsula looked at the relationship between landscape-scale forest conditions and stream temperatures (Hatten and Conrad 1995). Temperatures of 11 streams in unmanaged sub-basins (less than 15% of the mature forest in the sub-basin logged and no harvest within the riparian corridor) and 15 streams in managed sub-basins (more than 15% of forest logged, or harvest had occurred within riparian corridor) were monitored continuously during the summer of 1992. Water temperatures in the managed group were significantly warmer than in the unmanaged group. The difference was not explained statistically by elevation or the amount of shade in the monitored reach. Among sites with similar shade levels, those in managed sub-basins had warmer temperatures than those in unmanaged sub-basins. The most important predictor of temperature was the proportion of the sub-basin in late seral stage forest, regardless of whether the basin was managed or unmanaged. This indicates that the proportion of late-seral stage forest in a sub-basin could represent a surrogate for the cumulative effects of logging activities within a sub-basin. The study concludes that stream temperatures cannot be successfully managed at the reach level unless basin-wide harvest activities are carefully considered.

Shade

The influence of forest practices on shade and stream temperatures is extensively documented in a large number of studies. The SAST appears to rely heavily on studies by Caldwell et. al. (1991) and Dent and Walsh (1997) in reaching conclusions about the effects of the FPA on shade and stream temperature. These studies provide some insights, but, as discussed below, have some significant problems. The SAST conclusions and sufficiency determinations should consider a number of additional studies and assessments completed over the last three decades that address shade and stream temperature (Lantz 1971, Summer 1982, Hall et. al. 1987, Beschta et. al. 1995, DEQ 2000, DEQ 2001a, DEQ 2001b, §319 ODF-DEQ shade study). Some of these studies document increases in stream temperatures of up to 30 degrees F following regeneration harvest (and burning) in RMAs (Hall et. al. 1987). The timeline for returning to pre-harvest shade levels varies by zone and forest type with recovery of riparian areas to old-growth shading levels taking from 10 to more than 40 years (Beschta et. al. 1995). While shade around some small streams can be provided by understory vegetation within a few years following harvest, understory vegetation does not provide large wood, or attenuate landslides, sedimentation rates, hydrologic regimes, and air temperature in a manner similar to mature forest. These factors are relevant to stream temperatures and protection of beneficial uses (e.g. salmonid spawning and rearing) as discussed in the next section.

The CWA §319-funded Shade Study (discussed in Appendix E of the SAST) was expressly designed to "[m]onitor the effectiveness of the Forest Practices in providing a range of shade conditions that are predicted to meet DEQ Standards for water quality" (§319 Shade Study Statement of Work). The ODF application for the §319 grant specifically focused on the need to 1) provide data to test the validity of shade targets developed in total maximum daily loads (TMDLs) and 2) determine the effectiveness of FPA basal area requirements in maintaining shade levels that meet TMDL shade targets. ODF took extensive shade and basal area measurements from 122 riparian management areas within recently harvested and "other" (not recently harvested) sites. Sites could not be randomly selected due to harvest timing, land owner willingness, and other factors. Basal area levels retained on recently harvested sites were in many cases significantly higher than FPA rule requirements. In spite of this, the quality of data from the 319 shade study is very sound and the data strongly validate the site-potential shade targets in DEQ TMDLs. Shade levels from the study track very closely with TMDL site potential shade targets (Attachment 3).

The shade study also demonstrates a significant difference between harvested sites and "other" sites both in terms of shade levels and the variability of shade levels for the two populations of sites. Median shade levels for harvested sites were 6.5% to 21.5% lower than shade levels on "other" sites when stratified by stream size (large, medium, small). For each of the stratified stream size data sets, 70% to 100% of the "other" sites had shade levels that were higher than the median shade level of the harvested sites. Pre-harvest basal area and shade measurements would have been necessary to determine exactly how much FPA harvest reduced basal area and shade. Harvest down to the standard FPA basal area targets would also be needed to test the full effects of applying the FPA requirements. Regardless, the shade study clearly demonstrates that there is high likelihood that the FPA requirements will reduce shade significantly below site-potential shade levels. Meeting the site-potential shade targets in TMDLs is necessary to meet the WQS for temperature in Oregon. This should be factored into the SAST sufficiency determinations.

Downstream Effects - Re-equilibrium

DEQ has completed subbasin-scale temperature analyses for several TMDLs. The TMDL temperature analyses incorporate extensive temperature, stream channel morphology, vegetation and shade information for entire subbasins. Forward looking infrared radiation technology accurate to within 0.5° C, dozens to several hundred instream temperature monitors per subbasin, 1-m resolution digital orthophotos, and hundreds of shade measurements taken with solar pathfinders are used in the DEQ temperature analyses. The DEQ analyses clearly demonstrate that stream temperature changes within a subbasin are cumulative in nature and that a number of factors such as shade, stream channel morphology, flows, and tributary/groundwater inputs cause changes in stream temperatures. The SAST (p. 26) provides the temperature profiles for the Grande Ronde, Umatilla and Tualatin rivers. These profiles clearly demonstrate the cumulative effects of stream heating and cooling at the subbasin scale. As noted above, under the FPA over 90% of private forest lands in a watershed receive very minimal protection. Shade, slope and bank stability, erosion levels, air temperatures, and large wood levels can also be adversely affected on the remaining 2% to 9% of the watershed with RMAs under the FPA. The DEQ TMDLs clearly demonstrate that the impacts of forestry and other land and water use practices can overwhelm stream heating and cooling processes throughout a watershed.

The SAST relies heavily on Caldwell et al. (1991) to dismiss the risk of cumulative downstream temperature impacts. This study states that "As long as there is at least a 150-m shaded reach between these streams where the canopy has been removed, there is minimal risk of cumulative downstream temperature impact (Caldwell et al. 1991)." The authors indicated that the re-equilibration of stream temperature would occur over a 150-m reach, which would represent one hour's travel time. This is approximately 0.14 ft sec^{-1}. A reasonable stream flow velocity during a low flow period would be 1.0 to 2.0 ft sec^{-1} with a resultant one-hour distance of 1,100 to 2,200 m. This is ten times the estimation by Caldwell et al. (1991). Even if their assumption were correct, further assumptions that there are sufficient groundwater inputs and substantial hyporheic interactions would be necessary to bring down the water temperature.

Just as importantly, Caldwell et al. (1991) looked at water temperatures downstream of unshaded reaches which entered reaches whose riparian zones were already degraded. The downstream comparison to a mature forest that contained some conifers was only done in one case. Measurements of re-equilibration were made along "control" reaches having artificially high stream and air temperatures. Heat energy that is quickly gained by a stream is retained and then gradually released back to the surrounding environment because water has a relatively high heat capacity. Given the forest conditions and flawed assumptions described above, Caldwell et al. (1991) provides little insight into the temperature regimes and dynamics provided by undisturbed forests.

The SAST also appears to rely heavily on data from one or more ODF monitoring efforts and technical reports. While the ODF monitoring efforts clearly show overall decreased shade levels and increased stream temperatures, there are significant questions about the methods and outcomes of these efforts (see page-specific comments below). For example, shade levels increased on two small streams, two large streams, and three medium streams after harvest in the riparian zone. It is not clear how this would be possible, especially over the short term. The SAST provides no clear statement of the sampling design, comparability or representativeness of selected field sites, or details of the particular field methods they used for gathering information on the characteristics of temperature in various streams. It is not clear whether the BMP effectiveness determinations are relying on the broad body of science related to forestry and stream temperature, a small number of studies, or whether the data cited is solely from the 1997 study by Dent and Walsh. The sample size apparently used seems small (n = 7 different streams) for extrapolating results broadly, and the sites are not necessarily comparable given the absence of geomorphic stratification for the sites, either before or after selection. It is not clear whether climatic factors such as seasonal temperatures, summer-time precipitation, snowpack and snowmelt influences, or others factors affected observed outcomes.

There are also questions about comparability among treatments in the different treated sites and whether they actually reflect the "maximum" riparian harvest allowed under the FPA. It not clear whether the condition of "untreated" downstream riparian areas as well as riparian areas upstream of the treatment sites were mature forest. If mature forest conditions were not present above and below treated (harvested) riparian areas, stream temperatures entering treated sites may be warmer than "normal" and the benefits of riparian areas to stream temperatures below treated sites may be less than expected for riparian areas in mature forest condition. The above factors could cause a substantial under representation of the adverse effects of harvest in riparian zones to stream temperatures.

Other Factors Affecting Temperature

Water temperature within a stream system is a function of both external factors, such as solar radiation, air temperature, and precipitation/flow, and internal factors such as width to depth ratios, connection to ground water, and hyporheic flow (Bilby 1991, Bilby 1998, Ward 1998, Poole and Berman 2000). Forest practices can affect external factors (e.g., by removing shade) as well as internal factors (e.g., by adding or removing large wood, which affects sediment routing and pool formation).

The riparian and upland functions provided by mature forests are clearly important influences on habitat structure (particularly provision of key pieces of large wood; Ralph et al. 1994, Abbe and Montgomery 1996, Bilby and Bisson 1998), water quality, and salmonid fishes (Bisson et. al. 1987, FEMAT 1993, Spence et al. 1996, Quigley and Arbelbide 1997). Habitat degradation has been associated with many of the documented extinctions or declines of anadromous and resident salmonid fishes in the Pacific Northwest, including Oregon (Nehlsen et al. 1991, FEMAT 1993, Henjum et al. 1994, Botkin et al. 1995, Independent Scientific Group 1996, National Research Council 1996, OCSRI 1997, Quigley and Arbelbide 1997). As noted above, the distribution of mature forest on private lands is extremely limited and significantly departs from historic levels. This condition impacts numerous factors related to stream temperature. As the draft SAST indicates, stream channel morphology is an important determinant of water temperature. As streams become wider and shallower, with fewer and shallower pools and fewer connections to floodplains and groundwater, they become more susceptible to warming. The SAST includes only a brief mention of bank stability (p. 30) and sediment dynamics (p. 31), and does not relate bank stability or sediment to forest practices. As described below, forest practices that affect large wood recruitment, sediment yield, storage, and routing also affect channel morphology. This needs to be considered in evaluating the adequacy of the FPA in achieving and maintaining water temperature standards.

Sedimentation and lack of current and potential large wood are key factors degrading fish habitat in western Oregon (FEMAT 1993, OCSRI 1997). Thom et al. (1999) describe results of a survey of randomly-selected sites in western Oregon in 1998. Survey sites were compared with reference reaches located mainly in unmanaged watersheds and wilderness areas, primarily in the upper portions of watersheds and on Federal lands. The areal extent of silt and sand on the surface of low gradient riffles was selected to typify potential accumulation of fine sediments in a stream. All of the areas had higher fine sediment levels than the reference reaches. Over 70% of the sites surveyed in the North Coast area had over 20% fine sediments in low gradient riffle units. The number of riparian conifers observed also differed markedly from the reference reaches. All of the areas showed low conifer numbers compared to reference reaches, with over 30% of the stream lengths surveyed having no large conifers in the riparian zone. The numbers of pieces of wood in the stream in survey reaches were similar to those in reference reaches. However, the number of key pieces of wood (over 10 m length, 60 or more cm diameter) in survey reaches was lower than reference reaches, with 50% of the stream length surveyed in each basin having less than 1 key piece per 100 m of stream channel (compared with the median value for reference reaches of 1.8 key pieces per 100 m of stream channel).

Large Wood

As noted in the SAST, large wood is an important component of salmonid habitat. In addition to providing cover and structural complexity, large wood strongly influences sediment storage, pool frequency, and pool volume (Bisson et al. 1987, Bilby and Bisson 1998). Large wood in streams has been reduced through a variety of human activities that include past timber harvest practices and associated activities, as well as the mandated cleanup activities that removed wood from streams throughout the region from the 1950s through the 1970s (FEMAT 1993, Botkin et al. 1995, Bilby and Bisson 1998). On forested lands in the Oregon Coast Range, non-random surveys conducted by the Oregon Forest Industries Council indicate that only 17% of the area's stream miles are at "desirable" levels (as defined by ODFW) for large wood pieces/mile, and that only 23% are in a "desirable" condition for large wood volume (OCSRI 1997). Large riparian conifers are at desirable levels along less than 1% of the streams on industrial and non-industrial private forest lands (OCSRI 1997).

Forest management activities within a distance equal to one site-potential tree height of streams (approximately 170 to 240 feet for mature conifer trees west of the Cascades, FEMAT 1993) have the potential to change the distribution, size, and abundance of large wood available for recruitment into streams (Hicks et al. 1991, Ralph et al. 1994, Murphy 1995, Spence et al. 1996). Because large wood recruitment potential declines rapidly moving away from the stream, a buffer of 100 feet includes about 80-98% of streamside large wood recruitment potential, depending on stand age and other factors (McDade et al. 1990, Van Sickle and Gregory 1990). The FPA includes RMA widths for non-fish bearing streams that range from 0 to 70 feet, and RMA widths for fish-bearing streams that range from 50 to 100 feet. For all of these stream types the removal of riparian treees can occur within the RMA to within 20 feet of streams (or within 0 feet for small non-fish-bearing streams). About two thirds of the basal area that could be expected in mature stands can be removed from RMAs under the FPA rules, and there are no basal area requirements for small non-fish bearing streams in the Coast Range and western Cascades.

Additionally, the FPA does not provide measures to ensure that potential large wood from unstable areas upslope of RMAs and adjacent to small non-fish streams is retained. Landslides and debris flows traveling down small steam channels can be important sources of large wood for fish-bearing streams in the Oregon Coast Range (McGarry 1994). McGarry (1994) found that about half of the large wood in Cummins Creek had been fluvially-delivered (transported), and determined that hillslope processes were important to the creation and persistence of quality habitat along the majority of a stream's mainstem. In addition, McGarry (1994) found that outside of the few locations that had large aggregations of large wood, non-transported wood occurred 87% of the time outside of the bankfull width on adjacent hillslopes and floodplains. Large wood within this area is more likely to persist within the system, and provides an important function of anchoring the portion of large wood within the active channel and bankfull width (Robison and Beschta 1990). Other studies examining riparian zone wood recruitment have purposely avoided stream reaches recently affected by landslides, or acknowledged the inability to account for the origin of about half the wood found in small stream channels (Van Sickle and Gregory 1990, McDade et al. 1990).

The SAST section on large wood sources needs to discuss the implications of riparian and upslope management on sources of large wood, regardless of whether each source can be specifically quantified, and the attendant effects on stream temperature and salmonid habitat. The FPA rules and practices do not ensure adequate recruitment of large wood from RMAs, unstable areas, or debris flow paths (Botkin et al. 1995, Murphy 1995, IMST 1999).

Sediment and Landslides

Log yarding and subsequent prescribed burning activities can increase soil exposure, runoff, and surface erosion, particularly when soils are compacted (Sullivan et al. 1987, Chamberlin et al. 1991). Removal of riparian trees can reduce bank stability, thereby increasing sediment delivery (Sullivan et al. 1987, Gregory et al. 1991). Large wood in small headwater streams retains sediment by forming depositional areas and dissipating energy (Bisson et al. 1987, Sullivan et al. 1987, Bisson and Bilby 1998). Sediment yields from headwater channels were greatly influenced by channel storage provided by large wood (Swanson and Fredriksen 1982). Without abundant channel storage elements, virtually all of the sediment entering a channel was routed downstream, while a channel with many storage sites from large wood only routed about 10% of the delivered sediments annually. Large in-channel wood also delays surface water passage, allowing it to be cooled by mixing with ground water (Bisson et al. 1987).

Clearcut logging on unstable landforms increases landslide frequency (Swanston and Swanson 1976, Sidle 1985, Swanston 1991, Robison et al. 1999). Based on an investigation of three streams in the Oregon Coast Range, Reeves et al. (1995) concluded that under a natural disturbance regime, periodic inputs of coarse sediment (boulders, cobble and gravel) and large wood in landslides may help create productive salmonid habitat, as these materials can be depleted in stream channels over long periods of time. However, landslides originating from harvested hillslopes, and debris flows that travel along stream channels where trees have been removed by harvesting, will deliver primarily sediment rather than large wood to streams (Hicks et al. 1991, Reeves et al. 1995). The FPA rules and practices do not preclude road construction or logging on unstable slopes or along debris flow paths, except where human life and property are at risk. The SAST sufficiency determinations should address the effects of the FPA on landslide rate and composition, sediment delivery, stream morphology, and temperature.

Road Effects

Construction of a road network can greatly accelerate erosion rates and sediment yield in a watershed (Haupt 1959, Swanson and Dyrness 1975, Swanston and Swanson 1976, Beschta 1978, Gardner 1979, Furniss et al. 1991, FEMAT 1993). Cederholm et al. (1981) reported that the percentage of fine sediments in spawning gravels increased above natural levels when more than 2.5% of a basin area was covered by roads.

On unstable slopes, road construction or improper maintenance can greatly increase landslide rates relative to undisturbed forest (Swanson and Dryness 1975, Swanston and Swanson 1976, Furniss et al. 1991, Robison et al. 1999), delivering large pulses of sediment to streams. Unpaved road surfaces continually erode fine sediments (Reid and Dunne 1984, Swanston 1991). Road networks can intercept, divert, and concentrate surface and subsurface water flows, providing a direct conduit for sediment into streams (Hauge et al. 1979, Furniss et al. 1991, Wemple et al. 1996). Stream crossing fills can also be a source of sedimentation, especially if culverts fail or become plugged with debris (Furniss 1991, Murphy 1995). Roads built near streams often eliminate part of the riparian vegetation (Furniss 1991), reducing large wood recruitment and shade, and may disconnect streams from floodplains and groundwater sources of cold water.

Reduction in large wood recruitment, increased landslide rates and sediment yield, more efficient sediment routing, and reduced bank and channel stability from logging, road construction, and road use can combine to make streams wider and shallower, with fewer and shallower pools (Sullivan et al. 1987, Swanston 1991, Furniss 1991, Gregory et al. 1987, Hicks et al. 1991). Such streams are more susceptible to warming. The FPA rules do not provide adequate measures to address the above sediment-related factors. The SAST sufficiency determinations should address these factors given their relationship to stream temperature.

Water Quality Standards and FPA Goals and Purpose

The stated purpose of ODF's Water Protection Rules at OAR 629-635-100(3) is protecting, maintaining, and where appropriate improving the functions and values of streams, lakes, wetlands, and RMAs. Protection, maintenance, and improvement of these functions and values is largely dependent on the total acreage within RMAs and the types, intensities and frequencies of forest management activities, both inside and outside of the RMAs. RMA width and tree retention requirements are key determinants of riparian functions that can affect stream temperature, such as shade, large wood recruitment, erosion control, and moderation of microclimate. The RMAs are, therefore, critical to meeting water quality standards. Based on an analysis of RMAs required under Federal, state, private, and tribal forest practices, the FPA provides inadequate protection of RMAs and the attendant functions and values they provide for Oregon's streams, lakes, and wetlands (see Attachment 2). The SAST validates the findings of the IMST that the FPA "is not sufficient to accomplish the recovery of wild salmonids" (IMST 1999).

The SAST and other studies and assessments indicate that forest practices under the FPA rules likely contribute to violations of Oregon's numeric water temperature criteria, and of the criteria at 340-041-0205(2)(b)(A) that are intended to implement the state's antidegradation policy and to protect threatened salmonids in Oregon[1]. When monitoring, research, assessments or other information demonstrate that practices under the FPA rules do not meet WQS, the rules need to be revised. The rules could be revised so that practices fully meet WQS and provide functional habitat for ESA-listed fishes during the BOF's consideration of the FPAC proposals. Also, the FPA rules include a provision for basin-specific rule changes that can address water quality issues in a particular watershed, subbasin, or georegion. Based on the substantial body of scientific literature demonstrating that Oregon forest practices likely adversely affect water quality and threatened species of salmonids, we recommend initiation of the basin-specific rule change process.

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[1]To accomplish the goals identified in OAR 340-041-0120 (11), unless specifically allowed under a Department-approved surface water temperature management plan as required under OAR 340-041-0026(3)(a)(D), no measurable surface water temperature increase resulting from anthropogenic activities is allowed:

(i) In a basin for which salmonid fish rearing is a designated beneficial use, and in which surface water temperatures exceed 64° F (17.8 ° C);

(iii) In waters and periods of the year determined by the Department to support native salmonid spawning, egg incubation, and fry emergence from the egg and from the gravels in a basin which exceeds 55° F (12.8° C);

(iv) In waters determined by the Department to support or be necessary to maintain the viability of native Oregon bull trout, when surface temperatures exceed 50° F (10.0° C);

(vi) In stream segments containing federally listed Threatened and Endangered species if the increase would impair the biological integrity of the Threatened and Endangered population.

PAGE-SPECIFIC COMMENTS

The location of the referenced text in the specific comments is by page number and paragraph from the SAST.

Page 4, Paragraph 5
Last sentence, add timing of rearing of bull trout and cutthroat trout. Bull trout may rear in stream gravels for 220+ days out of 365.

5, 3 Sentence 3. Last sentence should read: "Riparian buffers of roughly 30 m (100 ft) are generally acknowledged in the scientific literature as minimum for protection of many riparian functions."

5, 4 The second sentence should identify the "various results" being referred to.

P. 6-10 This section of the Executive Summary is based on the main text of the document. Comments on the main text provided below also apply to the Executive Summary as appropriate.

13, Chart 1. The analysis decision tree in Chart 1 (left arm, third tier down) is flawed in cases where the current effects of BMPs are masked by past practices (legacy effects). This approach will fail if the legacy effects mask the new effects enough so that statistically significant findings can not be reached.

14 In general, this section should rely on a broader range of literature, and should more thoroughly describe the potential sublethal effects of water temperature on salmonids, since those effects likely are more prevalent than lethal effects in forested landscapes. Also, we disagree with the implication that only summer maximum temperatures are of concern. Stream temperatures in late summer or early fall, while occurring after the summer maximum, may be warm enough in managed landscapes to adversely affect salmonids that hold and spawn at that time (such as spring chinook in the Grande Ronde, Imnaha, John Day, Willamette, and Rogue River basins; Lichatowich et al. 1993, Myers et al. 1998). Another consideration outside of the summer maximum period is temperatures during out-migration and smoltification. Temperatures must be cooler than the Oregon rearing standard to fully support the outmigration of steelhead, spring chinook, and coho salmon, which occurs in spring and summer (Bell 1991, DEQ 1995, Weitkamp et al. 1995, Spence et al. 1996). Spring chinook require temperatures of 3.3-12.2°C for smoltification and outmigration (DEQ 1995). The preferred smoltification temperature range for coho salmon is 12.0-15.5°C (Brett et al. 1958). The upper limit for parr-smolt transformation and out-migration of steelhead trout is in the range of 11.3 to13.0°C (Zaugg and McClain 1972, Adams et al. 1975, Zaugg and Wagner 1973, Zaugg 1981, McCullough 1999). DEQ (1995(b)) states "It is recommended for all salmonids that temperature not exceed 54°F (12.2°C) to maintain the migratory response and seawater adaptation in juveniles..." If spring temperatures are too high, salmon smolts will revert to a pre-smolt physiology and remain in fresh water (Spence et al. 1996, McCullough 1999).

14, 1-2 Information for steelhead and cutthroat trout needs to be included in this discussion. Summer steelhead in Oregon enter freshwater from spring to summer and hold until spawning in late winter or spring in the following year (Busby et al. 1996). Incubation of eggs and fry may extend into summer for a number of steelhead stocks including Lower Columbia River steelhead, Middle Columbia River steelhead, and Snake River steelhead (Howell et al. 1985, Busby et al. 1996). The rearing period for all of these stocks, as well as other steelhead populations, includes the summer.

14 Footnote 3. We would appreciate an opportunity to review a draft of Dr. Danehy's work on thermal requirements of bull trout.

15, 3 Some important sublethal effects are not mentioned in this section. Temperatures above 15.6-17.8°C (60-64°F) can contribute to increased pre-spawning mortality; out-migration from unsuitable areas; increased disease virulence; reduced disease resistance; and delay, prevention or reversal of smoltification (Berman 1990, Marine 1992, DEQ 1995, McCullough 1999).

15, 4 If there is a direct connection between the lethal limits in Table 2 and the State's temperature standard, this connection should be made clearer.

20, 5 Stream channel widening can also be an important heating factor. This should be discussed and integrated into the final analysis.

23, Figure 5. It is not clear what the black boxes with arrows to the lines refer to.

23, 3 The last paragraph should be used to summarize the data provided in Figure 5 (e.g., what is happening to both curves at width=100 ft.), rather than to present a hypothetical example of something that is not shown in the Figure.

25, Figure 7. Note that the state water quality standard for bull trout (from Table 1, p. 14) is considerably below the recorded temperature values in both stream segments. Thus, neither of these stream segments would support bull trout spawning, egg incubation, or emergence. It would be helpful if the figures were summarized or interpreted, and related to something that is biologically meaningful if possible.

25,3 The SAST lists five primary factors controlling stream temperature, then appears to only consider shade in the SAST determinations.

26, The x-axis of figures 8 and 9 is not readable.

27, 2 Suggest modification of sentence 4 to "Floodplain roughness is increased by riparian vegetation which slows stream velocities and increases retention time of water on the floodplain while reducing local shear stresses and bank erosion."

28, 3 Sentence 2. The SAST should avoid sentence constructions/phrases such as "some argue" or "various results". A valid analysis needs citations and actual presentation of findings for the reader to compare. Also, when using or referencing findings, a summary of those findings should be provided. The paragraph as a whole leaves the reader uncertain of the foundation for the argument being presented.

29, 5 In contrast to the "conclusion" of Caldwell, Beschta's statement (above paragraph 4) is presented as an hypothesis. The contrast in information provided or analyzed by both Caldwell and Beschta should be a bit clearer.

29-31 In discussing factors that control temperature, the role of basin hydrology is understated and the relationship of channel form to its valley form is not addressed. The TMDL prepared for Simpson forest lands in Washington included analysis which demonstrated that lithology and topography, which ultimately defined the character of the valley through which streams flow, was paramount in defining the range of channel conditions found within a given area. This landscape stratification scheme, with refinements in channel type based on basin area, relative channel confinement and gradient, allowed for a much more tailored means to observe and predict how streams would respond to differing levels of shade and sediment input. The data on temperature from > 400 mi^2 area suggests that shade is not always the most important determinant of stream temperatures everywhere, and that streams and their characteristic temperature signatures can differ significantly in their response to riparian timber harvests. Other studies suggest that factors such as total basin area harvested within a short period may be a more important determinant of stream temperatures than riparian zone stand conditions alone (Hatten and Conrad 1995). The SAST discussion should be broadened to include the above valley form and landscape scale factors relevant to stream temperature.

30, 1 Add to paragraph 1 "Greater vertical variability exists in streams with a well defined pool/riffle sequence, which causes more water to be forced into the hyporheic zone due to hydraulic pressure."

30, 3 Second sentence should not limit the known occurrence of hyporheic zones to the downstream end of riffles. Hyporheic zones can occur almost anywhere along a stream gradient, depending on factors that are not fully understood.

30, 3 Last sentence also should indicate that we cannot currently predict where hyporheic zones are to be found. Interruption or alteration of hyporheic flows is a possible side effect of ground disturbance; ground disturbance is not evaluated in final risk determinations when comparing the likelihood of attaining temperature standards.

30, 4 Stream Bank Stability/Instability. This section should be more inclusive of various stream bank failure mechanisms. The discussion of stream bank erosion is limited to one failure mechanism and is too simplistic to be of use. The statement "Stream bank erosion reflects looseness of bank soil, rock and organic particles. The opposite condition is cohesion of stream bank soil, rock and organic particles" implies that cohesive banks are more stable. While it is true that cohesive banks are less likely to erode due to single particle detachment, they are more likely to erode because of mass failure from saturation, over-steepening, or undercutting.

According to Thorne (1990) "mass failure of non-cohesive banks occurs by shearing along shallow, planar or slightly curved surfaces. The motivating force is shear stress on the potential failure plane due to the downslope component of weight..." He continues that "most mass failures of cohesive banks occur following rather than during high flows in the channel. This is because the switch from submerged to saturated conditions that accompanies drawdown in the channel approximately doubles the bulk unit weight of the bank material, increasing the motivating force on the potential failure surface in about the same proportion." Later in the same paragraph, the statement "vegetation strengthens particle cohesion by increasing rooting strength that helps bind the soil and add structure to the stream bank" is unclear. It implies that vegetation merely increases a rooting strength that the soil already contains – the vegetation provides rooting strength. Again from Thorne (1990): "Soil is strong in compression, but weak in tension. Plant roots are weak in compression, but strong in tension. When combined, the soil-root matrix produces a type of reinforced earth which is much stronger than the soil or roots separately.....roots are effective in both adding tensile strength to the soil and, through their elasticity, distributing stresses through the soil, so avoiding local stress build-ups and progressive failures."

31, 2 Stream bed roughness is more important than bank roughness in determining Manning's N values. The SAST discusses only bank stability.

31, 4 Modify sentence 2 to include: "The degree of sinuosity is related to **landscape position,** channel dimensions, sediment load, stream flow, and the bed and bank materials."

32, 1 The discussion of riparian characteristics and hyporheic flow should expanded to include a more detailed discussion regarding in-flow (upwelling) and out-flow (downwelling) that is associated with functional hyporheic/surface flow interactions.

32-33 The information on these pages suggests that other factors besides shade— i.e. groundwater, floodplain connectivity, microclimate, etc., can affect stream temperatures. This information should be included in making risk evaluations.

33, 2 Add to "Energy lost through evaporative heat transfer can result in a decrease in stream temperatures if heat losses are greater than heat gains (Benner & Beschta 2000)" ...which is important during winter months when streams lacking riparian cover are exposed to severe cold.

34, 1 Add "fire, wind, insects, pathogens" etc. to "wildlife, etc," (list of disturbances), and consider other references besides Swanston (1991) as necessary. Perhaps "wildfire" was intended instead of "wildlife"?

34, 3 Need to introduce the definitions of Type F, N, small, large, etc. here or prior to regional summaries. The RCR terminology also should be defined and explained.

34,3 There is no clear statement of the sampling design, comparability or representativeness of selected field sites, or details of the particular field methods used for gathering information on the characteristics of temperature in various streams. It is not clear whether the BMP effectiveness determinations are relying on a number of studies or whether the data cited is from the 1997 study by Dent and Walsh. This is especially problematic if the determinations are being made based on one or a few studies that provide very limited data and the determinations are then extrapolated to the wider universe of streams in Oregon. The sample size apparently used seems too small (n = 7 different streams, with sampling sites distributed within them), and the sites are not necessarily comparable given there is no geomorphic stratification for the sites, either before or after selection. For example, if as described for Dent and Walsh (1997) on p. 36-37, there were eight "sampling sites", all on one stream, and all within one year (1995), what conclusions may be drawn? This will depend on whether 1995 was a typical or atypical year with respect to climatic factors such as seasonal temperatures, summer-time precipitation, snowpack and snowmelt influences, or others factors that could affect the observed outcome. The sufficiency determination should consider a range of conditions including a worst case scenario (i.e., a year with low snowpack, and warmer than usual spring and summer temperatures). It is not clear what features of the study streams are universally applicable to the myriad of other stream types subjected to the general treatments afforded by the BMP's. The sensitivities of all streams would likely vary depending on channel condition, ground water inputs, orientation, substrate composition, and a host of other factors.

35, 2 List of reports. Identify how can they be obtained, which are most relevant, and what parts of each is relevant. Some of the ODF Technical Reports do not seem to be in the "References" section at end, while Caldwell (1991), which is Washington Department of Forestry "grey" literature, is in the references section. For the first report, the parenthetical statement (Small Type N Streams) conflicts with the statement in the following paragraph that the monitoring sites included in this study are mostly medium and large streams.

35, 3 It would be helpful if this paragraph ("A review of...") established a context for the discussion that follows. For example, how does it relate to the questions on p. 13? The usage "pre-post" should be explained.

35, 5 Sentence 3 ("For each reach...") should state how far downstream of the harvest unit the temperature probes were placed.

36, 1 Unclear presentation of findings, compared to tables. Using the ANOVA method, did temperatures actually decrease in treated streams that were located higher in the basin? Was this a reliable finding, or could it have been due to sampling error, or lack of adequate control for time? The reader needs to understand what types of streams these findings are specific to. Do the ANOVA and Wilcoxon non-parametric tests agree on these specific findings? The text suggests that additional sampling locations downstream of the treatments may have been used. The data for these additional downstream reaches do not appear to be included in Table 4, which includes only T (treated) and U (upstream controls?) reaches.

36, 3 Table 3 should read "Table 4". Also, the question as originally posed is related to the analysis framework on p. 13 (not p. 6 as referenced). The approach in the chart and with respect to this question is flawed (see comment on p. 13, Chart 1).

37, 1 Last two sentences: The described approach to determining if a change in temperature is due to a treatment effect or to a temporal shift in climate is not exactly appropriate, given that it seems there was considerable overlap (as described on the previous page and as shown at least in Figures 11 and 13) in time between the pre- and post- samples. Only if there was poor overlap or if the pre- or post- samples could not be compared (in time) would this be important. It is unclear whether, for each category of stream tested, controls for time effects were adequate. It appears that controls for time were adequate, at least for the small stream category. Figure 16-1 (small streams upstream; upstream controls) showed no change in temperature with time. Therefore there is a clear test of the null hypothesis for small streams.

38 Table 4 displays summary information about the sites at which the data were collected. There is no explanation to decipher the meaning of various column headings, e.g. rate type—is this the rate of change in temperature? What do the letter codes mean? Although the "post harvest year" is given, there is no information on when the "treatment" actually occurred. Also, since no information is given on years in which pre-harvest data were collected it appears that there were different periods of time between the "treatment" or harvest and the post-harvest field data collection. If this is the case, it brings into question some of the apparent conclusions reflected in Figure 19. The bar graph in Figure 19 shows a net increase in shade shortly following harvesting in 2 of 9 small streams, 3 of 7 medium streams, and 2 of 7 large streams. These results are counterintuitive. Since the SAST does not describe how "shade" was measured, it is not clear if the methods used have sufficient inherent inaccuracy to explain this result or if those particular sites had more time to recover before they were measured post-harvest.

38 It is not clear how treatments applied to the selected sites were standardized. Evidently, there were 3 riparian treatment types, CC = clearcut, TH = thinning, and hardwood conversion, here described as RCR = riparian conifer restoration. According to Table 4, some treatment sites had both sides of the native riparian zone subject to the treatment, while other sites had only one side (which side and its aspect are important) harvested. Also, it is unclear what the "upstream" sites represent, since they too appeared to have some sort of pre- and post-harvest data collection. Were the riparian areas in the upstream sites in mature forest condition? Was this meant to illustrate changes *not* attributable to treatments, or were upstream sites subjected to treatments? The graphical displays of the analysis results (Figures 16 - 17) don't explain how much time lapsed between pre- and post- sampling, and whether there was inter-annual variability in weather patterns that might explain differences. Additional narrative explanation for the figures should be provided.

39 It appears that the bulk of the sample analysis involved data from seven streams, with 28 sites distributed among these seven streams. It is incorrect to represent 6,740 individual measurements as the sample number. Figures 11-13 are intended to show how these "samples" are distributed over time at each site, for pre- and post-harvest, and for both "upstream" and treatment sites. The

graphs are very unclear—there is no legend to explain what information the reader is expected to glean from them.

54,3-5 The fact that elevated temperatures in small streams still remained below temperature standards does not reduce the potential cumulative effects of such temperature increases, or address the antidegradation standard.

55 The effects determinations appear to be derived through an analytical approach that considered only shade and stream temperatures and attainment of numeric, fixed temperature targets, rather than how the whole suite of forestry BMPs affects riparian and stream channel functions and support of beneficial uses. There may be some evidence to suggest that a given riparian harvest provides adequate shade along a stream, in some years. That falls short of demonstrating that a designated beneficial use, such as salmonid spawning, is protected. Shade is just one factor affecting temperature and temperature is but one criterion set to ensure beneficial use support. Other in-channel and riparian features may provide compensatory factors that ameliorate less-than-ideal temperatures. Industrial-scale timber harvesting has and will likely continue to impose a multitude of effects that change the overall, long-term suitability of instream habitats required for recovery of salmonids (see Ralph et al. 1994, and others referred to in General Comments). These include the input and routing of organic matter (small and large wood, detrital organic materials), water, and sediment (from yarding, roads and landslides).

The determinations should specifically identify the data that they are based on. As noted below, the statements in the determinations do not seem to be fully justified by the data presented. The determinations should consider factors other than shade and should be based on the full body of science rather than a single or several limited studies.

55, 2 Based on the data, sentence 1 should read "it is likely..." or "it is very likely" not "has the potential to...result in some increases in stream temperatures."

55, 2 Last sentence: the last sentence should simply say "stream temperature increases are likely...", not "it is likely...[that] increases are also possible..." Based on the data, and the true (and highly significant) test which discounted the null hypothesis, "likely" also fits the data better than "also possible."

55,2 Need to explain the "Mixed" finding for Medium Streams in Table 5 (see Figures 16-3 and 16-6 for medium streams).

55,3 What is the likelihood that the downstream reach will not have also been harvested, or be harvested within a reasonably short period of time?

55,3 Cumulative effects have not been addressed. If ten of these "small type N" streams drain into a larger stream, the combined total of their input could be nearly equal to the flow of the larger stream. This **would** have a significant impact on stream temperature. Accordingly, the last sentence: should read: "...10 percent of the receiving stream are unlikely to **individually** influence temperatures..." (add the word "individually").

55, 4 The statement that the current BMPs are likely to be effective in minimizing temperature increases seems to overstate the case based on the variable nature of the data presented.

55 Footnote 7: We disagree that stream flow and/or channel width are not likely to be affected. An alteration in watershed cover may affect hydrology. Typical changes in hydrology due to watershed changes, especially where there are roads, will be an increase in the frequency and

magnitude of high flow events. This increase may lead to channel widening, and channel widening is acknowledged in this document to lead to stream temperature increases.

56, Table 5 is premised only on shade, i.e., on relatively short-term responses of streams to changes in shade alone, using no information about any other mechanism for temperature increase (see General Comments). Also, it appears that some of the entries (e.g., Large streams) are based on opinion, not on data provided here.

57, Therefore, Tables 6 and 7 may be invalid. Table 6 appears questionable, especially in the Large (all treatments) category.

58, The risk findings in Table 8 are not all supported by data presented in the draft, or else supporting data were not readily evident.

58 Based on the full body of the best available science we agree with the conclusion in Table 9 that small and medium sized streams (both F & N types) are not adequately protected when the "treatment" involves clearcut and hardwood conversions. The full body of science supports the same conclusion for large type F and N streams under the FPA rules. While the ODF monitoring study did show a decrease in shade levels and an increase in stream temperatures for most of the sites monitored, the shortcomings of the overall sampling design and methods used by ODF need to be addressed.

58 Tables 8 and 9, while seeming reasonable in some cases, may be invalid in others, because they are premised on Tables 5, 6, and 7. There is no basis or rationale presented for Tables 7 and 8. For example, for small type N streams under Clear Cut management, it is hard to understand how to get from Table 5 (Is forest harvesting under current BMPs a potential cause of stream temperature increases...Very Likely) to Table 8 (What is the level of risk that current BMPs are the cause of temperature standards not being met... Low to Moderate). These do not seem to be consistent responses, and no explanation is provided. These qualitative conclusions should be backed up with and related to the box and whisker plots presented earlier.

59, 1 Last sentence. This interpretation implies that if grazing and water withdrawal adversely affect stream temperatures, then contributing increases due to timber management practices do not need to be assessed. This is not consistent with the CWA or ESA. Under these laws forest practices need ensure that WQS are met and that harvest activities avoid "take" of ESA-listed species.

59, 7 The discussion of coldwater refugia in four above paragraphs is fine. However, if a specific definition for coldwater refugia is lacking, how can the standard to protect these be met?

60, 1 First 2 sentences: As stated previously, these conclusions are not well supported in the document. Sentence 3, "Relative to other streams...": This sentence seems to run counter to the regulatory requirement. A more important question to address is: will streams of various types and sizes, and with various beneficial uses, meet the temperature requirements under current BMPs?

60, 4 The third sentence in this paragraph is an example of the mis-use of the assumption that shade is the only factor affecting stream temperature, despite the fact that elsewhere in the draft it is acknowledged that there are other important factors.

APPENDICES

- Some of the key information on important disturbance processes (in Appendix D) need to be brought up front, or at least summarized better in the main body of the analysis.

- There is not enough information on other mechanisms besides shade for thermal changes—especially the relationship between streamflow and temperature, increased sedimentation, potential channel changes, and disruption or reduction in groundwater inflows from ground disturbance (see general and specific comments above). Also, large wood has been known to sort and build gravels and lead to increased local upwelling (areas of upwelling can be important low temperature refugia for bull trout and other cold-water species.

- See the Antidegradation Policy for Surface Waters and High Quality Waters Policy (p. 79). How are these going to be implemented?

- The BMPs and underlying assumptions are not consistent with a "holistic approach" and clearly do not achieve a desired future conditions similar to that of a mature forest. As noted in the comments above, shade, large wood inputs, and sediment filtration are significantly compromised functions under the FPA rules and BMPS.

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Attachment 2

Comparison of Riparian Protection Measures in Oregon

Forest management practices for private, State, Tribal, and Federal forest lands in Oregon include riparian protection measures to provide water quality, fish and wildlife protection. Riparian areas, given their proximity to streams, lakes, and wetlands, are critical for large wood recruitment, shade, stream bank and slope stability, sediment retention, and air temperature moderation. As discussed in detail in Attachment 1, there is extensive scientific research and analysis that documents the importance of riparian functions to water quality and fisheries. The areal extent and configuration of riparian management areas (RMAs) and the management requirements applied within those RMAs are the primary determinants of RMA functionality.

Figure 1 provides a relative comparison of the acreage designated as RMA under the "rules" for private, State, Tribal, and Federal forest lands in Oregon. The RMAs from the forestry rules for westside Federal forest lands (NWFP), forest lands managed by the Confederated Tribes of the Warm Springs (Warm Springs), forest lands under the proposed habitat conservation plan (HCP) for the Northcoast State Forests, and private forest lands under the Oregon Forest Practices Act (FPA) are compared for the North Fork Kilches watershed. The forestry rules for the NWFP would designate the largest amount of acreage as RMA (100%) of the forest practice rules in Oregon. In Figure 1, the RMA acreage required under rules for private, State, and Tribal forest lands is expressed as a percentage of the RMA acreage for the NWFP. For example, RMA acreage required under the FPA would constitute approximately 7% of the acreage required under the rules for NWFP RMAs for the stream network in the North Fork Kilches watershed. The percentage number above each bar in the figure represents the comparative RMA acreage for each of the four sets of forestry rules.

The Figure 2 provides a relative comparison of tree retention requirements within RMAs under the forestry rules for private, State, Tribal, and Federal forest lands in Oregon. In Figure 2, tree retention is expressed as basal area to allow comparison of the various rules. The forestry rules for the NWFP would require retention of the largest number of trees or basal area within RMAs (100%) of the forest practice rules in Oregon. Under the NWFP the entire RMA is managed specifically for aquatic conservation and other late-successional and old-growth associated species. In Figure 2, the basal area retained within RMAs under rules for private, State, and Tribal forest lands is expressed as a percentage of the basal area that would be retained under the NWFP rules. For example, the basal area retention requirements within RMAs under the FPA would constitute approximately 3% of the basal area that would be retained under the NWFP rules in RMAs within the stream network in the North Fork Kilches watershed. The percentage number above each bar in the figure represents the comparative basal area retained within RMAs for each of the four sets of forestry rules. As shown in Figures 1 and 2, the FPA designates substantially less area as RMA and require retention of substantially fewer trees (basal area) within those RMAs than do the forestry rules for State, Federal, and Tribal lands in Oregon. The resultant reduced riparian function adversely affects both water quality and salmonid fisheries as described in Attachment 1.

Figure 1.

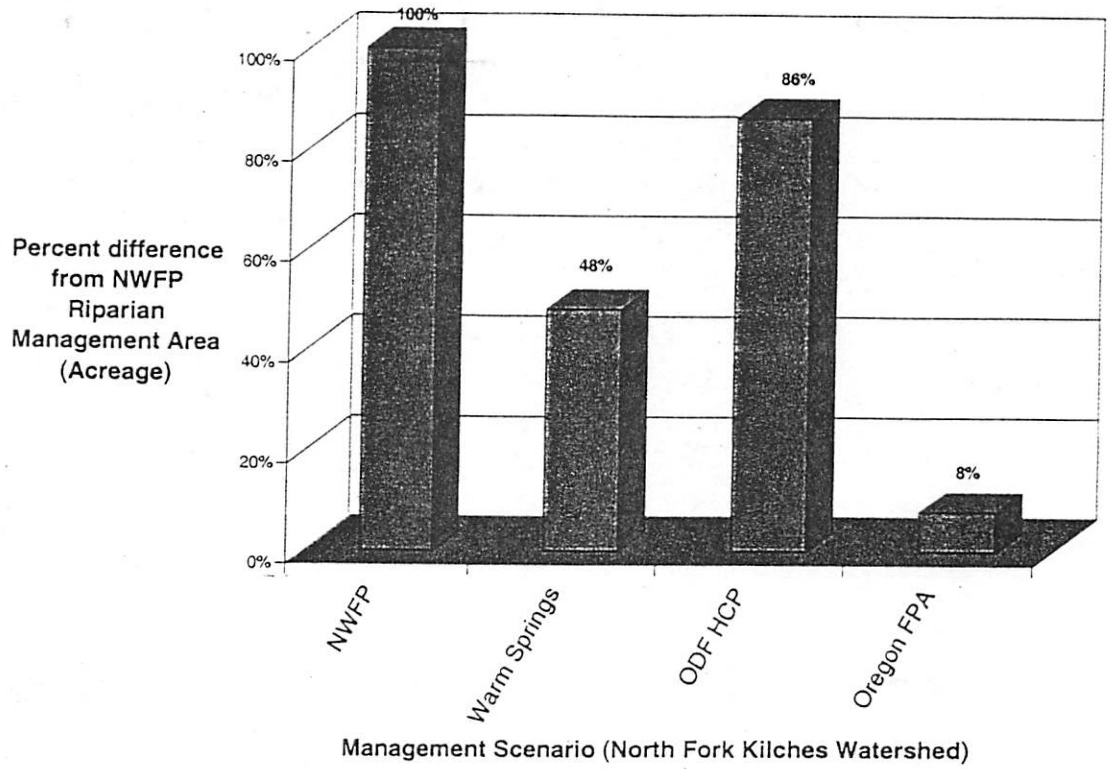
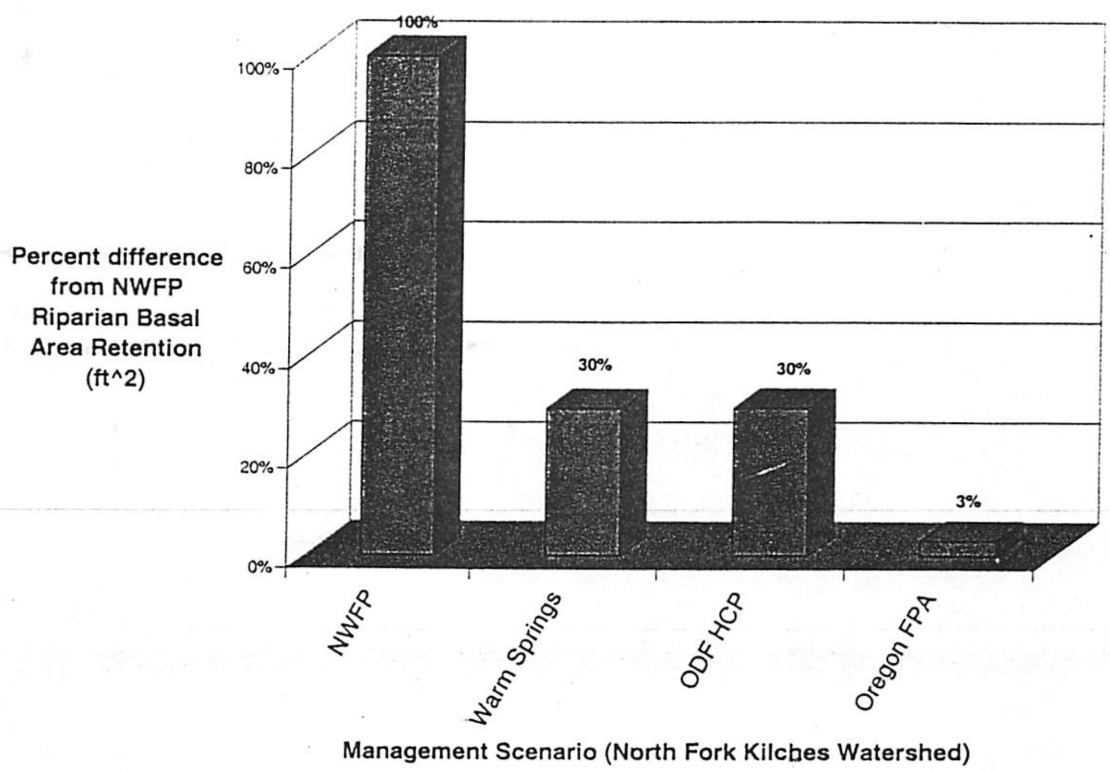


Figure 2.



Attachment 3

Total Maximum Daily Load (TMDL) Shade Comparison

Figures 1 and 2 compare the site-potential shade targets from the Upper Grande Ronde River and Tualatin River subbasin TMDLs with the shade data from an Oregon Department of Forestry 1999/2000 shade study funded under Clean Water Act Section 319. The shade study measured shade on recently harvested sites (FPA Treatment) in riparian areas and other riparian sites which had not been harvested recently, including sites with late-seral forest (Control). The numbers along the left margin of the first two figures in Attachment 3 denote shade levels (% Effective Shade). The numbers along the bottom margin of the figures approximate the active stream channel width (Near-Stream Disturbance Zone Width). The "shade curve" (descending line in the upper portion of the figures) shows the site-potential effective shade levels for varying near-stream disturbance zone widths. The potential shade level gets lower as the near-stream disturbance zone gets wider. The vertical bars along the site-potential shade curve indicate the differences in effective shade levels that occur due to stream aspect (e.g., stream running north to south, east to west). The control sites (shaded diamond symbols) in both the Grande Ronde and Tualatin River Subbasin figures correlate very well with the TMDL site-potential shade curves. The FPA Treatment sites (circle and triangle symbols) provide lower effective shade levels, falling below the site-potential shade curves. The basic relationship between shade levels at Control sites and lower median shade levels at FPA Treatment sites holds true for the full body of data sets (122 sites) from the shade study.

Figure 3 demonstrates how far shade levels at FPA Treatment sites and Control sites deviate from site-potential shade targets in the Tualatin River Subbasin TMDL. The numbers along the left margin of the figure indicate the deviation from the TMDL site-potential shade levels (both above and below potential). On the left margin 0% correlates with the TMDL site-potential shade target as does the horizontal line to the right of 0%. The bottom margin of the figure shows specific FPA Treatment sites and Control sites that match up with the bars in the figure. All of the unshaded bars matched with the FPA Treatment sites show shade levels below the TMDL shade target. The average deviation of FPA Treatment sites from TMDL shade targets is -23.8%. The shaded bars, which align with the Control sites, fall both above and below the TMDL shade targets and have an average deviation of 0.2% above the TMDL shade targets.

The data from the 122 sites in shade study consistently show higher median shade levels at Control sites than at FPA Treatment sites for all the data sets for all stream sizes. The data from the FPA Treatment sites also consistently have a higher deviation from median shade levels than do Control sites. The lack of preharvest basal area and shade measurements at FPA Treatment sites precludes a precise analysis of how much harvest affected basal area and shade levels. In addition, the basal area levels at many of the FPA Treatment sites are higher than the current Oregon FPA basal area requirements potentially understating the shade reduction that would result from meeting the FPA requirements. On some of the sites grazing, disease, and other natural disturbance may also have affected shade levels, particularly on some Eastern Oregon sites. These non-harvest disturbances would not likely be significant on most Western Oregon sites given the absence of grazing in the Coast Range and the longer disturbance return intervals.

[illegible]

[illegible]

[illegible] disturbances may also have affected shade levels, particularly in some Eastern Oregon [illegible]

Figure 1. Tualatin River Subbasin TMDL Effective Shade Surrogate Measures (DEQ Data) and Measured Effective Shade Data (ODF Data, 1999)

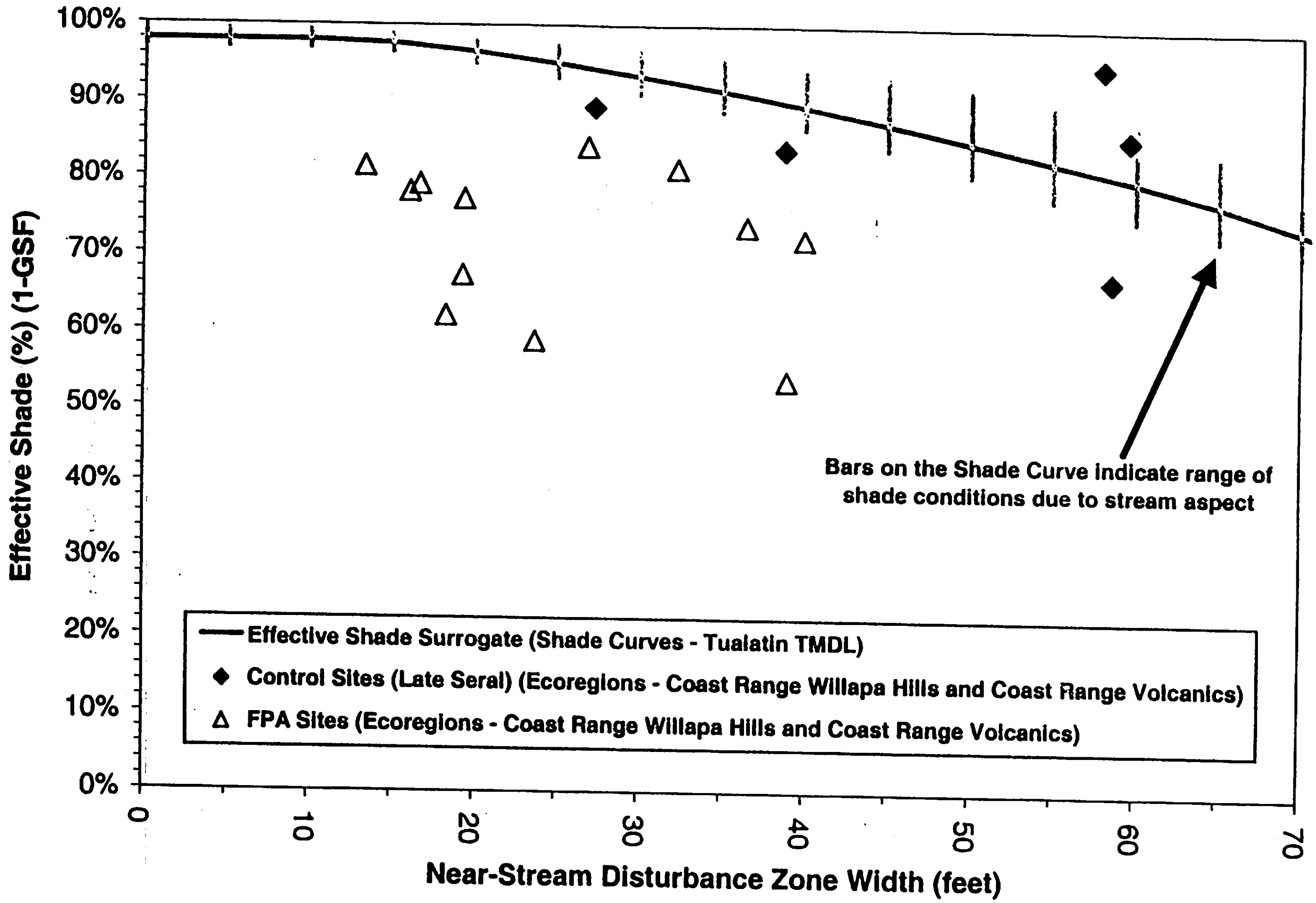


Figure 2. Grande Ronde River Subbasin TMDL Effective Shade Surrogate Measures (DEQ Data) and Measured Effective Shade Data (ODF Data, 1999)

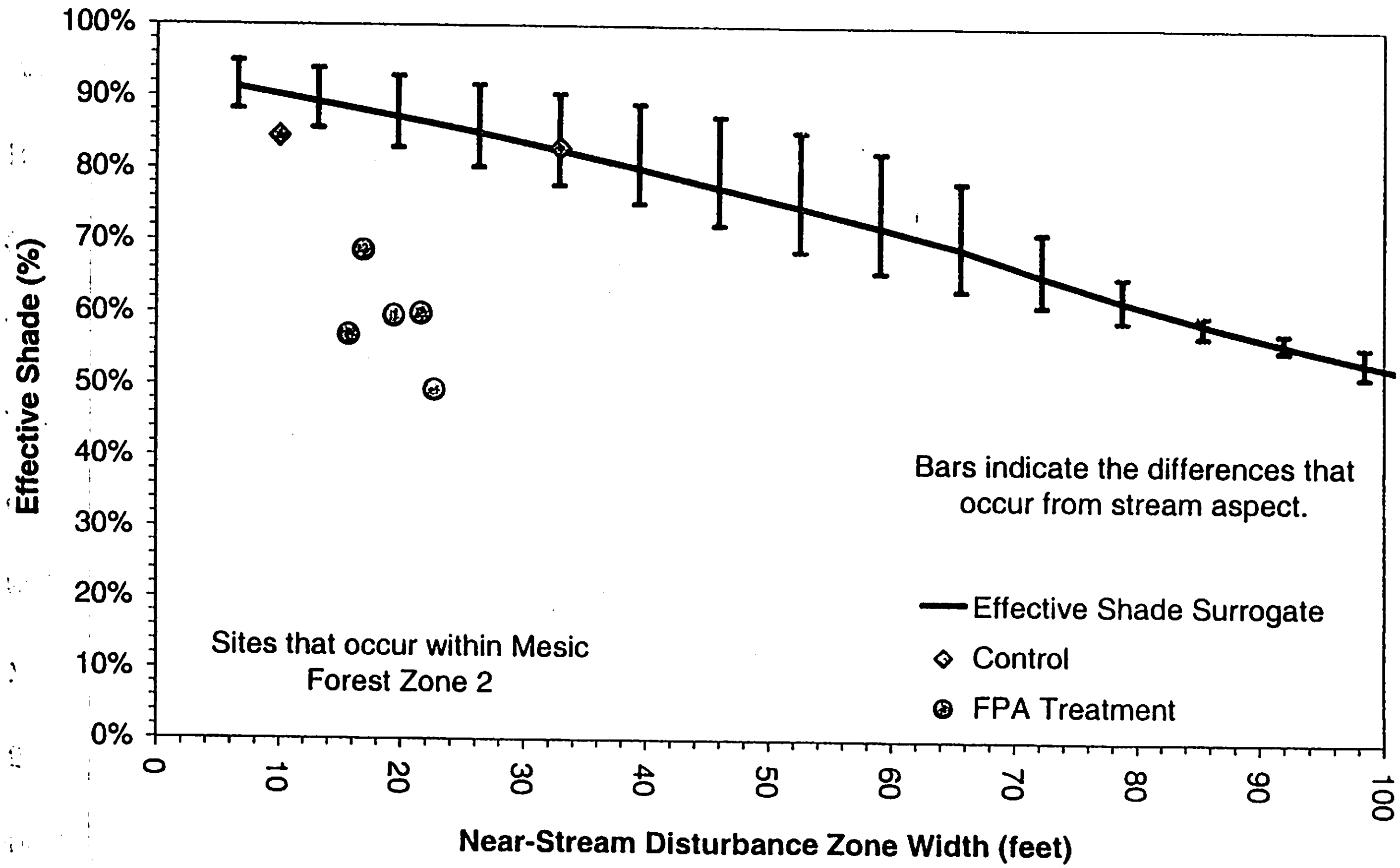


Figure 3. Deviation of Measured Effective Shade Data (ODF Data, 1999) from Tualatin River Subbasin TMDL Effective Shade Surrogate Measures (DEQ Data)