to measure than slope distance, horizontal distance for slope would better incorporate riparian management area dimensions.

This guidance and rationale for forest management by the USFWS indicates that a 150-ft buffer on each side of a 100-year floodplain filters <u>most</u> of the sediment from surface flows. It acknowledges that it provides <u>some</u> microclimate and shallow groundwater thermal buffering. It provides a margin of error for hillslope instability, blowdown, and channel movement. In addition, it also requires protection of non-fish bearing tributaries, seeps and wetlands. All these precautions are jettisoned by the current land management proposal.

Protection of All Headwater Streams is No Less Important for Maintaining Water Quality than Protection of Perennial, Fish-Bearing Streams

The importance of maintaining the high quality of headwater streams was recently noted by Fischer et al. (2000):

> *Although buffer strips are important along all river and stream reaches, those in headwater streams (i.e., those adjacent to first, second, and third order systems) often have much greater influences on overall water quality within a watershed than those buffers occurring in downstream reaches. Downstream buffer strips have proportionally less impact on polluted water already in the stream. Even the best buffer strips along larger rivers and streams cannot significantly improve water that has been degraded by improper buffer practices higher in the watershed. However, buffer strips along larger systems tend to be longer and wider than those along smaller systems, thus potentially providing better wildlife habitat and movement corridors (Lock and Naiman 1998).*

Providing Extremely Narrow Buffers on Small Streams Increases the Incidence of Blowdown that Would Further Weaken Protection of Streams from Water Quality Degradation

When narrow buffers are left along streams as a concession to protect against stream heating to some level, the effectiveness of this "protection" is frequently compromised by blowdown. In 1975-1977 Steinblums et al. (1984) (as cited by Pollock and Kennard (1998) studied 40 buffer strips of 1-15 year age that ranged in buffer width from about 30 to 190 feet. Steinblums found that 5 of 12 narrow buffers (30-80 ft) lost 33% of the original stand volume to blowdown, yet only one wide buffer had significant blowdown.

Sherwood (1993) (as cited by Pollock and Kennard (1998) resurveyed the buffers from the Steinblums study. At this point the buffers were 15 years older. He found that 3 more narrow buffers had windthrow accounting for >20% of basal area. Also, 4 of the 5 narrow buffers where Steinblums observed significant windthrow had additional losses in basal area due to windthow. No wide buffers lost >20% of basal area due to windthrow.

More recently, Mobbs and Jones (1992), in a survey of riparian buffers in the Olympic Peninsula, found that windthrow in buffers <75 ft wide caused a 5-50% loss in 28% of all designated buffers. Buffers that were >75 ft wide had the same level blowdown in only 12% of designated buffers. Their plot of all data however shows a sharp reduction in percentage blowdown to approximately 125 ft, with a lower rate of decline in blowdown from 125 ft to 500 ft buffer width (Mobbs and Jones 1992, as cited by Pollock and Kennard 1998).

The USDI-BLM DEIS Ignores the Science of Microclimatic Effects within the Riparian Buffer and Over the Streams Regarding Protection of Aquatic Ecosystems

The USBLM alternative considers only a limited aspect of microclimate—solar radiation reaching the stream. Other important aspects of microclimate, such as relative humidity, wind speed, air temperature, and soil temperature are ignored. The soil temperature linkage to shallow groundwater temperature and solar radiation has already been discussed as microclimatic effects of the proposed alternative.

The remaining aspects of microclimate are also important in maintaining a riparian environment that can keep stream temperatures cold as well as supporting the viability of obligate riparian plant species, amphibians, birds, and other wildlife.

Several authors have demonstrated the importance of buffer strip widths in protection of microclimate characteristics similar to those typical of intact, forested streamside areas. Brosofske et al. (1997, Image 1) found that buffers of >45 m on each side of the stream are necessary to eliminate most microclimatic effects of an upslope clearcut. However, due to the depth of penetration of effects from the clearcut into the forested riparian buffer, natural riparian conditions may require even greater buffer widths for the buffer itself to be protected, especially when the buffer is south facing. Chen et al. (1995) observed that humidity and wind speed can be affected as much as 240 m or more from a clearcut into a Douglas fir forest. Dong et al. (1998) reported that air temperatures near the stream were increased by 2-4°C after harvesting. In addition, the variation in temperature over the stream increased after harvesting. Buffers >70 m were found to be needed to protect against air temperature increases stemming from upslope harvest.

Ledwith (1996) showed that mean air temperature at streamside decreased asymptotically as buffer widths increased to 150 m. Likewise, mean relative humidity at streamside increased as buffer widths increased to 150 m.

ODEQ's Upper Sucker Creek TMDL (1999) for this southern Oregon coastal stream states:

> *It should be noted that this modeling exercise solely focused on solar radiation as a function of riparian vegetation and the shade it provides the stream. Additional parameters that are related to riparian vegetation that affect stream temperature are wind effects and possible summertime flow augmentation by increasing the volume of water stored in riparian areas (see MARGIN OF SAFETY). In*

essence, excluding wind effects and flow changes as they relate to riparian vegetation condition almost certainly underestimates the cooling attributed to allocated riparian restoration scenarios.

The modeling example given at one point in the ODEQ TMDL document for Upper Sucker Creek limited itself to only shade. The USFS/BLM TMDL ISE never did extend its analysis beyond shade effects on temperature. However, ODEQ noted that a valid TMDL would consider other factors important in water temperature regulation. Among them they noted a microclimatic factor and a streamflow factor. Wind speed is a function of density of riparian vegetation and buffer strip width (Brosofske et al. 1997). Wider buffers that are intact significantly reduce wind speed and penetration of warm air masses into the stream environment from neighboring clearcuts. Clearing riparian zones in headwater streams and exposing them to drying effects of direct solar radiation is antithetical to maintenance of summertime flows.

A study of New Zealand native rainforests (Davies-Colley et al. 2000) indicates that gradients of light and soil temperature were steepest at approximately 10 m from the edge of a forest opening, but at 80 m from the edge, light intensity was only 0.7%. This indicates that the response in light and soil temperature may reach an inflection within a relatively short distance from an edge, but the diminution of effects from the edge continue well into the forest away from the edge. Wind speed, air temperature and vapor pressure deficit required at least 40 m to stabilize. Similar results were found by Young and Mitchell (1994) (as cited by Davies-Colley et al. 2000) who found that air temperature and moisture gradients penetrated 50 m into the forest from the clearcut edge. The study by Davies-Colley et al. (2000) revealed that gradients of microclimate were minimal on cloudy days but were great under full solar radiation and on windy days. These authors recommended forest buffers of at least 40 m on both sides of small (<3.5 m) streams to protect the riparian ecosystem.

The USDI-BLM DEIS Ignores Numerous Comprehensive Reviews of Buffer Widths Needed to Provide a Full Spectrum of Ecological Functions

Buffer widths effective for a wide variety of riparian functions and outputs have been reviewed by numerous sources in the past decade. Among these sources, some of the conclusions that can be cited are:

Washington Department of Fish and Wildlife (2005) reviewed 1500 pieces of scientific literature on the importance of riparian areas to fish and wildlife in developing statewide riparian management recommendations. WDFW recommended the following riparian habitat area widths:

Type 1 and 2 streams and channels with widths >20 feet should have a buffer width of 250 ft on each side of the streams.
Type 3 channels that are 5-20 feet wide should have a buffer on each side of 200 feet.
Type 3 channels <5 ft wide should have a buffer of 150 on each side.

They stated that buffers of up to 197 feet are required to control streambank erosion, up to 164 feet for recruitment of LWD and 328 to 656 feet to protect and restore bird and mammal populations.

Where type 4 and 5 streams were on terrain with high mass wasting potential, the recommended width was 225 feet. In cases where the 100-year floodplain exceeds the widths specified, the width recommended would then extend to the outer edge of the 100-year floodplain.

WDFW (1997) (cited by Christensen 2000) recommended a buffer of 225 feet on Type 3 and Type 4 streams with high mass wasting potential. They also recommended buffers of 150 feet on Type 4 streams. Type 4 waters are >2 feet width and may be perennial or intermittent.

A review of buffer requirements (Muskoka 2003) concluded that buffers should be wider with increase in percent slope. Many such recommendations have been made in the literature, but Muskoka suggested that the most reasonable of these was an increase in buffer width by 2 feet per 1% increase in slope. For sediment deliver reduction on a 2% grade, 90% could be prevented with a buffer of 30 m or more. With increased slope, greater distances are required. LWD function requires 30-50 m. Removal of nutrients and coliform bacteria required 4 to 36 m, with 30 m cited most. Bank erosion protection required 30 m. Bird, large mammal, and small mammal protection required 30-200 m.

Other recent reviews have encompassed these reviews and other sources (e.g., Pentec 2001, Kindig and Cedarock Consultants 2003). Appendix A of Kindig and Cedarock Consultants (2003) provide tables of citations for riparian widths that provide the following functions: LWD recruitment, bank stability/erosion control, organic litter, water quality, nutrient removal, sediment filtration, microclimate, and temperature control. Probably the most extensive review available on buffer widths needed to provide for these various functions was compiled by Knutson and Naef (1997). Appendices B and C of Knutson and Naef (1997) provide extensive detail on required buffers for various percentages of function (perpendicular distance from the stream in meters). Full consideration of providing a high level of protection that encompasses all these functions would require at a bare minimum meeting the buffer widths suggested by FEMAT (1993) (Chan et al. 2004, Image 1). To the extent that even FEMAT buffers permit some level of thinning, it may be necessary to require additional buffer width to maintain functions considered by Knutson and Naef (1997).

Narrow Riparian Buffers such as Proposed by USDI-BLM have been Shown to Cause Serious Impacts to Salmonid Populations

Newbold et al. (1980) studied the effect of buffer strip width on macroinvertebrate density and diversity on northern California streams. Their research led to the conclusion that buffers <30 m resulted in extreme variation in relative abundance of taxa, with some streams being highly affected by logging. More careful analysis revealed that in the cases where narrow buffers had minor impacts, the riparian harvest was conducted

extremely carefully with individual tree selection. The wide-buffered streams (>30 m) had macroinvertebrate communities that were indistinguishable from those from the unmanaged cases.

One of the best available studies showing the impact of a series of riparian buffer widths on fish communities was that by Jones et al. (2006). This research from northern Georgia trout streams contrasted riparian buffers of 30-m width vs. 15-m width. These authors found that stream segments with 15-m wide buffers had higher peak temperatures (measured as the 7-day average of the daily maximum or 7-DADM). The 7-DADM temperatures increased by about 2±0.3°C with halving of buffer width. This relatively small increase in temperature is, however, sufficient to shift the streams from trout supporting to non-trout supporting streams. In addition, the narrow-buffered streams had 25% greater levels of fine sediments in riffle habitats. Trout populations responded dramatically to the multiple effects of the 15-m wide buffers relative to the wider buffers. Young trout biomass had an 87% reduction (95% confidence limits were 66% and 97% reduction).

The young trout provided a good indication of trout reproductive success. At the scale of 2nd to 5th order trout streams in northern Georgia, it was determined that 63% of streams had the potential to maintain water temperatures with a probability >50% of supporting young trout where buffer width was 30 m. However, if buffer widths were 15 m, there was a probability <9% that these streams could maintain temperatures capable of supporting these fish. These authors cautioned that this study does not indicate the cumulative impact of deforested gaps (e.g., gaps in riparian buffer corridors). Such a cumulative impact could be sufficient to overwhelm the beneficial aspects of 30-m buffers on the remainder of the riparian corridor.

Riparian harvest where buffers of <30 m width are left produce a decline in brown trout abundance by >50% relative to controls. In addition, significant reductions in leptiphlebiid mayflies and stoneflies were observed under these riparian buffer width conditions associated with upslope clearcuts (Moore and Richardson 2003). These authors call for buffer widths of 30-100m to protect against most impacts of riparian harvest.

It has frequently been assumed that riparian clearings are no problem for aquatic communities. In fact, some studies have found that clearcuts within extensive old growth tracts can create conditions where local increases in periphyton and fish production occur due to the light inputs but the long-term effects of riparian harvest and regrowth lead to more impoverished aquatic biota than found in old growth streams (Murphy and Hall 1981). The problem with this scenario is that cumulative warming and clearings at a basin scale lead to progressive stream warming that shrinks the overall useable thermal habitat for entire salmonid populations. ESA-listed salmon populations on the Oregon coast under such conditions have had prime, low-gradient stream habitat converted from optimum thermal conditions to marginal or intolerable temperatures. Progressively, the only suitable temperatures become limited to higher elevations and at higher stream gradients that are not conducive for salmon production. Salmonid densities tend to

decline as temperatures increase (Lessard and Hayes 2003, Image 1). In Oregon, the decline in steelhead densities with increasing temperature was shown by Li et al. (1994, Image 1). Jones et al. (2006) provided a logistic model illustrating the probability of presence of young trout, whereby high probability of trout presence occurred at temperatures <19.5°C and low probability occurred at temperatures >21.5°C. Temperatures were expressed as 7-DADM temperatures. Progressive watershed development, indexed by road density, leads to a reduction in salmonid production at a basin scale (Reeves et al. 1993, 1995). Extensive literature surveys have shown that salmonid distribution tends to decline to zero as maximum water temperatures approach 22-24°C (McCullough 1999). The sensitivity of salmonid distribution, survival, and productivity to high water temperature makes it imperative to take all feasible steps to limit further increases in water temperature at a basin level. High risk activities should not be considered at any local scale until standards have been achieved at a broad spatial scale in watersheds supporting listed or sensitive fish species (Rhodes et al. 1994).

The USDI-BLM Preferred Alternative Will Likely Cause Negative Impact to Aquatic Species Other than Fish

Kiffney et al. (2003) completed one of the most rigorous studies available investigating the effect of clearcutting of headwater streams on macroinvertebrates and periphyton. The extent of headwater clearcutting was only 20-25% on these watersheds that were 12-89 ha (30-220 acres). Harvest units affected 250-650 m (predominantly 250-400m) of stream length. The study area was southwestern British Columbia, where headwater streams were clearcut with three to four replicates of 0-m, 10-m, and 30-m stream buffers and controls. Even with 30-m buffers, photosynthetically active radiation (PAR), water temperature, periphyton biomass, and periphyton inorganic mass were significantly greater than in controls during certain seasons. These authors concluded that uncut buffers ≥ 30 m on each side of the stream were essential in limiting biotic and abiotic changes linked to clearcut timber harvests of headwater streams. They also provided an extensive citation to literature that supports equally wide buffers for protection of aquatic or semi-aquatic species and riparian-dependent species in sensitive headwater streams, such as invertebrates, amphibians, bryophytes, birds, mammals, and fish.

Small streams were found to be especially sensitive to effects of clearcutting with buffers ≤ 30-m width. Part of the reason for this sensitivity is the tendency for these channels to experience low flows and channel widening. Channel widening can be caused by bank destabilization due to increased sediment inputs that increase from increased road building and/or use and clearcutting that accompany headwater logging. In addition, forest harvest operations along streambanks and cleared corridors for skyline operations can either directly or indirectly expose banks to damage, destabilization, and widening. Cattle or sheep grazing is one of the most significant bank destabilizing land uses that often accompanies clearcutting and thinning. Livestock break down banks of all stream sizes and increase channel widening. Wider channels for a given streamflow result in increased solar input and stream heating, regardless of the condition of the immediate streamside vegetation.

Impacts to the macroinvertebrate communities from various buffer treatments were related to the combination of increased light intensity and water temperature, associated with the elevated solar radiation inputs. Streams with no buffers had solar fluxes that were 58 times greater than those in the uncut controls, while the 10-m and 30-m buffers had fluxes that were 16 and 5 times, respectively, the levels found in uncut controls. In terms of maximum summer water temperatures, the streams with no buffer increased in temperature by 4.8°C, while those with 10-m and 30-m buffers increased by 3°C and 1.6°C, respectively.

The energy base of headwater streams is heavily dependent on the quality of the riparian vegetation. Even small decreases in the riparian forest cover in headwater streams can lead to significant shifts in the food base of aquatic species (England and Rosemond 2004).

The USDI-BLM Preferred Alternative for Riparian Harvest and Shading Ignores Site Potential and Restoration Goals Already Set in TMDLs

The riparian management portion of the USDI-BLM WOPR DEIS is based on the premise that any timber not needed to provide the desired ACD of 80% on perennial streams can be removed and that shade is not important on intermittent streams. This management plan is not based upon site potential, site potential tree height buffer widths, or tree heights, other than having a minimum height needed to produce an minimum ACD value. Site potential tree height and site potential ACD can frequently be greater than the minimum 80%. ACD values greater than 80% are often cited in south coastal Oregon TMDLs as targets, but the USDI-BLM DEIS does not even support the TMDL plans.

The Oregon DEQ TMDL for Lower Sucker Creek indicates that an ACD of 80% is the potential simply for the mainstem.

> *The excessive width of the main stem increases solar radiation absorption, increasing stream heating. The average shade value on private land is 26%. Full site potential shade is 55% to 80% with an average of 61%. On lands managed by the BLM, the current average shade value is 40%. Site potential shade is 55% to 80% with an average of 58%. In the absence of natural disturbance, full recovery for all reaches is expected to take 70 years.* (ODEQ, Lower Sucker Creek TMDL).

The table below for Lower Sucker Creek, a tributary to the Illinois River in southern Oregon coast, shows that in the mainstem of Sucker Creek, existing shade on BLM, private land and BLM/private land is very poor. However, potential shade on these stream reaches ranges from 65 to 80% shade. On Bear Creek and Little Grayback Creek the existing shade is high on all ownerships (83-92%) while the potential shade is 96%. The BLM's riparian proposal is based on the theory that any shade above 80% is excess that can be removed with no consequence to water temperature. In so doing, the BLM plans to employ the crude tools of the Oregon nomograph or the SHADOW model (see

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USFS/BLM 2005) with its gross categories of channel orientation, channel width, August 1 shade widths, to calculate needed tree heights, and numerous other layered assumptions and generalities.

Table 4 Shade Summary for BLM and Private Land

Location	BLM Managed Land		Private Land		BLM & Private	
	% Average Existing Shade[1]	% Average Potential Shade[1]	% Average Existing Shade[1]	% Average Potential Shade[1]	% Average Existing Shade[1]	% Average Potential Shade[1]
Main Stem	40	80	26	61	31	65
Bear Creek	93	96	88	96	88	96
Little Grayback Creek	92	96	83	96	86	96

[1]Average shade is averaged for the length of the stream analyzed

> *As the result of past timber harvest, there is little mature (late seral) vegetation in the riparian areas on the lower main stem and its tributaries (figure 11). On Bear Creek, a small section managed by the BLM, contains the only remaining mature vegetation (figure 11, dark green area) on that stream. The BLM manages 4.4 miles of perennial stream within the Little Grayback analysis area. Approximately 39% of the riparian area managed by the BLM was harvested in the past. Those areas, as well as the small amount of private land, are in an early seral stage with vegetation consisting of 100% hardwoods (figure 11, yellow area). The remaining 61% of the riparian area managed by the BLM is in a late seral stage consisting of mature conifers. (ODEQ, Lower Sucker Creek TMDL).*

On the mainstem Sucker Creek almost all late-seral vegetation has been removed, resulting in the very low shade values. Even on Little Grayback Creek, 39% of the riparian area was harvested by the BLM. Despite this level of impact, the USBLM wants to take high risk measures by thinning the remaining late-seral vegetation and relegating it to a narrow primary buffer.

The Upper Sucker Creek TMDL (ODEQ 1999) states:

> *Monitoring has shown that water quality in the Sucker/Grayback Watershed often does not meet State water quality standards. The narrative and numeric standards for temperature, flow modification and habitat modification are not achieved in the mainstem reaches of the Sucker/Grayback Watershed. Section 303(d) of the Federal Clean Water Act (1972) requires that water bodies that violate water quality standards, thereby failing to fully protect beneficial uses, be identified and placed on a 303(d) list. Following further assessment, Total Maximum Daily Load (TMDL), will be implemented to restore water quality.*

A comparison of the existing shade on the major tributaries to Upper Sucker Creek with the potential shade conditions shows that for this water quality limited mainstem stream,

numerous tributaries have 60-70% or 70-80% shade and other tributaries have >80% shade (ODEQ, Images 2 and 3). Despite a relatively high percent shade for the watershed as a whole, the mainstem has a low percentage shade (50-60%) and frequently exceeds water quality standards. Despite this type of overall basinwide temperature analysis, the approach being recommended by the USDI-BLM in its WOPR DEIS for similar watersheds in coastal Oregon is to harvest more trees in the late-seral stages. There is not even an indication that there is a tree community diversity problem existing there.

The entire USFS/BLM TMDL ISE on riparian shade and its application in their WOPR DEIS is predicated on the idea that they are able to remove riparian vegetation with impunity if they aim to maintain 80% "effective shade." This concept is also based on the notion that there is little value in riparian vegetation beyond the primary buffer zone, so that no-cut primary zones can be reduced to a minimum on the basis of only channel width and average slope gradient, accounting only for shading effects. These concepts represent a departure even from ODEQ's temperature TMDLs, such as that done on the Upper Sucker Creek watershed. Temperature modeling on Upper Sucker Creek was done on the basis of 200-ft buffers, not 25-ft primary zones (ODEQ, Image 1). Further, the USFS/BLM concept that a target of 80% shade or a heat loading of 440 BTU/ft^2/day was universally applicable was not reflected in the ODEQ Upper Sucker Creek TMDL (ODEQ, Image 1 and 4). Many tributaries to Upper Sucker Creek, as well as Lower Sucker Creek, have the natural potential to develop up to 96% effective shade or less than 440 BTU/ft^2/day heat loading (ODEQ, Images 2-5). Using both of these surrogates for heat loading, ODEQ assigned restoration targets on all streams for which it had estimates of natural potential that were equal to the natural potential. That is, if the current percentage effective shade was 70% but the natural potential was 96%, the restoration target was 96%, not 80%. They do not give free rein to lower effective shade on these water quality limited streams and still expect to meet standards. On streams for which ODEQ had not established natural potential estimates, it assigned an interim goal of 440 BTU/ft^2/day heat loading (ODEQ, Images 4 and 5), which it thought it could achieve with a shade value of 80%. However, given that both ODEQ and USFS/BLM state that effective shade is a direct surrogate for heat loading, it is a logical deduction from this evidence alone that if the natural potential of a headwater stream is for 96% effective shade and 16% effective shading is removed, the heat loading would increase by 16%. ODEQ took the 80% shade target as an interim goal only for streams to which it did not have the time to develop natural potentials. The USFS/BLM have the time to develop natural potential estimates for these streams but choose not to. If the current effective shade on a headwater stream is 96% and the USFS/BLM plan to reduce shading to 80% with the rationale of improving riparian quality, the linkage between effective shading and heat loading suggests that water temperatures would increase beyond the natural potential rate of heating. The impact of cumulative increases in headwater heating in basins such as Upper Sucker Creek would be counter-productive to meeting water quality standards. It is such cumulative impacts that are already causing this stream to exceed standards and that must be reversed.

The USFS/BLM TMDL Implementation Strategy Evaluation (ISE) is Significantly Flawed and is a Poorly Grounded Scientific Basis for Riparian Management

> p. 4. *The approach includes a logic outlining how management of Riparian Reserves contributes to the long term protection and restoration of water quality.*
> p. 6. *By design, full implementation of the NWFP was intended to protect and restore water quality over the long term.*

The USFS/BLM TMDL ISE outlines an approach to water quality regulation that is really focused only on water temperature. Water temperature, in turn, is conceived of being regulated only via regulation of shade management. Shade management is not conceived of in terms of site potential tree height and the shade values that would emanate from that but only in terms of a modeled height sufficient to generate shade. Although not alluded to in the sentence above, but revealed in the WOPR DEIS, buffers conceived later as a series of layers with progressively weaker levels of protection. This further breaks down the concept of site potential tree height. The shade values taken as the target values are not the shade that would have been derived from site potential trees but 80% of that. And lastly, the approach is one not of maintaining current levels of shade but allowing loss of current shade with the expectation that there will be a future glide path toward meeting standards some time in the future.

The series of ideas strung together in the USFS/BLM TMDL ISE is presented not as a decision document but as a kind of scientific explanation of the justification for this approach. However, in the DEIS this approach is adopted as the complete logic path for riparian management, ignoring in the process the full set of riparian values that were intended to be managed in the FEMAT process. The USFS/BLM TMDL ISE itself is a very weakly documented set of arguments and linkages with a large set of questionable assumptions.

The focus on riparian management only in terms of water temperature ignores the myriad functions of riparian vegetation and buffer zones other than water temperature regulation. Functions of buffers (due to their width, length, and connectivity) and the riparian vegetation (due to its community composition, diversity, tree height, canopy characteristics, rooting depth, basal area, canopy cover) include the following: water temperature control, nutrient filtering, large woody debris production, channel stabilization, microclimate protection, sediment retention, windthrow protection, wildlife habitat. Calculations of buffer widths needed for provision of shade requirements have no bearing on meeting the demands for all the other riparian functions. Many of the functions of riparian forests are best served by late seral stands. By considering a forest only as a shade producing mechanism and following the implications of this, it is then possible to justify young stands as meeting this goal. Young stands on small stream channels may achieve shade targets, but young stands do not meet one of the key objectives professed in this USFS/BLM TMDL ISE —to enhance community structural complexity and diversity. In addition, this does not allow the riparian buffer to provide many of its other functions.

The abandonment of site potential tree height as an ecologically useful guide to buffer widths implies that riparian environmental conditions within buffers can be identical in the "new" buffers (i.e., tiered buffers with progressively weaker protection standards) as in intact buffers equal in width to 2x or 1x SPTH widths. This implies that if 80% ACD stream shade targets are met on a stream that may have had 100% ACD and this is accomplished by use of 50-year-old trees rather than late-seral, all microclimate values, sediment retention, LWD, and all other functions provided by the full-width late seral buffer are also provided by the multi-tiered, minimal-width buffer with progressively reduced protection levels.

The USFS/BLM TMDL ISE claims that it outlines the logic for long-term protection and restoration of water quality. The water quality claim can be translated to mean only water temperature. The concept of "long-term protection and restoration" as revealed in the DEIS means adoption of shade targets that are no greater than 80% effective shade, based on the unfounded assumption that 20% of "effective shade" really has no ability to lower water temperature. This concept of "long-term" also is code for harvesting trees now with the idea that it will lead to improved riparian forests some time in the future. This is a means of borrowing from the present, accepting a worsening of current conditions, and expecting that at some future date conditions will be better. The future template though is not even based on late-seral forests as a target for community condition. In addition, it does not make use of a watershed analysis that would indicate the overall riparian condition in a watershed. If a stream system is in mixed ownership and is not meeting state standards for water temperature, this USFS/BLM TMDL ISE justification would still condone further reduction in current shading if future shade would purportedly be assumed to be either restored or restored with some type of improvement in vegetation community composition.

> p. 5. *However, as a result of regulatory requirements to comply with the Endangered Species Act (ESA), objectives to preserve biodiversity, and lack of adequate technical resources to evaluate and adjust buffer widths, a regulatory precedent that recognizes 300-foot riparian buffers along fish bearing streams, was established and has been maintained in most cases.*

> p. 4. *Third, the approach develops and presents shade nomographs as a tool for analyzing and demonstrating how vegetation thinning in of Riparian Reserves can contribute to water quality restoration.*

The statement above implies that in the years since adoption of FEMAT rules, it has not been financially feasible to evaluate and adjust buffer widths in a sensitive manner that would protect biodiversity, comply with the ESA, and presumably, permit all other functions of riparian buffers to operate in an optimum manner. Now, one would have to assume that the financial resources are available to allow this kind of sensitive protection. Otherwise, one would assume that the USFS/BLM has found that the use of a simple nomograph and adoption of a crude but minimal buffer width and a riparian thinning program is sufficient to be able to claim that riparian conditions will improve in the future, despite removing current shade. If this is the current state of affairs, it appears

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that riparian management is so simple now with the technological breakthrough of developing a shade nomograph that anyone can begin removing all the unnecessary trees with very little planning and, at the same time, protect all known functions of riparian buffers.

> p. 4. *Several WQRPs completed for the NWFP area found that management of designated streamside zones (e.g., Riparian Reserves) can provide sufficient stream shade to protect or recover stream temperature in waters listed as "impaired" on the State's 303(d) list.*

Streams listed on the 303(d) list are not listed only for water temperature. Violations of sediment standards are even more numerous than those for water temperature. This is especially true in the Oregon south coastal region. It is not realistic for riparian buffer width protection to be conceived of only as a shade modeling exercise.

> p. 7. *Riparian Reserves include areas designated to maintain the hydrologic, geomorphic, and ecologic processes that affect riparian condition, fish habitat, and standing and flowing water. Every watershed on federally administered lands under NWFP direction has Riparian Reserves. Riparian Reserves are not reserved from management but rather are "reserved" to protect and restore aquatic and riparian dependent resources.*

> p. 8. *By design, the Riparian Reserve network was intended to maintain and restore hydrologic, water quality and riparian processes. As well, Riparian Reserves were intended as transition zones between upslope and aquatic areas, travel and dispersal corridors, and connectivity corridors within a watershed.*

> p. 9.*Many effects of riparian vegetation on streams decrease with increasing distance from the streambank; among these are root strength, large wood delivery, inputs of particulate and organic matter to streams, shade, riparian microclimate, water quality and habitat. FEMAT (1993) reviewed variations in buffer widths to support these riparian functions. Of focus in this analysis is the relationship of riparian vegetation to stream shade and water quality.*

> p. 16. *Thus although vegetation removal (e.g., thinning) could affect existing shade as long as the critical shading vegetation is protected effects to water quality should be either negligible or of short duration. It should be noted that thinning affects other watershed processes that affect water quality (e.g., sediment delivery, bank stability, wood recruitment) however the effects of thinning on these processes is beyond the scope of this analysis.*

The quotes above from the USFS/BLM TMDL ISE indicate that more riparian functions than shade are recognized as significant elements of FEMAT. Even though elements such as LWD delivery vary as a function of distance from the stream, they do not vary in the same manner as shade. The USFS/BLM TMDL ISE misleads by inferring that because there is some variation in effect with distance, shade is a good surrogate for

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everything. Despite the acknowledgment of multiple riparian functions, functions other than shade are mentioned, then ignored. The USFS/BLM TMDL ISE excuses this by claiming that it is simply a document dealing with water temperature. The paper, however, describes only the effect of shade in controlling water temperature. The fact that other riparian functions, as well as other mechanisms for protecting water temperature (the sole riparian function discussed), were ignored in the TMDL ISE was somehow overlooked when this methodology was imported into the DEIS as the sole means of evaluating riparian buffers.

> p. 7. *Sediment loads from intermittent streams can alter channel shape in receiving perennial streams, causing heating. However, this potential impact is not further assessed in this assessment.*

Sediment impacts from intermittent streams were acknowledged in a footnote, but the effect of riparian protection and buffer width in preventing these sediment impacts on stream heating were not discussed. This alone is a major oversight.

> p. 11. *The Figure illustrates that as effective shade increases beyond 40% there is a corresponding reduction in stream temperature to a point (e.g., approximately 80%) beyond which further reduction in stream temperature as a function of shade is not measurable (Boyd 1999). Eighty percent does not represent a minimum threshold, standard, or load allocation but simply that point beyond which a reduction in stream temperature as a function of shade may not be measurable.*

There are many streams in SE Oregon, such as the Williamson River, where effective shade cannot be expected to reach 80% (Boyd and Kasper 2002). However, there are others where the potential shade is nearly 100%, such as on the Lower Sucker Creek (ODEQ 2002). It is reasonable that 80% effective shade would not be a standard to be applied everywhere. However, where potential effective shade is naturally low (e.g., <60%), it should not be assumed that thinning would have a negligible effect.

> p. 13. *SHADOW is a physical model that is used to estimate stream shade and the width of areas providing shading vegetation. Although the accuracy of SHADOW has been demonstrated (Figure 14) it must be recognized that temperature responds to many variables, all which may not be included as components of the SHADOW model.*

The accuracy of SHADOW was shown on p. 27 in a figure that was not labeled (it followed Fig. 14) (USFS/BLM, Image 6). This figure shows that in the mid-range of measured ACD readings with the Solar Pathfinder, there was a much weaker relationship with modeled shade using SHADOW modeling. SHADOW accounts for solar position, vegetation height, stream orientation, and side slope. Although the description of this model in the TMDL ISE may simply be exceptionally poor and incomplete, there are other factors that would account for shading. For example, vegetation height is not the only vegetative factor that would account for shade. Plant community canopy layering,

tree form (Cross 2002), leaf area index, and community type are other key factors. Relative to use of a Solar Pathfinder, it is more difficult to estimate the effectiveness of shading when canopy cover is close to 50%. This could account for the width of the plot of measured vs. modeled values on p. 27. For example, when the Solar Pathfinder says that effective shade is approximately 60%, the modeled values can range from 0.25 to 0.8 despite the Pearson correlation of 0.88. The confidence limits plotted in this figure represent a very precise relationship in the mid-range whereas this is not really the case. It appears that these confidence limits were not computed correctly or else the methodology used does not apportion variance and resulting confidence meaningfully across the range of data.

> p. 13. *For the present analysis it was assumed that peak stream temperatures occur during July and August. Based on this the sun's zenith and azimuth angel[sic] on August 1st were used to represent "the period during which peak stream temperatures would be recorded" and were used, among other variables, to calculate the width of the riparian area necessary to provide effective shade.*

It appears that the nomographs were based upon canopy closures of >65% and an assumption of solar altitude and azimuth values for August 1. Although July and August tend to be the warmest months, occasionally very warm stream temperatures can occur in late June and early September. In addition, the solar altitude varies significantly from its maximum around June 21 to August 1. The tree height needed to produce effective shade is greater on June 21 than it is on August 1. By estimating tree characteristics that would produce shade only on August 1 rather than June 21, the USFS/BLM add one more exception that allows riparian trees to be shorter. This, in effect, is based on the concept that if we only need to be concerned with the solar radiation on August 1, because the solar altitude is less on this date than on June 21, it takes less tree height to be effective. It also implies the position that temperature exceedances near June 21 are so rare that it isn't worth conserving trees to protect against solar warming early in the summer.

ODEQ's (1999) Upper Sucker Creek TMDL indicates:

> *Stream temperatures exceed State water quality standards in summer and early fall salmonid rearing months (June, July, August and September).*

Although this TMDL also notes that the conditions producing state standards exceedances coincide with *"prolonged solar radiation exposure, warm air temperature, low flow conditions and decreased groundwater contribution,"* it is feasible for these conditions to also occur at the height of solar radiation intensity (late June).

USFS/BLM (Image 7) shows the modeled effects of thinning on stream temperature with use of the SHADOW model. It represents that at a basal area of 280 (probably ft^2/acre) although units are not given) effective shading is 80%, while at basal area of 80, effective shading is 50%. This would indicate that 71% of all basal area can be removed and only reduce effective shading by 37% (or 30 percentage points). This conclusion is not supported by any measured values, although one would assume that USFS/BLM Image 6

supports the contention that Solar Pathfinder data and SHADOW-modeled data are identical.

> p. 25. *Emmingham et. al. (2000) measured the change in air temperature and humidity for various levels of thinning in riparian areas in the Oregon Coast range. Air temperatures for the control and normal thin were generally the same whereas a 3 to 5 degree Celsius increase in temperature was recorded for heavier treatments. A normal thin might reduce canopy closure by 50%.*

The quote above from Emmingham et al. (2000) in the USFS/BLM TMDL ISE indicates that a "normal thin" might reduce canopy closure by 50%. Canopy closure is the index used in SHADOW to reflect riparian condition in addition to average tree height. If a normal thin is 50%, it appears that removal of 71% of basal area, as in the paragraph above, represents a heavy thin. If the SHADOW model is to be believed, small reductions in effective shading (e.g., only 37%) can produce large increases in air temperature (e.g., 3-5°C or more).

> p. 18. *A study on the Umpqua and Siuslaw National Forests measured the changes in ACD with varying riparian buffer widths (Brazier and Brown, 1972). The sites, located adjacent to clearcut harvest units had variable buffer widths. Steinblums et al. (1984) conducted a similar study on the Willamette and Mt Hood National Forests and in the North Umpqua Resource Area of BLM. Results of the two studies illustrated lower ACD for the Willamette, Mt Hood, and North Umpqua than for sites with similar buffer widths in the Umpqua and Siuslaw National Forests. Steinblums et al. (1984) focused on the effects of windthrow in riparian areas adjacent to clear-cut harvest units. Of the 22 study sites, 13 sites contained 50 to 88% of the original buffer volume still standing at the time ACD measurements were recorded. This could account for the lower ACD measurement results from that study.*

The above quote from the TMDL ISE attempts to discount the study of Steinblums by claiming that many of his sites suffered from loss of original buffer volume. Again, if the SHADOW model results from USFS/BLM Image 7 are to be believed, one would have to assume that if basal area were reduced from 280 to 140 ft²/acre, the change in effective shade would be from 80% to about 70%. It is presumably for this reason that the USFS/BLM study prefers the Brazier and Brown shade curve over the Steinblums curve. The Steinblums curve, however, would argue for the need for a buffer width of at least 140 ft to provide adequate shade. [see Pollock and Kennard 1998].

This issue of potential blowdown in the Steinblums et al. (1984) study raises the issue of current condition. If either the primary zone is lacking in shade cover or there is potential for blowdown, is it acceptable to overlook this and remove trees in the secondary zone anyway, thinking that cover in the primary zone will be restored at some future date?

> p. 18. *It is important to note that the ACD value for a given buffer depends on vegetation density; thus, the results from Steinblums et als. work. In more open*

stands wider buffers become necessary to achieve the same ACD as would be achieved given similar vegetation with a closer spacing (Brazier and Brown 1972).

Although the purported reduction in vegetation density due to blowdown in Steinblums et al.'s work was reported by USFS/BLM as between 22 and 50% (i.e., 50-88% canopy cover), the USFS/BLM indicates that in these cases a wider buffer would need to be left to provide the essential shade. A consideration of the conditions that led to loss of vegetation cover in Steinblums et al. would have led to the realization that riparian thinning increased the incidence of blowdown. The USFS/BLM intend to conduct riparian thinning, however, without the precaution of retaining the extra buffer widths that they say would be necessary in the cases, such as with Steinblums et al., where blowdown has already occurred. For reasons such as this, the USFS/BLM plan does not account for contingencies and take a precautionary approach, nor does it use a "measure of safety approach." It apparently intends to conduct riparian harvest (thinning) under the guise of improving stand conditions that would lead to improved shade some time in the future regardless of the current water temperature conditions at a site or downstream. It would ignore the impacts already made on non-federal lands and add additional short-term (10-50 years) impacts, depending upon channel width. There is no indication how thinning a monoculture would lead to improved riparian tree community diversity without planting.

p. 18. *Study results illustrated that as riparian area widths increased from 10 to 60 feet, ACD increases (Figure 8). The results also illustrated that increases in ACD decrease beyond buffer widths of 60 feet.*

USFS/BLM Figure 8 (or Image 1) (taken from Brazier and Brown, Image 2) referred to above claims that from a buffer width of 10 to 60 feet, the ACD increased, but after 60 feet, the increase diminished. This is not the case. There was a straightline increase in ACD from 50 to 100 ft buffer width. Because buffer strip widths larger than 100 feet were not presented, there is no indication that the rate of increase in ACD decreases beyond that. It is also not indicated in the TMDL ISE what the characteristics of the buffer widths were in the Brazier and Brown paper and whether these results apply at all to all Oregon coastal streams that are the subject of the DEIS. If the current stream conditions average something less than late-seral in condition and we assume that Brazier and Brown's study was based on late seral conditions, it is very likely that ACD for a given buffer width would be less under the current conditions on typical, managed BLM lands. [See critique of Brazier and Brown's study. It appears that their buffers represent an extreme range of managed riparian conditions.] This would argue for maintaining larger buffers according to the TMDL ISE logic, but this is not what is intended in the DEIS.

It is likely that in many streams there is potential for ACD to increase beyond 80% with increasing buffer strip width exceeding 100 ft. The "tree behind a tree" logic (USFS/BLM, Image 5) argues that there is either a tree present along the azimuth to the sun or there is not. A tree is equated to 100% shade; absence of a tree is equated to 100%

sun. There is no qualitative effect of cumulative reduction in solar input with increased path through the canopy allowed for in this interpretation. This fallacy is responsible for the abrupt termination of ACD at 100 ft in Brazier and Brown (Image 2).

> p. 18. *Angular canopy density (ACD) is the measure of canopy closure as projected in a straight line from the stream surface to the sun. ACD measures the quality of the shadow the canopy provides as the angle of the sun changes throughout the day. ACD is a proxy, if you will, for the quality of the shadow cast.*

USFS/BLM TMDL ISE (Image 2) shows a relationship between ACD and effective stream shade (percent). ACD (angular canopy density) is a measure of canopy closure as projected in a straight line from the stream surface to the sun (p. 18). As such, it should account for the cumulative reduction in light penetration along the path to the sun or light quality. Effective shade is (total solar radiation-total solar radiation reaching the stream)/total solar radiation (p. 19). But Image 2 indicates a relationship between ACD and effective shade that is essentially a straight line from an ACD of about 30% to 90%, spanning about 65 to 85% effective shade. In this relationship from Park (1991), an ACD of 65% has an effective shade of 80% (p. 20). The TMDL ISE also claims that a 3% gain in effective shade (the shading that is related to stream heating) is produced by increasing ACD from 65 to 80%.

> p. 9. *While the process of introducing and removing heat from a stream is complex, certain processes are more important than others in determining how stream temperature is affected by solar inputs (Beschta, 1987). If it is agreed that solar radiation is the most important source of radiant energy affecting stream temperature, given constant surface area and stream flow, any increase in heat entering a stream from solar radiation will result in a proportional increase in stream temperature (Brown, 1972).*
>
> *Solar radiation is the most important source of radiant energy affecting stream temperature (Brown, 1969; Beschta, 1997).*

The quotes above indicate that proportional increases in heat input to a stream result in stream temperature increases and solar input is the predominant cause of heat transfer to a stream. Nonetheless, the TMDL ISE argument implies that an increase in solar radiation can be accompanied by no increase in heat transfer. This relationship whereby a reduction in ACD can occur with virtually no increase in stream heating is not well established and is contrary to ODEQ 1999 (Image 1). More research needs to occur to establish effective means to correlate ACD with transmission of solar radiation through the canopy that would produce stream heating.

The USFS/BLM TMDL ISE acknowledges that "calculating effective shade can be difficult" (p. 26). Consequently, to make riparian thinning easy for widespread use, the Oregon Shade Nomograph was developed. The nomograph was developed for average streams on N-S, NE or NW, and E-W orientations based on an average 65% canopy closure or greater. The Solar Pathfinder was used to estimate effective shade. One

would assume that the Solar Pathfinder is to be used in the field, but it is not clear whether the Oregon Nomograph was developed with the aid of the SHADOW model or was an empirical estimate from some field condition. It is ironic that the Oregon Nomograph was based on a canopy closure of 65%, but the Steinblums model was discounted for having a reduced canopy closure comparable to what is recommended by USFS/BLM in the Oregon Nomograph. Supposedly the reduced canopy closure in the Steinblums et al. model would have resulted in the need for wider buffers to protect the stream. The Steinblums et al. model also reveals the need to protect a much wider buffer than the Brazier and Brown model.

Taking the E-W oriented stream as an example, the Oregon Nomograph indicates that with a riparian forest canopy closure of >65%, a 20-ft wide channel requires a 110-ft tall tree to produce 80% shade on a 0-30% slope. Also, a 20-ft channel requires a 100-ft tree to produce 80% shade when the slope is >60%. However, this does not mean that we should adopt 100-ft tall trees for the riparian when the site potential tree height is 170 ft. There are many other reasons to retain wider buffers on steep slopes, such as retaining sediment that would wash into the channel. In addition, large trees also have an important role in producing natural levels of LWD in stream channels that require buffers linked to SPTH. If the canopy closure is <40%, the same 20-ft channel requires a 110 ft tree to produce 65% shade from a 0-30% slope according to the canopy closure correction chart (p. 31). This presents a preposterous conclusion though where one could claim that at 20% canopy closure you could have 65% shade while at 80% canopy closure you could have 80% shade. Referring again to the Emmingham et al. study, one would expect very large increases in air temperature by reducing canopy closure by this extent (i.e., 80% canopy closure to 20% canopy closure).

A further problem with the Oregon Nomograph method is that a buffer width is not indicated in the nomograph (p. 30-31). One has to then back up to Table 3 (p. 23) to see that if tree height is 60-100 feet, one would have a primary shade zone of 50 ft on a slope of 0-30%. If the tree height were 120 feet and the canopy cover were maintained at >65%, one would need <40 ft primary buffer width on a slope of <30% (USFS/BLM, Figure 13, p. 22). This again implies that logging in the secondary zone outside the 40-ft buffer would be permitted despite the potential for increased sediment delivery and reduction in LWD input. If the hillslope is increased to >60%, the primary buffer increases only from 50 to 60 ft in the case where tree height is 60-100 ft. This again is not protective of riparian functions. It is also a significant assumption that canopy cover reduction from 100% to 65% can be made in the primary zone with no impact on the ability of the primary zone to shade the stream or any greater need in the secondary zone for additional tree cover.

The nomograph indicates what tree height is needed to provide shade on a certain slope, but if trees of this height are not present or are a small component of the community, this is not accounted for in what trees may be removed from the secondary zone. The nomograph is supposedly used in the field because the average forester does not have the capacity to run the SHADOW model. However, the SHADOW model is run on the basis of the simple output of the nomograph, which returns only the height of the tree that

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would be needed as a minimum to produce shade (not for June 28 but for August 1). This tree height data then is used in a gross application of the SHADOW model to return a one-size fits all buffer width category that does not account for actual variations in ACD. The nomograph does not account in a meaningful way for variations in canopy quality. If the canopy density is >65%, the effective shade expected on a 20-ft channel with 110-ft trees is 80% shade. If canopy closure is 40-60%, the corrected shade value is 70% shade. If canopy closure is 0-40%, the corrected shade value is 65% shade. If any compensating leave tree requirements are made in the secondary zone based on these variations in effective shade in the primary zone they would be very small because there is very little difference in shade predicted across the range from 100% canopy cover to 0%. This set up makes the entire application of the nomograph useless for protecting water temperature.

Input for the nomographs consists of channel width, tree height, and percent slope. The TMDL ISE claims that this input can be obtained from either aerial photographs or other sources, such as the USFS/BLM Integrated Vegetation Mapping Project (IVMP) (p. 32). The web address given at the BLM does not actually work for downloading these data (November 23, 2007).

The two IVMP data sets used by the USFS/BLM are vegetation DBH and canopy closure (p. 32). Canopy closure is most accurately accessed from aerial photographs, but there is no indication how the canopy closure data were determined in this database. Use of a spherical densiometer would provide less accurate estimates.

The relationship between DBH and tree height is relatively well established for a particular site class, but the first step in this conversion is to identify the site class. This carries with it some level of uncertainty. A site that is highly productive can grow trees that achieve a greater height for a given DBH category. The relationship between DBH and height is also relative to tree species, which is not specified in the USFS/BLM TMDL ISE. Further, if site class and tree species are known, the tree height can be estimated for a particular tree, but determining the average DBH for an entire riparian community is another matter. If a tree community is truly multistoried as the white paper claims it wants, the average community DBH would be a mixture of the diameters of overstory and understory trees. This would reduce the height of trees entered into the nomograph.

The TMDL ISE then suggests that in order to characterize stream shade, one calculates average shade by first establishing "a crosswalk between the IVMP DBH and tree heights."

An example crosswalk is given below for conifers in the Little River Watershed, although it is not clear whether this would apply universally within this watershed and to all conifer communities, no matter what the mix of conifer species.

DBH (in)	Height
0-4.9	25
5-9.9	50
10-19.9	100
20-29.9	130
30-49.9	150
50+	180

Step 1 of the example application indicates that tree height is actually a "weighted average tree height" (p. 32). No explanation is given for what would be considered in the weightings. Presumably the number of trees in each DBH class is used to weight the average heights, but when a DBH is 0 to 4.9 inch, one would have to wonder if all seedlings can be included in the weighting. This ambiguity could render the weighted value arbitrary. Are average DBH values for just the dominant (largest) trees to be calculated? What percentage of canopy closure for a tree community would the largest trees need to comprise to be averaged? For example, if the table above is used to represent the largest size category and we have 10% of the conifer community existing cover comprised of size class 30-49.9 inch DBH, do we just average these tree diameters to represent the entire riparian buffer? If so, the total shade value of the buffer would be far different than if this size class (150-ft tree height) occupied 80% of existing canopy cover. The lack of detail in the TMDL ISE concerning methodology makes it virtually useless as a field guide for the average logging company. Its vagueness would permit virtually anything to be allowed. As a justification for the use of either SHADOW or nomographs to estimate shade, the TMDL ISE is far from a scientific treatment of the subject. It creates more ambiguities than it clarifies. This document has experienced 22 revisions since July 9, 2002 and it is so useless as a guide that it could not be credibly employed as a field implementation method.

Step 1 continues with the directive: "*to read the percent shade from the nomographs, estimate average active stream width from the mid-point of the mainstem and average of the side slopes*" (p. 32). It is not clear what length of stream reach is expected to be considered in calculating mean stream width. The stream width is specified as the active stream width. The location of the current wetted channel in relation to the center of the active channel is not discussed. If the wetted channel is flowing outside the centerline of the active channel, the actual solar radiation reaching the water surface could vary from what is expected on the basis of merely "active channel width," which is the entire width of meander of flows within bankfull stage. What happens in a wide bankfull channel if the summer wetted channel flow shifts from one side of the channel to the other? How does this affect the buffer width? Why would the average of side slopes be calculated on an E-W oriented stream (i.e., averaging the slopes on the south and north sides of a stream) when a program such as SHADOW considers only the side slope angle of the slope on the south side of the channel?

Step 2 of the example application of the TMDL ISE methodology is to calculate the percentage of the total riparian area that is in harvest units. Step 3 is to identify sites proposed for riparian thinning and to distinguish those areas with <50% canopy closure. The TMDL ISE presents no data on the relationship between canopy closure and

effective shade, yet there is an assumption in the example application that if canopy closure is <50% there might not be riparian harvest. Otherwise, there could be.

Step 3 states that any proposed harvest area that has a canopy cover <50% should be identified on a 1994 orthophoto quad (p. 33). The use of 13-year old photography is not necessarily a good indication of current condition. Unless this is updated with data on recent harvest, there is a high probability of overharvest.

Step 4 involves calculation of average shade in harvest units to reflect the effects of past management. In this step, calculation by means of nomograph and IVMP data are compared with photo interpretation and SHADOW modeling. The example implies that there is a high degree of correspondence between these (p. 33), but this is never really established as a fact. Photo interpretation using orthophotos may indicate canopy cover, but it does not indicate tree height. Only the use of stereo photos, LIDAR, or on-the-ground measurement would indicate tree height and distribution of height by cover percentage. The stream channel shown follows many different orientations through the proposed harvest units. There is also no confirmation that assigning stream reaches to 1 of 3 different orientation classes is sufficient to capture the shading dynamics.

In the example, the current shade was 58-60%. In Step 5, the recovery time is then estimated as the time required for the stand to achieve 80% stream shade. The natural shade potential of the stream is not considered, making this exercise unrealistic. It was then determined that 95-foot tall trees, needed to produce 80% shade, would require 50 years to grow from the smallest trees in the managed riparian area. This guidance is also ambiguous. The smallest trees could either be seedlings, saplings, or more advance tree growth. It is also unclear how this area is conceived of as a riparian harvest unit where the current effective shade is 58-60% and the target is 80%. Based on the general approach taken in the TMDL ISE, it may be with the idea that by harvesting some of the small trees in the harvest unit, the other small trees will be able to grow to the size of shade-producing trees within 50 years. No mention is made of the time required for natural processes of tree mortality, self-thinning, growth, and development of site-potential shade compared with the active intervention approach. No discussion is made of the loss in current shade against an average background level of 58-60%, the soil compaction and disturbance incurred in riparian harvest, or the increased level of sediment delivery in pursuit of an 80% shade level that is expected in 50 years.

> p. 42. *Information used in this analysis can be obtained from aerial photos, satellite imagery, and stand age class records. In some cases field verification using a Solar Path Finder may be needed. This information is then put into the SHADOW model.*

The Condition Assessment section indicates that all information on tree height and cover will be input to the SHADOW model. Here, no mention is made of the use of the nomograph.

p. 42. *The level of rigor should be consistent with the existing situation and the pertinent components of a temperature TMDL including a Margin of Safety (MOS) and Reasonable Assurances (RA). Unmanaged landscapes reflect the highest MOS and RA.*

Oregon's TMDL development requires that a margin of safety be employed. Throughout the TMDL ISE description of the shade analysis and buffer width identification, there is no mention of how a margin of safety would be provided for either managed or unmanaged landscapes. Leaving a landscape unmanaged undoubtedly is a measure for providing a high MOS. However, there is no indication how, when conducting thinning, any MOS is provided for the managed stands so that high qualities are restored or maintained.

p. 42. *Provide condition data to DEQ for % shade modeling of the mainstems, or provide DEQ with SHADOW modeled inputs. Headwater streams will either be modeled by the FS/BLM or not included in the assessment. This information would be returned to the FS/BLM for integration into the WQRP.*

The Condition Assessment section indicates that headwater streams will, largely, not be modeled for shading. This is a huge exception, considering that the preponderance of riparian length is found on headwater streams and these are highly determinant of the overall pattern of temperature downstream and throughout the drainage.

Federal Land Summary Current Shade Conditions and Recovery

Drainage	% Flow of main stem	% Existing Shade	% Probable Target Shade	% Shade Loss/ Gain	Type of Disturbance	Years to Shade Recovery

Total Shade Values on Federal Lands within Watershed

Type of Disturbance	% Existing Shade	% Shade Loss/Gain	% Probable Target Shade	Years to Full Site Potential Recovery	Proposed Treatment
Summary Harvest					Follow ACS for all management activities within the riparian zone of all perennial streams

The table above (p. 43) indicates several problems with the analysis. Only federal lands are considered in evaluation of existing shade. The influence of current condition on private lands has a significant bearing on the risk levels for taking thinning actions on federal lands. Only mainstems and perennial streams are considered. Existing shade is noted but the conditions under which % shade loss would be contemplated are not clear. It is suggested that *"if varying from the minimum buffers described in the temperature*

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strategy, provide further information showing how they meet the water quality standard for temperature. " (p. 44). The opening given here for abuse of the riparian areas is very substantial. Increasing temperatures on headwater streams is a significant weakness in Oregon state temperature standards. Theoretically, standards are intended to reflect cumulative forest practices at the point of greatest impact downstream. The USFS/BLM have not specified any cumulative effects methodology by which to ensure that the effect of multiple current and ongoing impacts to riparian condition reflected downstream does not contribute to temperature exceedance. It is likely that the federal plan will rely on individual, segmented actions on headwater tributaries not increasing beyond the downstream temperature limit. That is, if the standard for the most restrictive temperature in the drainage is a mainstem where the standard is 16°C, yet the groundwater entering the headwater channel is at 11°C, it is possible that the USFS/BLM is expecting to be allowed to raise the headwater water temperature by 5°C. These important cumulative effects concerns are not addressed at all in the document, leading to the conclusion that high-risk activities would be entertained in overthrowing the precautionary FEMAT procedures for the ACS.

> *p. 44. The guidance and tools provided in parts 2 and 3 of the temperature strategy should be used to determine where and how much vegetation can be managed in Riparian Reserves with low risk to water quality. Include a discussion of how these tools were used to obtain the information provided below.*

> *Riparian Reserves include areas designated to maintain the hydrologic, geomorphic, and ecologic processes that affect riparian condition, fish habitat, and standing and flowing water. Every watershed on federally administered lands under NWFP direction has Riparian Reserves. Riparian Reserves are not reserved from management but rather are "reserved" to protect and restore aquatic and riparian dependent resources.*

It is claimed that the tools provided in this guidance in the USFS/BLM TMDL ISE can be used to provide data specifying how Riparian Reserves can be actively managed via thinning to provide low risk to water quality, yet providing timber harvest. Again, there is allusion to the multiple reasons for existence of the Riparian Reserves, but this concern is obliterated with reference only to protecting water quality and also "reserving" the riparian area so that it can be managed (i.e., thinned) to protect it. The reduction of risk is not built into the proposed methodology in any way. In fact, the SHADOW model was described as a means to determine the "required minimum no-cut buffers necessary to maintain and restore site-potential riparian shade" (p. 47). This leaves no margin of safety. The no-cut buffer is only applied in the primary zone. As a way to cover the wide-ranging concerns for cumulative effects and risk, the user is encouraged to basically throw in the kitchen sink with miscellaneous reports such as watershed analyses, "applicable information resultant of cumulative effects analyses" that might be available, and updates on restoration planning (p. 44) as a papertrail to justify a set of individually harmful actions.

Under "Goals and Objectives" it is stated that *"the protection and recovery of water quality will depend on implementation of the Resource Management Plans and Forest Plans as amended by the NWFP. Paramount to recovery is adherence to the Standards and Guidelines of the NWFP to meet ACS objectives including protection, restoration, and active management of riparian areas."* Strict adherence to the Standards and Guidelines of the NWFP somehow has morphed into strict adherence only to an ambiguously worded USFS/BLM TMDL ISE on the use of Solar Pathfinders, nomographs, and SHADOW model for estimation of shading. The full set of objectives in the NWFP includes restoration of the distribution, diversity, and complexity of watershed and landscape-scale features to ensure protection of the aquatic systems to which species, populations and communities are uniquely adapted; maintaining and restoring the spatial and temporal connectivity within and between watersheds; maintaining and restoring the physical integrity of the aquatic system; maintaining and restoring the water quality to protect the survival, growth, reproduction, and migration of individuals composing aquatic and riparian communities; maintaining and restoring the sediment regime (timing, rate, storage, transport); maintaining and restoring instream flows; maintaining and restoring floodplain inundation (timing, variability, duration); maintaining and restoring species composition and structural diversity of plant communities (riparian and wetlands); maintaining and restoring native plant, invertebrate, and vertebrate riparian-dependent species. There is no discussion in the TMDL ISE how all these objectives are subsumed by a crude method for estimating minimum shade levels.

Dent and Walsh (1997) described the effectiveness of RMA's and HWC's (hardwood conversions) in maintaining stream temperature:

> *Under the Oregon Forest Practices Rules, Riparian Management Areas (RMA's) are established on streams running through or adjacent to harvest areas (OAR 629-635-310). The width of the RMA depends on the stream size (small, medium or large) and stream type or beneficial use (fish, domestic or none). For example, medium-sized (M), fishbearing (F) streams have an RMA that is 70 feet wide measured as slope distance from the normal high water mark. All understory vegetation must be retained within 10 feet of the high water mark, all overstory vegetation must be retained within 20 feet of the high water mark, and all trees that lean over the stream must be retained. Trees can be harvested beyond the 20 foot distance and within the 70 foot RMA if there is sufficient basal area in the RMA. Basal area requirements vary with stream size, type and georegion and are described as standard and management targets. The standard basal area target for medium type F streams ranges, depending on the geographic area, from 90 to 140 square feet on each side of the stream, per 1000 feet of stream (OAR 629-640-100). In addition, there are diameter, minmum tree numbers and species requirements for the stand composition of the RMA.*

Rates of warming in five different stream RMAs ranged from 0.29 to 2.0°F/1000 ft. Sheythe Creek had a bankfull width of 20 ft and had the greatest rate of stream warming within the RMA (i.e., 2.0 °F/1000 ft). Percentage cover in the RMA was 60% (Dent and

Walsh 1997), which is similar to the 65% cover recommended by the USFS/BLM. According to Image 7 of the USFS/BLM TMDL ISE, a basal area of 140 ft^2 would provide approximately 70% shade. This level of shade would result in approximately a 2.0 °F/1000 ft increase in water temperature according to Image 3 of the USFS/BLM TMDL ISE, a figure that corresponds to the rate of heating in the Sheythe RMA. However, the Oregon Forest Practices BMPs specify that there would be a no-cut buffer on the first 20 ft of riparian buffer and a basal area that would supposedly equate to approximately 70% shade in the outer riparian zone out to 70 ft. This information from Dent and Walsh (1997) indicates that it is already known that forest practices such as proposed by USFS/BLM are not likely to be effective. Further, USFS/BLM propose to maintain only 50% canopy cover in the outer zone after riparian harvests (i.e., between 60 and 100 feet from the CMZ).

USFS/BLM Make Underestimates of Shade Potential on the Basis of Basal Area in their TMDL ISE

Cumulative basal area/acre was graphed versus distance from stream to evaluate the influence on shade of basal area from trees that are farther away from the stream. Shade categories were created and the cumulative basal area was averaged for sites within each category at incremental distances from bankfull (Figures 24 and 25). The shade categories were low (20-40%), fair (40-60%), moderate (60-80%), and high (80-100%). Scatterplots of individual sites grouped by shade category are provided in Appendix E and show a wide range of variability in each category. This is also demonstrated by the error bars (one standard error from the mean) in Figures 24 and 25.

In the Coast Range, there were no differences between basal area of sites with fair (40-60%, n=2) to moderate (60-80%, n=16) shade. However, at approximately 80 feet from the stream, sites with high (80-100%, n=10) shade had consistently higher basal area than those with fair to moderate shade. At 100 feet from bankfull, Coast Range sites with fair shade averaged 207 sq.ft./acre, while those sites with high shade averaged 303 sq.ft./acre. (Allen and Dent 2001).

With distance from the stream in the Blue Mountains, cumulative basal area (ft^2/acre) became greater and the shading provided by trees at 100 ft from the stream was significant. In the Oregon Coast Range, Allen and Dent (2001, Images 1 and 2) didn't find such a uniformly significant relationship between shade and distance from the stream. However, it appeared that at 100 ft from the stream, the additional shade provided by trees was likely biologically important, although it couldn't be confirmed statistically.

Allen and Dent (2001, Image 3) described a relationship between basal area (ft^2/acre), live crown ratio, and predicted % shade. They found that $\geq$ 80% shade on a southern RMA (100-ft wide buffer) on an E-W oriented stream could be produced with a basal area of 250-300 ft^2/acre and a live crown ratio (LCR) of $\leq$ 40%. The relationship between basal area and live crown ratio is explained by these authors as:

For example, the same basal area could produce small LCRs in an evenly spaced stand of small trees or a stand of larger trees arranged in patches. This same basal area could also result in a large LCR in a stand of widely spaced large trees.

By contrast, Image 7 of the USFS/BLM TMDL ISE shows only an 80% shade (based on SHADOW modeling) at a basal area of 280 ft^2/acre. Allen and Dent (2001, Image 3) showed that 80% shade at a basal area of 80 ft^2/acre occurred only if the LCR was very low. This would be a forest stand typical of a small DBH, high density stand that is not late-seral and does not produce large trees desirable for LWD production. This is opposite to the professed objectives of FEMAT in riparian areas.

The Cumulative Effects of Elevated Stream Temperature Harm Fish

As the ManTech Report (Spence et al. 1995) noted, "perhaps no other environmental factor has a more pervasive influence on salmonids and other aquatic biota than temperature." ManTech Report at 85. The cumulative effect of elevated water temperatures can be quite severe.

When discussing temperature impacts to salmonids, it is important to remember how temperature affects entire aquatic ecosystems in addition to a particular stream segment. First, the influence of elevated temperatures can continue downstream, as the water in the stream does not rapidly cool down. Therefore, if several activities occur along the stream, their effects on temperature will accumulate.

Second, increased stream temperatures decrease available habitat within a river basin. Salmonids use habitat in a stream system from the cold headwaters (assuming channel gradients are low enough, generally less than a 15-20 percent slope) downstream to the upper temperature distribution limit (generally in the stream zone where maximum daily temperatures exceed 22 to 24°C). As land management actions (e.g., riparian canopy removal, channel widening, sedimentation, water diversion) cumulatively increase water temperature, the distribution limit shifts upstream thereby decreasing total available habitat. The reduction in thermal suitability in low gradient habitats in mainstem rivers is a particularly serious loss to the productive capacity of spring and fall Chinook. In the mid-region to headwater streams, these impacts are particularly of concern for steelhead.

Third, the cumulative effect of prolonged high water temperatures on aquatic biota is a concern. Although stream temperatures may rise to levels stressful to fish for only part of the day, over a number of days, the heat stress on the fish can cumulate and cause harm.

Once impaired, it is vital to first stop further degradation and then concentrate on restoration efforts. However, continuing activities such as riparian logging near degraded stream reaches virtually forecloses the possibility of lowering water temperatures and attaining water quality standards in either the short or long term.

Climate Change has a High Probability of Exacerbating the Risks to Water Quality and Fish Populations in Deviating from the FEMAT Guidelines for Riparian Management

Aquatic biologists have warned of the dangers of global climate change to fish and water quality for several decades already. This forewarning has largely been unheeded and treated as speculative or unnecessarily alarmist until recently. Currently, the global analysis of climate scientists (Intergovernmental Panel on Climate Change) is overwhelmingly clear that the global climate has been warming and that the impacts are significantly caused by human action. The literature supporting these conclusions is enormous and as decisive on a subject regarding estimated future consequences of current actions as can be made in science. The effects of climate change on water quality will be experienced throughout the United States and will significantly degrade water quality (Gleick 2000, Climate Impacts Group 2004). Modeling studies, such as Jager et al.'s (1999) show that the impact of increased climate warming on fish populations will be to reduce the local distributions of salmonid species within existing drainages and confine them to headwaters where, presumably, colder temperatures are found. However, these coldwater zones are found predominantly at higher altitudes and in steeper gradient streams. The limited ability of salmonids, especially salmon, to use higher gradient streams will result in significant reductions in populations and added threat of extinction. The ISAB (2007) emphasized the importance of prevention of water quality degradation by taking a precautionary approach in land management. This note of caution should apply strongly to the USDI-BLM in its DEIS development. The USBLM has proposed a high risk revision of its forest management that will significantly limit the ability to recover listed and sensitive aquatic species dependent upon cold water. Full protection of all streams supporting fish populations and comprehensive protection of all headwater tributaries providing cold, clean waters to downstream habitats is essential as a key part of the recovery of these species. The USBLM disregards the breadth of scientific literature that argues for full protection of riparian ecosystems and opts for significantly handicapped, high risk buffers that do not adequately address water temperature requirements of aquatic populations, not to mention other critical functions. Further, the USBLM disregards the effects of climate warming that have already been documented and will continue to increase.