State of California
North Coast Regional Water Quality Control Board

PEER REVIEW COMMENTS

FOR THE

TOTAL MAXIMUM DAILY LOAD IMPLEMENTATION POLICY FOR SEDIMENT IMPAIRED RECEIVING WATERS

November 12, 2004

State Water Resources Control Board
North Coast Region
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Santa Rosa, California 95403
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PEER REVIEW COMMENTS - INTRODUCTION

In order to strengthen the proposed TMDL Implementation Policy for Sediment Impaired Receiving Waters (TMDL Implementation Policy) and the Salmonid Freshwater Habitat Targets for Sediment-Related Parameters, staff of the North Coast Regional Water Quality Control Board (Regional Water Board) requested peer review from three professors in the University of California system. The peer reviewers were requested to only evaluate and comment upon the scientific portions of the proposal. Policy issues are beyond their scope of responsibility and review.

This chapter is divided into three parts: the questions that Regional Water Board staff asked of the reviewers, the reviewer's comments (which are included verbatim), and staff's responses to those comments.

When the peer reviewers were initially contacted and their review solicited, Regional Water Board staff were developing an amendment to the ***Water Quality Control Plan for the North Coast Region*** (the Basin Plan) titled the "Action Plan for the Albion River, Big River, Noyo River, and Ten Mile River Watersheds Sediment Total Maximum Daily Loads," or TMDL Action Plan. It was the TMDL Action Plan that peer reviewers assessed and commented upon.

Since that time, the TMDL Action Plan has evolved into the TMDL Implementation Policy. The scope expanded from four watersheds in coastal Mendocino County to all sediment impaired watersheds in the North Coast Region. The process changed from a Basin Plan amendment to a Resolution of the Regional Water Board. The content became more encompassing and general. For example, the specific implementation plan requirements and associated timelines of the TMDL Action Plan are no longer present in the TMDL Implementation Policy. In their place is direction to the Executive Officer to rely upon the use of all existing authorities and regulatory tools to more effectively address sediment waste discharges.

Although there have been changes to the documents that the peer reviewers commented upon, much of the scientific content and scientific basis for the proposal have remained consistent, and peer review, as conducted, is still valuable. Questions asked of the peer reviewers in regards to the problem statement chapter of the TMDL Action Plan are equally applicable to the justification for the TMDL Implementation Policy, which is laid out in the "whereas" findings of Resolution No. R1-2004-0087. The salmonid freshwater habitat targets have not significantly changed; they are now included in a stand-alone document attached to the TMDL Implementation Policy, whereas they were previously incorporated as a distinct chapter within the TMDL Action Plan.

Many of the requirements of the TMDL Action Plan (such as the requirements to inventory, prioritize, control, and monitor existing sediment waste discharge sites) will continue to be required of landowners under the TMDL Implementation Policy. The difference is that the TMDL Action Plan proposed to establish specific time frames and requirements for all landowners within the four Mendocino Coast watersheds, whereas the TMDL Implementation Policy proposes to require such actions of landowners on a case-by-case and site-specific basis throughout the North Coast Region using existing authorities and tools. Therefore, all the questions asked of peer reviewers that pertain to the implementation plan, the monitoring plan, and the definition of unstable areas are still pertinent and necessary.

QUESTIONS ASKED OF PEER REVIEWERS

Problem Statement

For each of the four watersheds, Regional Water Board staff has concluded that excessive inputs of sediment to the four rivers have caused a reduction in the quality and quantity of instream habitat. This has resulted in a situation where the four rivers are not fully supporting their beneficial uses, and water quality objectives for suspended material, settleable material, and sediment are being exceeded. Staff based this conclusion on declining salmonid population trends and the impacts to freshwater habitat from excess sediment.

Questions: Is the above conclusion scientifically valid? Does the rationale described in the draft Staff Report and Basin Plan Language adequately support the conclusion?

Water Quality Targets

The TMDL Action Plans contain a suite of instream and upslope water quality targets. The targets are designed to be used as indicators of watershed health and tools for determining the effectiveness and success of the TMDL Action Plans in attaining water quality objectives and protecting beneficial uses. Regional Water Board staff will compare sampling and monitoring data to water quality targets to determine watershed conditions and recovery status. The water quality targets include the following parameters: aquatic insect production, embeddedness, large woody debris, backwater pool distribution, lateral scour pool distribution, primary pool distribution, sediment substrate composition - % fines, sediment substrate composition – D_{50}, thalweg profile, water temperature, V*, activity in unstable areas, disturbed areas, and a target for roads and railroads.

Questions: Are the proposed targets scientifically valid? For each target, does the rationale described in the draft Staff Report adequately support the proposed target value? If the instream targets are obtained, will the habitat requirements for all freshwater lifestages of chinook salmon, coho salmon, and steelhead trout be present in the water body? If the instream targets are obtained, will the habitat requirements for other aquatic life be present in the water body? Will the proposed parameters show a measurable response from changes in sediment discharges over time? Are the proposed targets appropriate for the local geology? Where an instream target is limited to a specific stream type or reach, is that stream type or reach appropriate, and are there other stream types or reaches that the target should apply to? Are the monitoring and sampling suggestions clear, concise, appropriate, and adequate?

Definition – Unstable Areas

The concept of an unstable area is used in the Water Quality Targets and in the Implementation Plan sections of the proposed TMDL Action Plans. The definition is a compilation of definitions found in geology texts, the Forest Practice Rules, and the Garcia River Sediment TMDL Action Plan. In-house Registered Geologists also assisted in developing this definition. The definition of unstable areas can easily be found in the Glossary of the Staff Report.

Questions: Is the definition of unstable areas scientifically valid?

Sediment Source Analyses, TMDLs, Load Allocations, and Margin of Safety & Seasonal Considerations

The proposed TMDL Action Plans contain summaries for each of these sections and are entirely based on the technical TMDLs established by the U.S. EPA. The technical TMDLs have been properly noticed and posted in the Federal Register. Therefore, scientific peer review of these sections is not necessary.

Implementation Plan - Road Management Plan

In all four watersheds, it is the proposed policy that new road construction, maintenance, and decommissioning shall retain natural hydrologic function. Regional Water Board staff have developed examples of road management practices consistent with this policy. The examples are based on the experience and professional judgment of staff.

Questions: In the majority of situations, will the example road management practices result in roads that retain natural hydrologic function? Are the example practices clear, concise, appropriate, and adequate?

Implementation Plan – Sediment Discharge Site Volume Thresholds

The TMDL Action Plans propose that dischargers inventory, repair, and possibly compensate those sediment discharge sites that discharge or threaten to discharge ≥ 1 yd^3/yr or ≥ 10 yd^3/10yrs.

Questions: Is the volume of 1 yd^3/yr or 10 yd^3/10yrs a significant sediment source? If discharged, does the proposed volume result in an adverse impact to anadromous salmonids and other beneficial uses? Is the volume of 1 yd^3/yr or 10 yd^3/10yrs easily recognizable? Please answer these questions while considering cumulative impacts and the persistent nature of sediment in a stream system.

Implementation Plan – Inventory Requirements

In order to address existing sediment discharges, the proposed TMDL Action Plans include a requirement for dischargers to inventory sediment discharge sites, roads, stream crossings, and unstable areas.

Questions: Are the inventory requirements adequate to allow the thorough review and analysis of sediment discharge sites, roads, stream crossings, and unstable areas and their threat to water quality? Are the requirements clear, concise, appropriate, and adequate?

Implementation Plan – Sediment Control Threshold

In order to address existing sediment discharges, the TMDL Action Plans include a requirement for dischargers to control at least 75% of the volume of sediment discharge sites under Phase I and Phase II in a five year time frame. This proposal is based on several studies and staff's professional judgment.

Questions: Is the proposal to require the control of at least 75% of the volume of sediment discharge sites scientifically valid? Does the rationale described in the draft Staff Report adequately support the proposal? Will the most significant sediment discharge sites be addressed under the proposal?

Implementation Plan – Sediment Control Requirements

The TMDL Action Plans also include a requirement for dischargers to develop a Sediment Control Plan. The Sediment Control Plan will contain a description of the selected sediment control practices, an estimate of the volume of sediment that will be kept from discharging to a water body, an estimate of the volume of sediment that will continue to discharge to a water body after prevention and minimization efforts, and a description of the inspection and maintenance activities.

Questions: Are the requirements of the Sediment Control Plan adequate to allow the thorough review and analysis of the sediment control practices and any remaining discharge? Are the requirements clear, concise, appropriate, and adequate?

Implementation Plan – Storm Period Inspection Frequency

In regards to the Sediment Control Plan, the TMDL Action Plans contain a suggestion to inspect sediment discharge sites after the first four inch rain event of the winter season and after any significant storm over two inches thereafter the same season until the sediment discharge site is 100% vegetated and the drainage is functioning as designed.

Questions: Will the above suggestion result in inspection and maintenance activities necessary for the short and long term upkeep and integrity of sediment control practices? Is this suggestion clear, concise, appropriate, and adequate?

Implementation Plan – Offset Compensation
(This question was asked of Dr. Kirchner and Dr. Resh, but not of Dr. Dietterick)

Offset compensation is sediment control work, often of natural sources, that compensates for the adverse effects of a discharge of anthropogenic sediment. Offset compensation is only required in certain circumstances as stated in the draft Basin Plan Language and Staff Report. If offset compensation is required, dischargers shall prepare an Offset Compensation Plan.

Questions: Do sound scientific knowledge, methods, and principles support the remediation of natural sediment discharge sites as compensation for anthropogenic sediment waste discharges? Do the proposed TMDL Action Plans require sufficient information to adequately characterize the volume of sediment that is discharged or that is prevented from being discharged? Are the offset compensation requirements clear, concise, appropriate, and adequate?

Implementation Plan - Implementation & Upslope Effectiveness Monitoring

The proposed TMDL Action Plans include requirements that dischargers photograph sediment discharge sites from the same location on an annual basis (i.e., photo-point monitoring).

Questions: Are the proposed requirements to conduct photo-point monitoring adequate to allow the thorough review and analysis of sediment control efforts over time? Is this monitoring component adequate to determine if there is a trend in the amount of sediment being discharged to water bodies? Are the implementation and upslope effectiveness monitoring requirements clear, concise, appropriate, and adequate?

Implementation Plan – Sediment Assessment Methods

There are several requirements throughout the proposed TMDL Action Plans to quantify the volume of sediment that as been discharged, has the potential to be discharged, or will be kept from discharging sediment to a water body in the four watersheds. A separate section in the Implementation Plan discusses recommended sediment assessment methods and models.

Questions: Are the recommended models and methods scientifically valid? Are there other models that should be used instead of, or in addition to, the recommended models and methods? Is it possible to quantify the uncertainty associated with the recommended sediment models and methods?

Monitoring Plan

The proposed TMDL Action Plans contain instream effectiveness monitoring and compliance monitoring requirements.

Questions: Are instream effectiveness monitoring requirements adequate to determine if sediment control practices are effective at keeping sediment from being discharged to a water body? Are compliance monitoring requirements adequate to determine if sediment related water quality objectives and water quality targets are being met? Are the monitoring and sampling suggestions clear, concise, appropriate, and adequate?

General Questions

As a reviewer, you are not limited to only addressing the issues and questions of particular concern that are listed above. We also invite consideration of the following "big picture" questions:

1. In reading the technical Staff Report and proposed amendment language, are there any additional scientific issues that are part of the scientific portion of the proposed rule not described below?

2. Taken as a whole, is the scientific portion of the proposed rule based upon sound scientific knowledge, methods, and practices?

Dr. Brian Dietterick's Comments

Review of Draft TMDL Action Plan

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October 25, 2004

I have reviewed the TMDL Implementation Policy. My comments are limited to the scope of the questions posed in Attachment 2, Scientific Review and Focused Questions. In my opinion, the importance of this review requires a thorough review of supporting documentation and a comprehensive literature search of other related current documentation. Time constraints do not support this level of review and as a result, this review was completed using professional judgment benefited from prior experiences and a limited review of supporting documentation.

Question 1: Is the above conclusion scientifically valid? Does the rationale described in the draft Staff Report and Basin Plan Language adequately support the conclusion?

Beneficial uses are undoubtedly being threatened by excess sediment in North Coast watersheds. However, the reliance of salmonid population trends to draw conclusions about the potential adverse effects from current land management activities is controversial. The effect that short-term climatic variability has on oceanic and hydrologic conditions and the relationship on anadromous fisheries and habitat conditions is poorly understood. It is also unclear the role that legacy land management activities play on what has been observed over the past decade and what we continue to observe amidst current activities and the short-term climate effects. Although this statement is largely conjecture, this variability arguably plays an important role in population trend analysis. This position suggests that wording in problem statements need to reflect this uncertainty.

Question 2: Are the proposed targets scientifically valid? For each target, does the rationale described in the draft Staff Report adequately support the proposed target value? If the instream targets are obtained, will the habitat requirements for all freshwater lifestages of chinook salmon, coho salmon, and steelhead trout be present in the water body? If the instream targets are obtained, will the habitat requirements for other aquatic life be present in the water body? Will the proposed parameters show a measurable response from changes in sediment discharges over time? Are the proposed targets appropriate for the local geology? Where an instream target is limited to a specific stream type or reach, is that stream type or reach appropriate, and are there other stream types or reaches that the target should apply to? Are the monitoring and sampling suggestions clear, concise, appropriate, and adequate?

This is the most complex set of questions posed for this review. Each question warrants a thorough literature review and documentation of studies that verify each of the methods proposed are capable of detecting change in habitat conditions over time. I'll begin with a number of general statements about the proposed methods. I do not believe the Staff Report presents a convincing argument that these parameters are capable of discerning improving or declining trends in instream sediment. These methods have been used to show significant changes, but the thresholds of change detection are not known and need to be evaluated within the context of precision and repeatability of each method.

2.1. Are the proposed targets scientifically valid? Will the proposed parameters show a measurable response from changes in sediment discharges over time?

Having been involved with sediment monitoring and geomorphic surveys designed to evaluate change, it is been evident that the timing when these methods are performed can generate very different results. The degree to which watersheds are hydrologically-active, along with storm and stormflow characteristics, can have a confounding effect on sediment delivery and transport. Consequently, most instream measurements will be responsive to these conditions, which can lead to significant variability that may be difficult to separate from any effect associated with land management activities. For

example, percent fines and D50 can vary throughout a stormflow event and depending on the degree to which a watershed is hydrologically-active that directly affects channel length and area, can supply and transport sediment downstream, and in some cases, overwhelm the transport capacity of the stream. The sediment in excess of what has been transported further downstream may be temporarily stored until the next event, or series of events. In California, where rain seasons are clearly defined, instream measurements are most often performed during the summer months. Thus, results are closely linked to the nature of the storm characteristics and the stormflow response of latter events of a season. The author of Testing Indices of Cold Water Fish Habitat (Knopp, 1993), did recommend that the influence short-term climatic variation on the indices be evaluated to determine the effect on the range of index values. It was not apparent that an evaluation of inter-season variability was ever done using the original dataset used in that study. Furthermore, the suggestion to also evaluate the effect that intra-season variability has on the response of these indices also appears to have been overlooked. Another point worth considering is that the discharge sites in many cases will be relatively small sediment contributions within the scope of the entire system. The effect of sediment discharges from these sites before or after treatment may or may not influence the local channel habitat features. Adverse impacts of beneficial uses from any one site, may be most impacted a significant distance downstream where suspended sediment may be more likely to be deposited. In short, evidence exists for successfully using instream parameters are used as indications of stream health relative to reference streams or reaches, but I have not seen the evidence to suggest these parameters can be successful to detect change resulting from sediment controls implemented on discharge sites.

As stated above: ***"Because of the inherent variability associated with stream channel conditions, and because no single target applies in all situations, attainment of the targets will be evaluated using a weight-of-evidence approach. When considered together, the targets are expected to provide good evidence of the condition of the stream, attainment of water quality objectives, and protection of beneficial uses."*** Details of how this "weight of evidence" approach will performed are not evident, nor is there evidence that this approach will be successful in identifying improving or declining trends in sediment delivery and transport.

2.2. Are the proposed targets appropriate for the local geology? Where an instream target is limited to a specific stream type or reach, is that stream type or reach appropriate, and are there other stream types or reaches that the target should apply to?

It was stated in the Knopp (1993) article and the staff report that targets are appropriate for watersheds found in the Francescan formation. Although there appears to be limited data to guide the setting of the targets, it is logical to assume targets should be adjusted based not only on stream type, but also local geology. The scientific justification for adjusting targets may be increasingly compromised by applying to other watersheds, particularly if the scope is increased to include the entire North Coast as proposed.

2.3. If the instream targets are obtained, will the habitat requirements for all freshwater lifestages of chinook salmon, coho salmon, and steelhead trout be present in the water body? If the instream targets are obtained, will the habitat requirements for other aquatic life be present in the water body?

It seems that achieving target values will elevate habitat conditions, and it seems reasonable the biological condition will improve. However, my expertise lies more in hydrology and the physical geomorphic condition and I can only speculate about the effects of incremental habitat improvements on the biological condition of these anadromous fish or associated aquatic life.

2.4. Are the monitoring and sampling suggestions clear, concise, appropriate, and adequate?

Generally speaking, the monitoring and sampling suggestions are not specific enough. For example, to merely state that BMI sampling should occur each spring without attempting to also target similar physical conditions of the stream. I am also inclined to want to see the evidence that suggests that BMI can be used to detect smaller improving or declining trends related to the implementation of sediment controls.

Question 3: Is the definition of unstable areas scientifically valid?

Yes, the definition includes multiple perspectives which are appropriate and needed.

Question 4: In the majority of situations, will the example road management practices result in roads that retain natural hydrologic function? Are the example practices clear, concise, appropriate, and adequate?

For the most part, the recommended practices offer a guideline that will promote natural hydrologic function as much as can be expected with a road. Insloped ditches essentially extend the length of watercourses, concentrate flow, and increase sediment delivery potential. Thus, outsloping should be promoted as the drainage measure of choice. There are specifics not included in the list of practices, but reference is made to the Weaver and Hagans text, and that should be adequate. Reference could also be made to the California Forest Practice Rules which provide similar road drainage guidelines, which are consistent with the Handbook for Forest and Ranch Roads.

Question 5: Is the volume of 1 yd^3/yr or 10 yd^3/10yrs a significant sediment source? If discharged, does the proposed volume result in an adverse impact to anadromous salmonids and other beneficial uses? Is the volume of 1 yd^3/yr or 10 yd^3/10yrs easily recognizable? Please answer these questions while considering cumulative impacts and the persistent nature of sediment in a stream system.

One cubic yard seems too small for many fluvial sources whether or not it is originating from a natural or anthropogenic source. We have developed the Near-Stream Sediment Source Survey for the Little Creek Watershed Study. A masters thesis, by Brooke Akers, is in draft form. The survey is designed to estimate current and future volume contributions from small streamside landslides and bank erosion voids. The survey used a threshold volume of 7.5 cubic yards and most all sites were not of an anthropogenic origin). This threshold erosional size was chosen because it is recognizable by different observers as a significant source and it has the potential to affect local and downstream habitat conditions. Understandably 7.5 yd^3 may be considered too large for most discharge sites (anthropogenic origin), but the perspective of sediment contributions of non-anthropogenic sources to anthropogenic sources needs to be better understood on a site-specific basis. The survey found that between 30 and 45% of the overall length of channels (about 13,000 feet) had either eroding banks or small streamslide landslides. This is significant and is common among many coastal mountain streams, particularly those having inner gorge characteristics. It may be advantageous in some watersheds to establish the threshold, or minimum volume higher to more realistically address those sites that have the greater impact toward improving beneficial uses.

Additionally, I suspect that the sediment source estimates for the Big, Albion, and Ten Mile Rivers underestimated the contributions from fluvial erosion, and that has also exaggerated the percent contributions of all sources originating from road sources. That's not to say that road sources are not important; road sources are arguably the most significant anthropogenic source associated with current land management activities.

Question 6: Are the inventory requirements adequate to allow the thorough review and analysis of sediment discharge sites, roads, stream crossings, and unstable areas and their threat to water quality? Are the requirements clear, concise, appropriate, and adequate?

With the exception of the 1 yd^3 minimum volume, the requirements appear to be reasonable. I am supportive of this type of ground-based approach. It can be effective in identifying and treating significant sediment sources. The other benefit of this approach over other more scientific approaches is that it can be performed by most landowners with very little training.

Question 7: Is the proposal to require the control of at least 75% of the volume of sediment discharge sites scientifically valid? Does the rationale described in the draft Staff Report adequately support the proposal? Will the most significant sediment discharge sites be addressed under the proposal?

If the question is, will a 75% reduction in sediment sources under Phase 1 and 2, result in improving habitat conditions and increase the likelihood that water quality objectives will be met, the answer is yes. I am not aware of the Madej study documenting the 75% reduction, nor the practices implemented to achieve the reduction, but it seems reasonable. The removal of the remaining 25% under Phase 3 may be problematic to resolve under many circumstances. I would recommend that a set of reasonable sediment control techniques or offset compensation be accepted for this remaining amount. It will also be very difficult, if not impossible, to evaluate effectiveness of a practice(s) in controlling the remaining 25 percent. Howerver, ground-based observations following storm events could still be effective.

Question 9: Are the requirements of the Sediment Control Plan adequate to allow the thorough review and analysis of the sediment control practices and any remaining discharge? Are the requirements clear, concise, appropriate, and adequate?

The three-phased approach seems reasonable and should allow for all significant sources to be treated. I also recommend that means by which effectiveness of the control measures is predicted be reconsidered. Eliminating this requirement would allow the landowner to comply without incurring additional expenses from hiring a consultant to predict effectiveness using methods that are gross approximations at best. A palette of acceptable methods can be made available, the landowner proposes treatment, and the plan accepted or declined following review by Board staff.

Question 10: Will the above suggestion result in inspection and maintenance activities necessary for the short and long term upkeep and integrity of sediment control practices? Is this suggestion clear, concise, appropriate, and adequate?

Language regarding the development and retention of the Inventory and Sediment Control Plan places responsibility on the landowner for identification and compliance. This is encouraging landowners to be responsible stewards, yet I anticipate opportunities for landowners to not achieve compliance either from negligence or from not having the appropriate level of feedback from Board staff (even with the outreach training as proposed). In short, there are indications that on-ground inspections will be lacking due to Board staffing limitations and this could be a detriment to achieving sediment control and improving beneficial uses.

Question 11: Are the proposed requirements to conduct photo-point monitoring adequate to allow the thorough review and analysis of sediment control efforts over time? Is this monitoring component adequate to determine if there is a trend in the amount of sediment being discharged to water bodies? Are the implementation and upslope effectiveness monitoring requirements clear, concise, appropriate, and adequate?

The photo-point monitoring requirements are well-stated and relatively easy for a landowner to implement. As stated, the ability for photo point monitoring to ensure sediment-control efforts are effective may be difficult for some discharge sites. Combining photo documentation with additional post-storm observations would provide additional assurance that measures are effective. Post-storm observations could be similar to step 4 in the requirements for the Sediment Control Plan.

Question 12: Are the recommended models and methods scientifically valid? Are there other models that should be used instead of, or in addition to, the recommended models and methods? Is it possible to quantify the uncertainty associated with the recommended sediment models and methods?

Twenty years of working with hydrologic models have convinced me that most watershed-scale models do not have the precision to detect change. Model parameter sets can be selected within acceptable ranges and yield order of magnitude differences in output responses when. The application to predict effectieveness pre- and post-treatment can show significant change, when in fact, no change in conditions has occurred. This is a broad generalization, but estimating representative parameter values, that are spatial averages at best for most watershed-scale models, introduces error and uncertainty in the model output. Some models include parameter optimization routines for calibration purposes, but the level of observed data required for calibrating sediment production or delivery models make this an unreasonable approach. (See Dietterick, B. C., J.A. Lynch, and E.S. Corbett. 1999. A calibration Procedure using TOPMODEL to determine suitability for evaluating potential climate change effects on water yield. Jour. of the American Water Resources Assn. 35(2):457-468). I have little confidence in WEPP or RUSLE except for making predictions on a gross scale – not to the level of change detection that is scientifically defensible for documenting the expected change or effectiveness of a particular sediment control practice.

Question 13: Are instream effectiveness monitoring requirements adequate to determine if sediment control practices are effective at keeping sediment from being discharged to a water body?

There are instances where effectiveness monitoring can be successful in determining the effectiveness of sediment control practices, but by and large I see this effort generating a lot of meaningless data. There is the variability in climatic conditions and the characteristics of stormflow conditions in any one season, that can that can affect the response of instream parameters, such as V* and percent fines. I also think that it is unlikely that remedying smaller discharge sites will change most instream parameters, such as pool distribution and percent fines, to the extent that can be detected and attributed to the restorative strategy.

I am supportive of visual observations, supported by photo monitoring, before and after sediment control implementation, as well as this type of ground-based monitoring immediately following significant storm events. I think it would be unwise and

a futile effort to recommend turbidity monitoring for most sites. I think if there is an instance where an increase in turbidity is evident to the eye, that the sediment source can be determined from visual observations and remedied more efficiently. I would also question the statement regarding being able to detect a 20% increase in turbidity over background levels.

Question 14: Are compliance monitoring requirements adequate to determine if sediment related water quality objectives and water quality targets are being met? Are the monitoring and sampling suggestions clear, concise, appropriate, and adequate?

Turbidity monitoring is a complex and expensive venture. There are different configurations possible for developing the ability to monitor turbidity and suspended sediment for detecting change. On an event basis, these efforts are often foiled by the failure to collect complete event datasets for the parameters necessary for determining loads, i.e. flow ,turbidity, and SSC. Instream turbidimeters are known to be labor-intensive instruments to operate in deployments where they are installed for entire seasons. They often record erroneous turbidity levels that are attributable to either instrument failure or interference within the flow column. Grad samples are not practical for describing the flux of sediment being exported during an event, nor practical for determining load estimates. The ability to be effective with any grad sampling strategy for turbidity or SSC analysis is extremely limited. I am strongly suspect of an attempt to install monitoring stations that will often be installed and operated without baseline data nor the benefit or a more more-controlled watershed experiment. Each station would require a significant capital investment, conservatively estimated to be $25,000. The operation costs are not apparent during startup and the need to calibrate and maintain the instrumentation requires constant attention. This translates not only to huge costs, but also a relatively high level of expertise. If the Board has the intention to fund such monitoring efforts, the money may be better spent on ground-based surveys that more effective to ensuring sediment controls are being effective and beneficial uses will improve.

DR. JAMES A. KIRCHNER'S COMMENTS

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30 October 2004

Rebecca Fitzgerald
North Coast Regional Water Quality Control Board
5550 Skylane Boulevard, Suite A
Santa Rosa, CA 95403
Dear Dr. Fitzgerald,

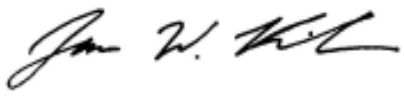
I have reviewed at length the proposed water quality control plan amendment and staff report, dated 2 August 2004, for the sediment TMDL for the Albion, Big, Noyo and Ten Mile River watersheds. My review is attached.

My review addresses the draft report alone, and not the references cited therein; for the purposes of this review I have assumed that those cited references do in fact substantiate the points for which they are cited. Likewise my review assumes that statements of fact in the draft report are correct as stated, except in cases where I have personal knowledge of the matters at hand.

There are a number of grammatical and typographical errors in the staff report and in the draft basin plan language, which I have not flagged in my review. One stands out, however; on page 2 of the draft basin plan language, the Albion River watershed is said to comprise "43 square miles, or 47,520 acres...". Since there are 640 acres in a square mile, at least one of these two numbers must be wrong.

Please let me know if you would like any clarification of the points raised in the attached review, or if there is any other way that I can be of assistance.

Sincerely,



James W. Kirchner Professor

1

Review of technical basis of proposed water quality control plan amendment for sediment TMDL for the Albion, Big, Noyo and Ten Mile River watersheds

James W. Kirchner Professor of Earth and Planetary Science University of California, Berkeley

1. The problem statement

Is the conclusion of the problem statement scientifically valid? Does the rationale described in the draft Staff Report and Basin Plan Language adequately support the conclusion?

The problem statement relies heavily on the USEPA TMDL documents for the four rivers. If those TMDL documents are scientifically valid (which this review has not directly assessed) then the problem statement and its conclusion are scientifically reasonable.

2. Water quality targets

Are the proposed targets scientifically valid? For each target, does the rationale described in the draft Staff Report adequately support the proposed target value?

I prefer the term scientifically reasonable rather than "scientifically valid". Taking each of the targets in order:

Benthic macroinvertebrates: generally reasonable. It is not clear why the target should be a score of 18 rather than, say, 14 or 22, or some other score. If there are specific data that reflect the change in biotic condition -- and specifically the suitability of salmonid habitat -- as the IBI score ranges above and below 18, those data should be shown or referenced.

Embeddedness: generally reasonable. It should be recognized that the degree of embeddedness can fluctuate over time, due to fluctuations in both streamflow and sediment supply. See, for example, Dietrich WE, Kirchner JW, Ikeda H, and Iseya F. 1989. Sediment supply and the development of the coarse surface layer in gravel-bedded rivers. ***Nature*** **340**: 215-217. Thus the apparent change in embeddedness between two successive surveys may not accurately reflect the long-term trend.

Large Woody Debris: The LWD volume targets, adopted from Fox (2001), are significantly higher than the LWD volume in ***any*** of the Northern California reference watersheds surveyed by Knopp (1993), and reported in Figure 3-11. The proposed targets correspond to 990-3170 m^3 of wood per 1000m of channel length, whereas the average in Figure 3-11 is less than 250 m^3 of wood per 1000m. It does not seem reasonable to set a standard that ***none*** of the reference watersheds meet. (Perhaps there is an error here, and the Knopp figures are per 100 meters, rather than 1000 meters?)

It also is problematic that the targets apply to channels with bankfull widths of 0 to 6, 0 to 30, and 0 to 10 meters, potentially being applied to very small channels. It does not seem not reasonable to require a channel that is, say, only 1 meter wide to have over 99 m^3 of wood, and over 11 key pieces, per 100m of length. Note, for example, that the 99 m^3 of wood would be sufficient to bury the entire channel roughly 1 meter deep along its 100m length. I agree with the assessment that sufficient data exist to propose numeric targets for LWD, but the targets proposed should take better account of differences between small and large channels -- perhaps excluding very small channels or specifying different targets for them -- and should be more clearly justified with respect to the reference watersheds.

Lateral Scour Pool Distribution: This target appears reasonable.

Primary Pool Distribution: This target appears reasonable. I concur that the CDFG objective of >50% pool frequency is desirable, but unattainable in view of the range of pool frequencies measured in reference watersheds.

Substrate Composition - % Fines <0.85 mm: This target appears reasonably consistent with the available data in the literature.

Substrate Composition - % Fines <6.40 mm: The data in Figure 3-16 indicate that this target should be expected to ensure reasonable rates of egg survival.

Substrate Composition - D50: The proposed water quality target (D50>69.5mm) is one that would not be met by two-thirds (12 of 18) of the reference streams surveyed by Knopp (1993). Unless the streams surveyed by Knopp (1993) are systematically different from these four rivers, it does not appear realistic to expect this target to be attainable. A more complete rationale for this target should be presented, or the target should be revised. The target is based on the average across the streams surveyed by Knopp, but that average is inflated by several very high values (including one that is nearly three times the mean).

Temperature: I cannot comment on the validity of this target, which is based on a draft staff report (Zabinsky and Azevedo 2004) that is not yet available.

Thalweg Profile: An increasing trend in thalweg profile variability is a reasonable target. If this measurement can be made more quantitative in the future, it may provide an effective tool for quantifying habitat complexity.

Turbidity: The turbidity target (less than 20% above "naturally occurring background levels") leaves open the question of what those background levels are. The draft acknowledges that this question is difficult to answer at present. But without some way to specify natural background levels, the turbidity target would appear to be impossible to apply in practice.

V*: This target appears reasonable. The deviations from the USEPA TMDL targets are justified, in my view.

Activity in Unstable Areas: Reducing sediment inputs from unstable areas will be crucial to reducing overall sediment loads to the four rivers. USEPA's TMDL documents specify that activities on unstable areas should be avoided or eliminated, whereas the proposed target here is simply that the number of activities should decrease over time. This appears to be a substantially weaker standard, and a rationale should be provided for preferring it over the USEPA standard. Three aspects of the proposed standard raise concern. The first is that it pertains to the "number of activities", without indicating how they should be counted. Second, it does not take account of the scale, scope, or impact of human activities, but only their number. Presumably if one replaces a one-acre garden and a one-acre pasture (two activities) with a 100-acre clearcut (one activity), the number of activities has gone down but the total impact has gone up substantially. Third, the target applies to unstable areas, but without a clear definition of what an "unstable area" is. The factors mentioned are all associated with slope instability, but it would seem difficult to enforce a standard that is based on a potentially subjective assessment of whether enough of these factors are present that a particular area should be determined to be unstable.

Disturbed Areas: The proposed target is that the number of disturbed areas should show a decreasing trend towards zero. In my opinion, the target should take account of the size, scope, and severity of disturbance; a trend from five small, moderately disturbed areas to one large, severely disturbed area (which might even subsume all five of the previous areas) would represent a decrease in the number of disturbed areas, but an overall increase in the negative impact on a watershed.

Water Quality Target for Roads and Railroads: I cannot assess the reasonableness these targets, because the draft does not specify what they are, referring instead to the USEPA TMDL documents.

If the instream targets are obtained, will the habitat requirements for all freshwater lifestages of chinook salmon, coho salmon, and steelhead trout be present in the water body?

I cannot provide an answer for this question; my own expertise does not cover all the habitat requirements for these species, nor are they enumerated in the draft.

Will the proposed parameters show a measurable response from changes in sediment discharges over time?

This of course depends on how much sediment discharges change over time. It is reasonable to expect some of these parameters to show measurable changes over periods ranging from years to decades if average rates of sediment discharge change by factors of two or more.

Are the proposed targets appropriate for the local geology?

The proposed targets are generally appropriate for geological conditions that prevail within the Franciscan Formation.

Where an instream target is limited to a specific stream type or reach, is that stream type or reach appropriate, and are there other stream types or reaches that the target should apply to?

They are generally appropriate. Several of the targets apply to reaches with gradients between 1% and 3%, leaving open the question of what (if any) target should apply to reaches with gradients less than 1%.

Are the monitoring and sampling suggestions clear, concise, appropriate, and adequate?

They are sufficiently clear, and reasonably suited to their purpose.

3. Definition -- Unstable areas

Is the definition of unstable areas scientifically valid?

The factors mentioned are associated with slope instability, but the draft does not provide a means to unambiguously determine which areas should be termed "unstable" and which should not. Identifying sites with a "high risk of slope failure" is a judgment call, made somewhat more difficult by the subjectivity of judging what constitutes a "high risk". It would seem difficult to enforce a standard that is based on a potentially subjective assessment of whether a particular area should be determined to be unstable.

4. Implementation plan -- Road management plan

In the majority of situations, will the example road management practices result in roads that retain natural hydrologic function?

They will help, but natural hydrologic function cannot be guaranteed. Roads are intrinsically less permeable than undisturbed terrain, and thus their hydrological function is inherently unnatural to some degree.

Are the example practices clear, concise, appropriate, and adequate?

Generally yes. The way that slopes are referred to is confusing. For example, a fill slope that is presumably two units of horizontal distance per unit of vertical distance is called a 200% slope, but in common language a 200% slope is one in which the vertical distance is twice the horizontal (i.e., a 63 degree slope!). This would exceed the angle of repose for all common non-cohesive materials. By contrast, the draft refers to hillslopes of "40% slope", which presumably means a 22 degree slope, in agreement with the common usage of the term.

5. Implementation plan -- Sediment discharge site volume thresholds

Is the volume of 1 yd^3/yr or 10 yd^3/10 yrs a significant sediment source? If discharged, does the proposed volume result in an adverse impact to anadromous salmonids and other beneficial uses?

This is all a question of scale and of timing. A single discharge of 1 yd^3/yr is quantitatively insignificant compared to the average sediment load of tens of thousands of tons per year. But if it is highly localized, and particularly if it occurs during low flows, it could have a significant local effect.

Is the volume of 1 yd^3/yr or 10 yd^3/10 yrs easily recognizable?

It will be recognizable if it is highly localized (such as a localized mass failure, or rilling and sheetwash associated with drainage on a short length of road surface). If it is spread over a large area, it will not be recognizable against the background erosion rate of hundreds of tons per square mile per year.

6. Implementation plan -- Inventory requirements

Are the inventory requirements adequate to allow the thorough review and analysis of sediment discharge sites, roads, stream crossings, and unstable areas and their threat to water quality? Are the requirements clear, concise, appropriate, and adequate?

The inventory requirements will, if conscientiously followed, generate an adequate database of existing and potential sediment sources.

7. Implementation plan -- Sediment control requirements

Are the requirements of the Sediment Control Plan adequate to allow the thorough review and analysis of the sediment control practices and any remaining discharge? Are the requirements clear, concise, appropriate, and adequate?

The control plan requirements should allow adequate review of the planned control practices and expected sediment discharges. The requirements are generally clear, except in point #2, which requires "(1) an estimate of the total volume of sediment waste that will be kept from discharging to a water body, and (2) an estimate of the volume of sediment waste per year that will be kept from discharging to a water body by the sediment control practice(s). It is unclear whether the distinction that is being drawn is between the amount per year and the total amount over all time, or between discharges prevented by sediment control practices and the total discharges prevented by all means.

8. Implementation plan -- Storm period inspection frequency

Will the suggestion result in inspection and maintenance activities necessary for the short and long term upkeep and integrity of sediment control practices? Is this suggestion clear, concise, appropriate, and adequate?

For clarity, the inspection requirements should specify what constitutes a "rain event". Four inches of rain falling in a week is probably not a rain event, whereas four inches in a day is definitely one.

9. Implementation plan -- Offset compensation

Do sound scientific knowledge, methods, and principles support the remediation of natural sediment discharge sites as compensation for anthropogenic sediment waste discharges?

The principle of offset compensation is generally sound, to the extent that the impairment of the water body results from the overall load of sediment, and to the extent that natural and anthropogenic sediment present similar risks to water quality. Thus an important component of the offset compensation guidelines is the requirement that offset sites should match the discharge sites in sediment composition and sediment delivery timing.

Do the proposed TMDL Action Plans require sufficient information to adequately characterize the volume of sediment that is discharged or that is prevented from being discharged? Are the offset compensation requirements clear, concise, appropriate, and adequate?

It is difficult to accurately estimate the volume of sediment discharge that will be prevented by any particular offset compensation actions. Thus it is appropriate that proposers of offset compensation actions should have the "burden of proof" of justifying their projections of sediment discharge that will be prevented.

10. Implementation plan -- Implementation & upslope effectiveness monitoring

Are the proposed requirements to conduct photo-point monitoring adequate to allow the thorough review and analysis of sediment control efforts over time? Is this monitoring component adequate to determine if there is a trend in the amount of sediment being discharged to water bodies? Are the implementation and upslope effectiveness monitoring requirements clear, concise, appropriate, and adequate?

Photo-point monitoring is well-suited to this task because it is relatively quick, simple, repeatable, and versatile. Photo-point monitoring will not provide a quantitative measure of changes in sediment discharge rates, but it will qualitatively indicate changes in the condition of sediment source areas.

It would be appropriate to include a requirement that the coordinates of each photo-point should be recorded using GPS. It would also be appropriate to require that when a photo-point is first established, the monitoring log should also include a photograph showing the location of the photo-point itself, in relation to nearby landmarks. On point 5, the wording should be changed to make clear that successive photos for any individual photo-point should be made at the same time of day, not that every site should be photographed at the same time of day (which would be infeasible).

11. Implementation plan -- sediment assessment methods

Are the recommended models and methods scientifically valid? Are there other models that should be used instead of, or in addition to, the recommended models and methods? Is it possible to quantify the uncertainty associated with the recommended sediment models and methods?

The recommended models and methods represent the best available science at present. Direct measurements (of eroded void volumes, for example) are much more reliable than model-based estimates. Thus it is appropriate to require those using model-based estimates of sediment discharges to justify the basis for those estimates and to quantify the uncertainties involved. In some cases (i.e., RUSLE), the accuracy of the erosion predictions has been assessed by comparison to experimental data. Those using such models should at least be aware of the likely uncertainties. If the uncertainties are unknown, one is not entitled to assume that they are small; thus it is helpful to stipulate, as part of the requirements for assessment methods, that the uncertainties must be quantified.

12. Monitoring plan

Are instream effectiveness monitoring requirements adequate to determine if sediment control practices are effective at keeping sediment from being discharged to a water body?

The instream effectiveness monitoring requirements are not spelled out; instead, the draft simply states that specific monitoring activities may be required. The most important issue is that the monitoring activities must encompass the hydrologic conditions of interest (high flow? low flow? spawning conditions?) and those conditions must be consistent each time the measurements are made. Otherwise spurious trends may appear as a result of differences in hydrologic conditions from one measurement period to the next.

Are compliance monitoring requirements adequate to determine if sediment related water quality objectives and water quality targets are being met? Are the monitoring and sampling suggestions clear, concise, appropriate, and adequate?

The monitoring provisions are appropriate, and are necessary to determine how sediment fluxes in the river systems are changing through time. As such they are essential to determining whether sediment discharges are being reduced as intended. It is essential to monitor discharge, turbidity, and suspended sediment quasi-continuously, because the majority of sediment discharge can occur during rare, brief storm episodes. These would likely be missed under a protocol of periodic grab samples (see, for example, Whyte, D.C. and J.W. Kirchner, Assessing water quality impacts and cleanup effectiveness in streams dominated by episodic mercury discharges, ***Science of the Total Environment***, **260**, 1-9, 2000).

13. General questions

In reading the technical Staff Report and proposed amendment language, are there any additional scientific issues that are part of the scientific portion of the proposed rule not described below? Taken as a whole, is the scientific portion of the proposed rule based upon sound scientific knowledge, methods, and practices?

To my knowledge, the proposed rule is based on the best available science at present. The science of erosion, sedimentation, and fluvial geomorphology is continually evolving and significant uncertainties remain. It is likely that significant advancements will be made in the science within the next 5 to 10 years. Therefore the provision for periodic reassessment is an important component of the action plan.

DR. VINCENT H. RESH'S COMMENTS

A REVIEW OF

TMDL ACTION PLAN

FOR THE

ALBION RIVER, BIG RIVER, NOYO RIVER, AND TEN MILE RIVER

WATERSHEDS SEDIMENT TMDL

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INTRODUCTION

This document presents a scientific peer review of the Action Plan for the Albion River, Big River, Noyo River, and Ten Mile River Watersheds Sediment TMDLs ("TMDL Action Plan") and the Preliminary Draft Basin Plan Language for the Action Plan ("Basin Plan Language"). In particular, the NCRWQCB requested review of numerous focused topics that can be grouped into three broad questions:

1. Problem Statement: are the rivers not fully supporting their beneficial uses due to increased supplies of sediment?
2. Water Quality Targets: will water quality targets, if met, insure the suitability of habitat conditions to support aquatic life?
3. Implementation Plan: is the implementation plan, as described, an effective approach for protecting the beneficial uses of the watersheds?

Although summarized in the TMDL Action Plan, the analysis of beneficial use attainment is described in more detail in the EPA's TMDL documents for each watershed (U.S. EPA 1999; U.S. EPA 2000; U.S. EPA 2001a; U.S. EPA 2001b). Thus, at the request of the NCRWQCB, this assessment involved review of all or portions of the following documents:

1. Action plan for the Albion River, Big River, Noyo River, and Ten Mile River watersheds sediment TMDLs. NCRWQCB, 2004a.
2. Preliminary draft basin plan language for the action plan for the Albion River, Big River, Noyo River, and Ten Mile River watersheds sediment TMDLs. NCRWQCB, 2004b.
3. Albion River TMDL for sediment. U.S. EPA, 2001a.
4. Big River TMDL for sediment. U.S. EPA, 2001b.
5. Noyo River TMDL for sediment. U.S. EPA, 1999.
6. Ten Mile River TMDL for sediment. U.S. EPA, 2000.

Furthermore, many relevant documents and published articles were also consulted (see Literature Cited) to evaluate the documents under review.

To address the three broad questions I: (1) examined available historic and current information on salmonid populations and stream-channel habitat conditions to consider the limiting factors of salmonid populations; (2) assessed whether water quality targets are scientifically valid and will address limiting factors for the survival of salmonid populations; and (3) evaluated the feasibility and effectiveness of the actions proposed in the implementation plan. Based on this analysis, this review is divided into three sections: (1) Limiting Factors for Salmonid Populations; (2) Water Quality Targets; and (3) Implementation Plan. At the end of each section, the relevant questions described in the "Scientific Review and Focused Questions" (Attachment 2) are addressed, and general recommendations for improvement are made. More detailed comments and recommendations are made within the text of each section.

1. LIMITING FACTORS FOR SALMONID POPULATIONS

Focus Questions: Is there evidence that the four rivers are not fully supporting their beneficial uses due to excessive inputs of sediment? Is this conclusion scientifically valid? Does the rationale described in the Action Plan and Basin Plan Language adequately support the conclusion?

The premise behind the sediment TMDLs is that "excessive inputs of sediment" have resulted in a reduction in the quality and quantity of aquatic habitat, which has resulted directly in a dramatic decline in salmonid populations. Although summarized in the TMDL Action Plan, historic changes in salmonid populations and channel conditions are described in more detail in the RWQCB's 2001 document "Assessment of Aquatic Conditions in the Mendocino Coast Hydrologic Unit" (RWQCB 2001), as well as the EPA's TMDL documents for each watershed (U.S. EPA 1999; U.S. EPA 2000; U.S. EPA 2001a; U.S. EPA 2001b). I relied upon these and other sources of information to evaluate to what degree salmonid populations have declined from historic levels, and whether continued decline is expected. To make the connection between salmonid populations and water quality targets, we first must consider which aspects of stream habitat are limiting population size. Second, the factors limiting salmonid populations must be understood to assess whether water quality targets are useful indicators of habitat quality. To do this, I used a variety of reports and surveys to examine the limiting factors for salmonids in the four watersheds (see Literature Cited). Based on this analysis, three broad factors were identified that may limit coho populations: (1) large woody debris/habitat complexity; (2) high sediment loads; and (3) high stream temperatures. However, sufficient data are not available to describe with certainty all of the potential factors that could limit the survival and growth of salmonid populations in these watersheds.

Status and Trends of Salmonid Populations

The primary species of concern in the Albion River, Big River, Noyo River, and Ten Mile River watersheds are coho salmon and steelhead trout. Chinook salmon existed in the Noyo River in the 1960's and are occasionally found in the Big River watershed, but it is uncertain whether these are native populations, strays from other coastal watersheds, or introduced hatchery fish. Chinook were introduced into the Ten Mile River several times, most recently in the 1980's, but after several years of successful reproduction it appears that the population has virtually disappeared (Maahs 1996). On the north coast of California, chinook salmon are generally present only in the larger rivers systems (e.g. Klamath River, Eel River, Russian River). Coho salmon of the Central California Coast are listed as endangered on the California Endangered Species Act (ESA) and are listed as threatened on the federal ESA. Steelhead trout and Chinook salmon are both listed as threatened on the federal ESA. Following the emphasis of the reports being evaluated (e.g. U.S. EPA 1999; U.S. EPA 2000; U.S. EPA 2001a; U.S. EPA 2001b), the focus of the population status and limiting factors analysis will be on coho salmon.

Albion River

No quantitative population estimates exist for the Albion River watershed prior to the 1990s (RWQCB 2001). Available data is insufficient to even estimate the historic distribution of coho within the watershed, other than observations of coho by the DFG in the 1960's and 1970's in the mainstem Albion River, South Fork, North Fork, and Kaisen Gulch (RWQCB 2001). Recently, Wehren (1996) estimated the coho spawning population of the Albion River mainstem and North Fork Albion River to range between 4 and 43, although this estimate is believed to be low because of limitations of the study (in RWQCB 2001). The RWQCB (2001) estimated the number of coho observed during intensive

stream surveys in 1996, using data from the Mendocino Redwood Company, to be between 309 and 2436 fish. Coho were observed in 9 streams in the watershed during MRC surveys (RWQCB, 2001). Elsewhere in the region, 1996 was observed to be one of the best coho runs of the decade, as a result of excellent climatic and oceanic conditions.

Big River

No quantitative coho population estimates exist for the entire Big River (RWQCB 2001), although CDFG estimated that there were 6000 coho spawners in the Big River watershed in the 1960's, based on habitat availability and numbers from other California streams (Taylor 1978). . Even qualitative observations of coho distribution in the watershed are limited prior to the advent of a DFG stocking program in the 1970s. Surveys in the 1950s and 1960s by DFG found high numbers of juvenile coho (250/100 ft.) in the South Fork Big River and Daugherty Creek, yet surveys found low numbers or absence in many tributaries affected by timber harvest practices (KRIS 2004e). Surveys in the 1970s established the presence of coho in 18 streams, although these observations were made while stocking programs were active (RWQCB 2001). Surveys in the 1980s and 1990s by DFG documented coho in only 3 of 11 streams (RWQCB 2001). Surveys by the Mendocino Redwood Company found very low numbers of young-of-the-year coho (in the major tributaries (Upper Big River, North Fork, East Branch North Fork, Two Log Creek, South Fork, and Daugherty Creek).

Noyo River

CDFG estimated that there were 6000 coho spawners in the Noyo River watershed in the 1960s, based on habitat availability and numbers from other California streams (Taylor 1978). The TMDL Action Plan presents data from the Noyo River Egg Collecting Station on the South Fork Noyo River, where adult coho returns have been documented since 1962. Adult returns have varied over the years from 16 to ~5000 coho, with higher values during the 1960's and 1970's (median of ~2500 fish) than the 1980's to present (median of ~500 fish). Temporal trends in returns since 1980 are primarily related to climatic and ocean conditions, which have strongly influenced run sizes (KRIS 2004d). Surveys in 2001 confirmed coho presence in most historical coho streams except the Middle Fork of the North Fork of the Noyo River (CDFG 2002).

Ten Mile River

There are no historic (pre-1980) quantitative estimates of coho populations, although CDFG estimated that there were 6000 coho spawners in the Ten Mile River watershed in the 1960's, based on habitat availability and numbers from other California streams (Taylor 1978). Recent salmonid surveys have revealed patchy distributions of coho, especially with regards to juveniles (data from Hawthorne Timber Company, in KRIS 2004a). A comprehensive basin-wide survey by Hawthorne Timber Company in 2000 revealed 1731 juvenile coho in the watershed, resulting in a conservative estimate of 2 spawning adults based on fry and smolt survival estimates of 2% and 5%, respectively (KRIS 2004b). Juveniles were only found in four tributaries, with 65% found in one stream, the Little North Fork. Relatively stronger coho runs have been observed in the Little North Fork and the South Fork Ten Mile; weaker or nonexistent runs occur in Redwood Creek, Mill Creek, and Bald Hills Creek (Maahs 1996; DFG 2002). Recent estimates of returning spawners are on the order of 50-100 coho salmon, although estimates from various methods range from 2 to 351 (Maahs 1996, DFG 2002, KRIS 2004b).

Because of the lack of historical data in these four watersheds, it is impossible to say to what degree coho abundance or distribution has changed. More recent surveys, however, confirm that coho

populations are consistently low. Data from the Noyo River suggests that, despite the stocking program, coho abundance declined precipitously in the 1980's and 1990's. Surveys of the Ten Mile River highlight the patchy distribution of juveniles and absence of coho in many streams in which they historically occured.

Although it is difficult to quantify the magnitude of the decline of salmonid populations in these four watersheds, there is convincing evidence of historic declines throughout the Pacific Coast and Northern California in particular (DFG 2002). Although highly qualitative, historic estimates of coho abundance statewide range from 100,000 in the 1960s to one million in the late 1940s (Brown and Moyle, 1991). The current population of native wild coho in California is believed to be less than 5000 fish (Brown et al. 1994), less than 1% of historic levels. Within the Central California Coast Evolutionary Significant Unit (CCC ESU), coho abundance data for streams indicate a recent decline since the late 1980's (DFG 2002). Widespread declines or extirpations of coho populations have occurred in neighboring geographic regions, such as the Garcia River and the Sonoma County coast (Gualala and Russian Rivers) to the south and the Mattole River to the north (DFG 2002).

Because the four watersheds in question are similar in both ecology and history of anthropogenic disturbance to other watersheds of the Northern California Coast, it is likely that trends observed throughout the region are generally applicable to these four watersheds. Given the size and channel characteristics of the four watersheds, and historical estimates of statewide coho populations, order-of-magnitude estimates for historic abundance of coho for each watershed are probably in the range of 5000 to 50,000. Current estimates of coho populations in the four watersheds, which range from ~10 to ~500, represent a small fraction (<1-10%) of historic abundances.

In conclusion, despite the deficiency of quantitative data specific to the Albion River, Big River, Noyo River, and Ten Mile River watersheds, there is compelling evidence that coho salmon populations have experienced drastic declines throughout the 20th century, continuing to the present. All four watersheds are believed to possess viable populations of coho salmon for all three brood years. However, coho are absent from a large number of historic coho tributary streams. Additionally, evidence of recent population declines in the 1990's to very low numbers (<100 returning coho) in these watersheds indicates that the populations may not possess the minimum sizes needed to sustain themselves. As in other streams, this suggests that coho populations will continue to decline and are in danger of extirpation (e.g. Brown and Moyle, 1991).

Habitat Requirements

Habitat requirements for coho salmon in Mendocino County are described in detail in a document produced by Stillwater Sciences for Louisiana Pacific (Stillwater Sciences, 1997). Primary importance to coho salmon is the quality of spawning gravels, in terms of the size of appropriate patches and the content of fine sediment. Given the presence of spawning gravels of sufficient quality, the quantity of winter rearing habitat is generally believed to be the factor limiting coho population size in the Pacific Northwest, as density-dependent mechanisms limit salmonid carrying capacities (Stillwater Sciences, 1997). The primary requirement of rearing habitat for juveniles is low flow velocity. Additionally, deep water, low temperatures, cover, and sufficient food resources are needed. These requirements are satisfied by deep pools, side channels, and abundant large woody debris (LWD).

Current Habitat Conditions and Potential Limiting Factors

Large Woody Debris/ Habitat Complexity

The impacts of 19th century logging practices have resulted in vastly altered stream conditions and watershed processes in the redwood region of Northern California, as detailed by Napolitano (1998) and Surfleet and Ziemer (1996) for the North Fork Caspar Creek watershed. In order to transport timber downstream to the mouths of river systems, felled trees were stacked in stream channels. To facilitate log drives, debris jams, wood, root wads, and other flow obstructions were removed in downstream channels, and multiple splash dams were constructed to provide for peak flows capable of transporting large volumes of wood. The immediate effects of these practices was the liberation of massive amounts of sediment stored behind debris jams, channel incision of 1-2 meters, and conversion of a complex, stepped channel with abundant sediment and wood storage to a straight, simplified channel with few pools and less pronounced steps (Napolitano, 1998). Following channel incision, floodplains were converted from depositional sediment sinks to terraces, inaccessible to flood flows, serving as large-volume sediment sources. Debris jams in streams in old-growth forests are composed of LWD with diameters ranging from 0.8 to 2.5 m. Currently, the largest LWD in the North Fork Caspar Creek is 0.5 m diameter, comparable to the largest second-growth redwoods in the surrounding forest. Debris jams composed of these smaller diameter logs are short-lived features that store less sediment and force the formation of smaller pools than their historical counterparts.

Following the initial removal of wood from streams in the 19th century, the Department of Fish and Game actively removed log jams from the Noyo River and other salmonid streams from the 1950s through 1980s (Holman and Evans, 1964; Sillwater Sciences, 1997). Further logging in the 1950s and 1960s reduced recruitment of LWD in these watersheds. Large woody debris is critical to the formation of large pools. Removal of LWD results in simpler channels, fewer and shallower pools, and reduced capacity to buffer large inputs of sediment (Bisson and Sedell, 1984; McMahon and Reeves, 1989). Because of the fundamental importance of LWD to stream channel morphology in coastal Mendocino County, these streams will not recover their historic morphology until stable log jams composed of large diameter LWD are abundant (Napolitano, 1998).

Logging practices such as log drives and the construction of splash dams were practiced throughout watersheds of Coastal Northern California. The Big River is believed to have had more permanent logging dams for log drives than any other north coast river, which remained in use until the last log drive in 1943 (Jackson, date unknown, in KRIS 2004c). Although the occurrence of dams and log drives are poorly known in the other three watersheds, this is most likely a result of the lack of historical documentation rather than the use of different timber harvest methods.

Although data is often lacking and, when available, collections were inconsistent across the four watersheds, there is evidence that levels of large woody debris are quite low, resulting in low levels of wood-formed pools and low habitat complexity relative to optimal conditions for salmonids. Surveys by the Coastal Land Trust Survey (in RWQCB 2001) documented low levels of habitat and pools formed by LWD in the Albion River watershed. Likewise, in the Ten Mile River watershed few pools are formed by LWD (U.S. EPA 2000). Even if streamside forests are not harvested for many years, LWD volume will not reach historic levels until existing second-growth trees mature into larger diameter (1-2 m) redwoods. In forests that were logged within the past 50 years, it may take another 100 years or more for large diameter trees to be recruited into stable debris jams. In some cases, active restoration may be more effective at improving habitat for salmonids than reductions in sediment supply. In Lagunitas Creek, Marin County, the addition of artificial, complex LWD structures has improved

channel complexity, pool depth, and habitat use by coho salmon (Leslie Ferguson, personal communication).

Sediment

Forest management practices, including road building and timber harvest, have resulted in vastly increased rates of sediment delivery to streams in the four watersheds. For example, in the Noyo River watershed, approximately one half of the sediment eroded by mass wasting between the 1930s and the present results from anthropogenic practices, such timber harvest, roads, and railroads (Graham Matthews and Associates, 1999). In addition, surface erosion from skid roads and vehicular roads have contributed large amounts of fine sediment to streams, and over 20% of the total sediment during the 67-year study period (Graham Matthews and Associates, 1999). Much of this sediment was eroded between the 1950s and 1970s, when second-growth forests were targeted for harvest throughout Northern California.

Increased sediment delivery can affect salmonids in many ways, although the most direct and pronounced effects relate to egg development and emergence. Infiltration of fine sediment into spawning gravels reduces gravel permeability, decreasing water flow and oxygen levels, which is related from empirical studies to egg survival and emergence (e.g. Tappel and Bjornn 1983). Increased sediment supply increases the frequency and depth of bed mobility during floods (Lisle 2000), increasing the likelihood that salmonid redds will be scoured below the depth of egg deposition.

Levels of fine sediment in the streambed are above optimal levels for salmonids (>14% of grains <0.85 mm) in some locations. Fine sediment (<0.85 mm) in bulk subsurface sediment samples from several locations in the Big River watershed (Graham Matthews and Associates 2001, in KRIS 2004h) ranged from 3.3 to 14.5 %. Fine sediment data (<0.85 mm) collected by the Hawthorne Timber Company at two sites between 1996 and 2001 (in KRIS 2004i) ranged from 9.7% to 24.7%, with just 2 out of 14 samples <16%. Similar data collected by the Mendocino Redwood Company in 2000 (in KRIS 2004j) averaged across sub-basins ranged from 10% to 15%.

Gravel permeability is also lower than optimal in many locations. Permeability data from the Mendocino Redwood Company (in KRIS 2004k) averaged across sub-basins in the Big River ranged from 629 to 7797 cm/hr, corresponding to predicted egg survival rates of 13% to 51%. Permeability values were generally higher in the mainstem Noyo River, ranging from 2080 to 23553 (MRC in KRIS, 2004).

In summary, forest management practices have resulted in increased rates of sediment supply to streams in the four watersheds. Based on existing data, fine sediment in the stream bed may be an important factor limiting the survival of salmonid eggs. Differences in data collection and reporting, however, prevent definitive comparisons between projects or watersheds.

Temperature

There is also evidence that water temperature may be a limiting factor for salmonids in certain locations. Mainstem streams in the Ten Mile River watershed may be warmer than optimal conditions for coho (Ambrose and Hines 1997, 1998). The North Fork of the Noyo River often exhibits warm temperatures, with maximum weekly average temperatures (MWAT) greater than 17 degrees Celsius, which is above the optimal maximum temperature of 16.8 degrees C (KRIS 2004f). The warmest temperatures in the region may occur in the mainstem and South Fork Big River, where MWATs are elevated above 16.8 degrees C for most of the summer season, and have exceeded 20 degrees C (KRIS 2004g). It is unknown to what degree these conditions have been affected by anthropogenic forest management practices. Although temperatures may be naturally warmer than optimal in mainstem

channels, it is likely that coho populations have persisted by seeking out cool-water refugia in tributaries or in deep pools. Changes in the availability of refugia resulting from altered habitat conditions in tributaries may force salmonids to inhabit mainstem streams, despite warmer temperatures.

Conclusions and Recomendations

Focus Questions: Is there evidence that the four rivers are not fully supporting their beneficial uses due to excessive inputs of sediment? Is this conclusion scientifically valid? Does the rationale described in the Action Plan and Basin Plan Language adequately support the conclusion?

In conclusion, based upon available data from streams in coastal Northern California, it appears that (1) LWD/habitat complexity, (2) increased sediment supply, and (3) high temperatures may be limiting salmonid production in the Albion River, Big River, Noyo River, and Ten Mile River watersheds. Lack of large diameter LWD, as a result of wood removal and timber harvest, has numerous cascading effects on channel morphology, sediment storage, and sediment transport processes. These effects can result in very poor habitat conditions for salmonids, especially juvenile coho salmon during summer and winter rearing. Increased levels of coarse and fine sediment reduce the probability of egg survival and emergence as a result of scour, burial, or subsurface clogging of gravels. High temperature primarily affects coho rearing during the summer season in mainstem channels. Based on limited data, current conditions of all three factors are less than optimal for coho populations in portions of one or more of the four watersheds.

Data from the four watersheds, combined with evidence from other north coast streams, indicates that salmonid populations have experienced massive declines throughout the 20th century. There is ample evidence that excessive inputs of sediment have resulted in drastically altered aquatic habitat conditions, which have significantly contributed to the decline of salmonid populations in Albion River, Big River, Noyo River, and Ten Mile River watersheds. In addition to sediment, large woody debris and temperature are also important factors that must be considered.

Problem Statement: Recomendations

1. Combine portions of the four problem statements into an overview section, which discusses commonalities between the watersheds (e.g. fisheries beneficial uses, CCC ESU status, general trends in salmonids, land use history, etc.). Within watershed-specific sections, the data and conditions particular to each watershed can be discussed. Currently, the problem statements jump back and forth between statewide, regional, and watershed estimates of salmonid populations. For example, the first sentence of the second paragraph of the Albion River problem statement begins by mentioning the decline of salmonids in the Albion River, but the rest of the paragraph is devoted to statewide trends.
2. Add information about potential limiting factors other than sediment, such as wood and temperature. Although wood is necessary to maintain the physical and biological integrity of these streams, I am unclear how the RWQCB might regulate a component of stream habitat that has been lost (wood) under the limitations of the current regulatory structure (i.e. pollutant-based TMDLs). Yet the focus of the TMDL is the restoration of salmonid fisheries, which cannot be accomplished by focusing exclusively on sediment. Although temperature and wood water quality targets are included, these factors should be discussed in the problem statement.
3. Add general information about the history of forest and watershed management on the redwood coast. It is important to convey that the effects of 19th century logging practices are still being felt

today, yet there is virtually no information on the magnitude of the physical and biological effects of those practices.

4. Add estimates of anthropogenic-derived sediment, from the sediment source analyses by Graham Matthews and Associates, to the problem statement. This is a critical link between 20th century land use practices and sediment supply that should be briefly mentioned in the problem statement.

2. WATER QUALITY TARGETS

Focus Questions: Are the proposed targets scientifically valid? For each target, does the rationale described in the draft Staff Report adequately support the proposed target value? If the instream targets are obtained, will the habitat requirements for all freshwater lifestages of chinook salmon, coho salmon, and steelhead trout be present in the water body? If the instream targets are obtained, will the habitat requirements for other aquatic life be present in the water body? Will the proposed parameters show a measurable response from changes in sediment discharges over time? Are the proposed targets appropriate for the local geology? Where an instream target is limited to a specific stream type or reach, is that stream type or reach appropriate, and are there other stream types or reaches that the target should apply to? Are the monitoring and sampling suggestions clear, concise, appropriate, and adequate?

Benthic macroinvertebrate production

The Russian River Index of Biological Integrity is composed of six metrics that describe benthic macroinvertebrate assemblages: taxa richness, percent dominant taxa, EPT (Ephemeroptera, Plecoptera, and Trichoptera) taxa, modified EPT index, Shannon diversity, and tolerance value. These metrics have been shown to be related to gross levels of water pollution from urban runoff and agriculture (e.g. pesticides, metals, eutrophication) and, as such, they are excellent indicators of water quality. There is no evidence that I am aware of (and no reason to believe), however, that these metrics are sensitive to changes in important habitat conditions for salmonids, such as gravel permeability, levels of fine sediment, pool frequency and depth, and increased temperature. It is reasonable to expect that a benthic assemblage scoring good or excellent on the RRIBI could exist in a highly embedded riffle unfavorable for salmonid egg development.

As a recommendation, it may be preferable to use the biological traits of benthic taxa as indicators of substrate conditions. In a recent study in the Eel River, Suttle et al. (2004) evaluated the effects of different levels of embeddedness on salmonids and aquatic invertebrates in experimental channels. Increased levels of embeddedness altered the benthic assemblage from one dominated by surface and crevice dwelling organisms (grazers and predators) to one dominated by burrowing taxa. This type of approach could be applied in these four watersheds by developing a database of biological traits specific to the taxa found in the watersheds.

Additionally, benthic invertebrates are important not only as indicators of stream condition but for their role as a food resource for salmonids. Changes in the benthic assemblage will alter prey availability for salmonids. The suitability of a benthic species as prey for salmon depends on many factors, including body size, mobility, habit, and propensity for drift. Again, a database of these biological traits could be developed specific for local taxa, and be used to infer relative differences in prey availability between and within watersheds.

Finally, I recommend that the name of the target be changed from “Benthic Macroinvertebrate Production.” In scientific literature, “production” is often used to connote production of biomass. The

RRIBI is an index of metrics which primarily relate to community composition, rather than abundance or total biomass. Instead, the target could simply be named "Benthic Macroinvertebrate Assemblage".

Embeddedness

The RWQCB proposes an embeddedness target of "an increasing trend in the number of locations where gravel and cobbles are <25% embedded." This is an appropriate target, as embeddedness is an important factor affecting substrate suitability for many aquatic organisms. I am wary of asserting that "the long term goal is for all wadeable streams and rivers to have embeddedness values <25%", however. It seems impractical to assume that this is a reasonable target for all streams and rivers, as there is little evidence that this is the "natural" condition of North Coast streams. In general, sustaining stream function requires a range of conditions to be present (Reid and Furniss, 1998).

Large woody debris

Large woody debris is of tremendous importance to the formation and maintenance of suitable salmonid habitat and stable channel conditions in northwestern California. The U.S. EPA (1999, 2000, 2001a, 2001b) suggested that an appropriate target for LWD is an increasing trend in the frequency and volume of LWD, except in the Ten Mile River watershed where target values are based on conditions in the Little North Fork of the Ten Mile River, one of the more productive coho streams in the watershed. The RWQCB, however, proposed specific target values for LWD frequency, volume, and key piece frequency for all four watersheds based on data collected by Fox (2001) in Washington. The RWQCB is correct to assume that the percentage of stream habitat formed by LWD in Little North Fork of the Ten Mile River does not represent suitable conditions and should not serve as a water quality target.

However, in contrast to the RWQCB's draft action plan, there are several reasons that LWD targets from Washington may not be appropriate for the Mendocino coast. Volumes of dead wood in streams draining old growth forests varies greatly both within and between forest/climatic types in northern California (e.g. Coastal Mountains, Sierra Nevada, Klamath Mountains, Cascade Mountains) (Lisle, 2002). Redwood forests have exceptionally high LWD loading levels: the median volume of LWD in streams draining old growth redwood forests is nearly an order of magnitude greater than other coniferous forests (Harmon et al. 1986; Lisle 2002). Within old-growth redwood forests, dead wood volumes may vary by an order of magnitude (Lisle, 2002). Whereas redwood dead wood lasts for centuries (Kelly et al. 1995), fir and spruce dead wood decays much faster, occurring on the order of decades (Cedarholm et al., 1997). Even with similar levels of wood recruitment, redwood debris jams can serve as longer-term stabilizing features in channels than wood from other conifers.

The RWQCB should consider that some data on LWD loadings from old-growth redwood forests is available (e.g. Keller and Tally 1979; Harmon et al. 1986). Given the high natural variability between old-growth streams, it may be more appropriate to specify a frequency distribution of dead wood volumes or frequencies rather than specifying one numeric target (Lisle, 2002). I suggest that two numeric targets could accurately describe optimal conditions: a minimum value and a median value of dead wood volume based on values from old-growth redwood forests. These values could be drawn from the studies of Harmon et al. (1986, in Bilby and Bisson, 1998), who found an average debris loading of 74.2 kg/m^2 in small streams in redwood forests, and Tally (1980; in Napolitano 1998), who observed a range of 12-268 kg/m^2, with a median value of 85 kg/m^2.

Pools: backwater pool distribution; lateral scour distribution; primary pool distribution

Pools are a critical component of juvenile salmonid rearing habitat. A high percentage of pools are associated with forcing from LWD. It is evident that reductions in LWD loading, channel incision,

and loss of floodplain connectivity have resulted in decreased frequency and depth of all three pool types. Still, it is advisable to set the targets as "an increasing trend", as variability in natural conditions across spatial and temporal scales should be expected (Reid and Furniss, 1998).

Substrate composition: % fines <0.85 mm; % fines <6.4 mm; D_{50}

Both of the percent fines targets seem appropriate, as they are empirically correlated with emergence success and significant amounts of data are already available from the four watersheds. The RWQCB should be sure to explicitly specify the methods to be used, as existing data has been collected from different locations (subsurface vs. surface samples; redds vs. pool tail-outs) and using different collection and sieving methods.

The median grain size of the bed is an important indicator of the suitability of habitat for spawning. As a water quality target for the four watersheds, however, D_{50} is not scientifically valid. Substrate composition is a factor of transport capacity and sediment supply. Reach-scale transport capacity varies with channel gradient, channel roughness, and flow (Knighton, 1998). Local-scale flow perturbations and tributary effects add considerable variability to grain size and transport capacity. Although sediment supply is an important variable affecting surface grain size, even a doubling of sediment supply, which is the maximum increase observed from sediment budget analyses by Graham Matthews and associates, would be very difficult to detect from surface grain size distributions (Lisle, 2000). Despite the RWQCB proposal to restrict application of the target to third-order streams with gradients between 1 and 4%, there is still tremendous variability in transport capacity between this range of streams. In general, transport capacity will be a more important determinant of surface grain size than sediment supply. Instead of D_{50}, other indicators that reflect sediment supply but account for transport capacity, such as Shields stress or Q*, would be more appropriate (see recommendations below for specific targets).

Temperature

The temperature targets are excellent indicators of stressful conditions for salmonids, as they are based on extensive empirical and experimental research. They are much improved from the existing targets in the NCRWQCB Basin Plan, which are qualitative in nature.

It is problematic that limiting factors for salmonids must be approached from the perspective of sediment. Although wider and shallower channels can cause increased temperatures, riparian shading and stream flow are much more important factors. The effects of historic logging on streamside shading must be tremendous, but these effects are not addressed.

The RWQCB should carefully specify where temperature monitoring should occur. Cold-water refugia, as is often found at the mouths of tributaries or in deep pools, plays an important role for salmonids in mainstem rivers. Monitoring should be targeted at a variety of channel locations to assess the range of temperature conditions available.

Thalweg Profile

The thalweg profile target of "an increasing trend in the variation around the mean thalweg profile slope" is an appropriate target for low gradient streams that are believed to have been simplified as a result of loss of LWD recruitment and increased sediment supply. It should not be applied to steeper streams, however, if those streams do not naturally exhibit a pool-riffle or forced pool-riffle (due to LWD or other obstructions) morphology. Based on data from Washington, there is significant overlap between pool-riffle and plane-bed morphologies (Montgomery and Buffington, 1997). Use of this target in streams steeper than ~2% would first require an evaluation of channel types and

morphologies in least-disturbed (e.g. old-growth) forests to document expected conditions for a range of slope classes.

Turbidity

The existing turbidity target (20% above background) is not appropriate to the biology of salmonids. However, the RWQCB is correct in its conclusion that sufficient studies have not been performed to propose an appropriate numeric target. The 25 NTU or 27 NTU chronic turbidity threshold is appropriate, but it is unclear how many consecutive days or total days above the threshold can occur before beneficial uses are affected. If rates of juvenile growth are found to be a limiting factor for salmonid populations, the RWQCB should consider establishing a target based on the 25 NTU threshold.

Turbidity monitoring can either be performed with continuous data collectors, which are quite expensive, or grab sampling. If grab sampling is performed, it is recommended that monitoring should target the days following the peak flow of significant storm events. Post-storm sampling (i.e. 1,2,3,5 days following peak storm flows) should document the length of time turbidity remains elevated above 25 NTU. In addition to providing data about the effects of turbidity on salmonid feeding, this data is also useful for identifying particular sub-basins with chronic sources of fine sediment.

The turbidity target is missing from Table 3-1 and should be added.

V*

Based on studies of tributaries to the Trinity River, V* is a good indicator of sediment supply, especially fines (Lisle and Hilton, 1991). Because fine sediment is usually removed from pools during storms, and redeposited during the falling limb of hydrograph (Lisle, 2000), this indicator most likely exhibits tremendous temporal variation, depending on the dynamics of the previous storm event.

The comparison of V* values from streams in the Klamath Mountains (Little North Fork Salmon River, South Fork Salmon River, Taylor Creek) is inappropriate, as the Action Plan points out. These streams primarily drain granitic watersheds, which produce high amounts of sand and do not represent undisturbed conditions.

Numerous unmanaged streams in the Coast Ranges have V* values ranging from 0.21 to 0.27. If the purpose of the target is to set standards representative of relatively undisturbed conditions, a higher target value should be used. Based on data presented in Figure 8 of Knopp (1993), which only includes data from the Franciscan Formation, a value closer to 0.30 might be more appropriate for distinguishing between relative levels of disturbance.

Rather than requiring a set number of pools or limiting the reach length to 1000 meters, it would be better to sample consecutive pools until the natural variation has been captured (e.g. the standard deviation is below a predefined target). "Field computers" used by Lisle and Hilton allow for the input of data in the field and the calculation of average values and standard deviations.

Activity in Unstable Areas

It is unclear how unstable areas will be defined. Although it is important to allow for decisions based upon site-specific conditions, making assessments on a site-by-site basis allows for very different interpretations of unstable areas by different assessors, unless very detailed guidelines are established. I worry that the process of defining unstable areas will be not be taken seriously by landowners and their natural resources staff, much as cumulative watershed effects assessments are treated in the timber harvest plan (THP) process.

I recommend a standardized approach for identifying unstable areas, conducted by the RWQCB across all four watersheds. This first step in the approach would be a GIS-based analysis of hillslope instability. The SHALSTAB model is a coupled hydrologic and hillslope model that predicts the potential of shallow landsliding across landscapes from digital elevation models (Dietrich and Montgomery 1998). This method was tested and validated in watersheds in Mendocino and Humboldt Counties, including the Noyo River watershed, and has been used by Louisiana Pacific for many years (Dietrich et al. 1998). Once a conservative determination of potential unstable areas has been made, a field analysis of sites that landowners believe have been misclassified could be performed by a well-trained hillslope geomorphologist. Given the SHALSTAB model's accessibility and efficiency, and the fact that it has already been successfully tested and applied in the region, it would be sensible to use this approach at least as a first approximation of hillsope instability.

Rather than proposing a decreasing trend in activity on unstable areas, it would be more appropriate to immediately limit the types of activivties that could be performed on unstable areas. Determination of allowable land use practices should be tailored to the degree of potential instability (log q/T values from SHALSTAB). If a site is believed to be moderately unstable, certain practices could be allowed as long as extra cautions are observed.

Disturbed Areas

The disturbed areas target does not describe the methodology that will be used to determine disturbed areas. Unless a detailed method for assessing disturbed areas is developed, it is recommended that the RWQCB eliminate this target.

The RWQCB correctly points out that the Equivalent Roaded Area method and other disturbance indices are not suitable for predicting the effect of land use on water quality. Because any sediment introduced into a watershed will eventually end up in a sensitive stream reach (spawning or rearing habitat), perhaps a better measure of the potential for disturbance would be the unstable areas target.

Water Quality Target for Roads and Railroads

An increasing trend in the number of properly functioning roads and railroads is an appropriate target. The guidelines given in Figure 8-3 seem reasonable, provided knowledgeable workers are redesigning or improving the roads. Again, I have concerns about the technical ability or motivation of private landowners to create properly functioning roads. No monitoring recommendations are given. It is important to standardize monitoring and assessment of road condition across the watersheds. Watershed-wide road assessments should be conducted at regular intervals (1-5 years) by professionals trained in road assessments.

Conclusions and Recommendations

Focus Questions: Are the proposed targets scientifically valid? For each target, does the rationale described in the draft Staff Report adequately support the proposed target value? If the instream targets are obtained, will the habitat requirements for all freshwater lifestages of chinook salmon, coho salmon, and steelhead trout be present in the water body? If the instream targets are obtained, will the habitat requirements for other aquatic life be present in the water body? Will the proposed parameters show a measurable response from changes in sediment discharges over time? Are the proposed targets appropriate for the local geology? Where an instream target is limited to a specific stream type or reach,

is that stream type or reach appropriate, and are there other stream types or reaches that the target should apply to? Are the monitoring and sampling suggestions clear, concise, appropriate, and adequate?

Reduced inputs of sediment, according to the prescriptions of the TMDL for each watershed, should gradually result in improved conditions for at least five proposed in-stream water quality targets: embeddedness, % fines <0.85 mm, % fines <6.4 mm, turbidity, and V*. Other water quality targets, such as large woody debris, backwater pool distribution, lateral scour distribution, primary pool distribution, temperature, will be moderately to minimally affected by reductions in anthropogenic sediment delivery to streams. Rather, the abundance and size of large woody debris and the frequency of stable log jams is the principal factor affecting many of these parameters, including the thalweg profile.

Water Quality Targets: Recommendations

1. The lack of definitive studies on the limiting factors of salmonid populations in these watersheds makes it problematic to establish which water quality parameters are most critical. It is unknown whether sediment-related factors, which primarily influence spawning and emergence, or wood and pool related factors, which effect rearing, are the most important reasons for the decline in salmonid populations. I recommend that a detailed limiting factors analysis should be undertaken, based on the critical freshwater life stages of salmonids. Biological monitoring of the two key life stages of salmonids (emergence and rearing) and physical monitoring of the associated habitat conditions would enable a determination of which specific factors are most important. Two hypotheses need to be further explored: (1) salmonid egg emergence rates are limiting populations as a result of high levels of fine sediment or bed scour; and (2) juvenile rearing success is limiting salmonid populations as a result of poor habitat conditions and low growth rates. The "emergence" question can be examined by the use of emergence traps over salmonid redds, and measurement of associated sediment related parameters such as gravel permeability, fine sediment levels, and bed mobility. The "rearing" question could be addressed by tracking the survival and growth rates of juveniles, and relating these factors to local habitat conditions such as pool size and frequency, LWD frequency, and water temperature. Theoretically, it would be possible to begin monitoring a wide range of parameters that are hypothesized to limit salmonid populations (such as gravel permeability and pool frequency and depth), gradually eliminating parameters as a better understanding of the most important factors is developed. Once the limiting factors are established, linkage analyses should be undertaken to investigate how watershed management affects the limiting factors. Only after these steps should final numeric water quality targets and management actions be established. For example, if emergence is found to be the limiting factor, reductions in sediment supply should be the focus of the Action Plan. If, however, rearing is the limiting life stage, improving rearing habitat should be the focus of the Action Plan. This is the approach that has been taken in the Bay Area with the Napa River Sediment TMDL.
2. It is highly recommended that Q* or bank-full Shields stress should be used as an indicator of sediment supply and bed mobility instead of D_{50}. Bed mobility is an important factor affecting scour of salmonid redds and other aquatic organisms. Q* is the ratio of bed load transport predicted from bed-surface particle size to that predicted from the particle size of the load (Dietrich et al. 1989). Bank-full Shields stress is a unit-less indicator of bed mobility, which accounts for surface grain size. Lisle et al (2000) examined relatively simple methods of measuring Q* and Shields stress from

reach-averaged variables and found that both were highly correlated with sediment supply and bed mobility. Reach-scale Q* values greater than ~0.4 indicated high sediment supply and bed mobility; values <0.1 indicated very low bed mobility and sediment supply. Bank-full Shields stress values higher than ~0.6 indicated significant portions of the bed were mobile; values <0.03 indicated relatively low mobility. Lisle et al (2000) recommend that both parameters could be useful as first order assessments of bed mobility and sediment supply.

3. I recommend that a gravel permeability water quality target be added. Gravel permeability is the most important indicator for the emergence success of salmonid eggs, and has been used extensively throughout the watersheds in question.
4. Most channel indicators relating to sediment and channel form respond very slowly to changes in management practices. Additionally, channel conditions often are relatively static until very large flood events reorganize the channel. For example, stream-bed sediment characteristics (permeability, fine sediment) will respond on the order of years to decades, while pool frequency and LWD loading can recover on the scale of decades to centuries (Reid and Furniss, 1998). It should be made clear in the Action Plan that detecting the effects of new management practices will require lengthy time periods (decades or longer).

3. IMPLEMENTATION PLAN

Definition- Unstable Areas

(see the discussion of the Activity in Unstable Areas target, above)

Road Management Plan

The example road management practices are clear and appropriate. However, these examples are inadequate preparation for inexperienced workers performing road management. Perhaps landowners performing road management activities, who do not do so under the guidance of trained professionals, should be required to take a training session.

Sediment Discharge Site Volume Thresholds

The one cubic yard and ten cubic yards/ten years volumes are significant and easily recognizable by a trained professional. The difficulty comes in predicting future sources of sediment. Because increased sediment supply is a cumulative watershed effect, any amount of sediment adds to the adverse impacts to salmonids.

Sediment Assessment Methods

Sediment assessment methods should be based upon field-based surveys of erosion and sediment delivery. Although predictive models (RUSLE, WEPP, SEDMODL2) may be useful for identifying problem areas, they should not be used as methods to quantify sediment delivery.

Monitoring Plan

Effectiveness monitoring should be focused on hillslope activities, the “first links of the cause-effect chain” (Reid and Furniss, 1998). Because the implementation plan is geared towards road management and hillslope stability, the best measure of the effectiveness of the prescribed management actions is sediment discharge from hillslope activities. It may take years or even decades to observe a channel response to increased sediment supply. If adaptive management is to be used in the TMDL

Implementation Plan, monitoring sediment delivery resulting from land-use activities must allow for an immediate assessment of the effectiveness of sediment controls, and information must be made available quickly enough that steps can be taken to reduce the impact of sediment delivery (Reid and Furniss, 1998).

In conjunction with hillslope monitoring, turbidity (or suspended sediment concentration) responds rapidly enough to be a useful indicator of effectiveness. Turbidity grab samples following storm events would be useful for identifying tributaries with higher fine sediment loads, which could indicate previously unknown upslope sediment sources.

Effectiveness monitoring is similar to implementation monitoring (section 8.3.10), except it should be performed at a broader scale than simply inventorying sediment waste discharge sites. Rather than strictly relying upon photographic analysis of existing problem areas, effectiveness monitoring should target potential future sources of sediment. Potential areas could be prioritized by topographic and hydrologic conditions using a hillslope stability model such as SHALSTAB (Dietrich and Montgomery, 1998), and by time since previous land use disturbance (timber harvest).

Conclusions and Recommendations

The RWQCB has done a commendable job outlining a plan for assessing sediment sources and problem areas, but I am worried that landowners will use inconsistent monitoring and assessment methods, resulting in analyses that are incomplete or not comparable. I recommend that the RWQCB do as much as possible to encourage landowners to pool their resources in order to finance a single, standardized approach to monitoring and sediment source analyses.

Cited Literature

Ambrose, J., and D. Hines. 1997. Ten Mile River Watershed 1996 Instream Monitoring Results. Georgia-Pacific West Inc. Fort Bragg, CA. 55 pp.

Ambrose, J., and D. Hines. 1998. Ten Mile River Watershed 1997 Instream Monitoring Results. Georgia-Pacific West Inc. dba The Timber Company. Fort Bragg, CA. 51 pp.

Bisson, P. A., and J. R. Sedell. 1984. Salmonid populations in streams in clearcut vs. old-growth forests of western Washington. Pages 12 1-129 in **W. R.** Meehan, T. R. Merrell, Jr., and T. A. Henley, editors. Fish and wildlife relationships in old-growth forests: proceedings of a symposium. American Institute of Fishery Biologists, Morehead City, North Carolina.

Brown, L.R. and P.B. Moyle. 1991. Status of Coho Salmon in California. Report to the National Marine Fisheries Service. Department of Wildlife and Fisheries Biology, University of California, Davis, CA. 95616. 89 p.
Brown, L.R., P.B. Moyle, and R.M. Yoshiyama. 1994. Historical Decline and Current Status of Coho Salmon in California. North American Journal of Fisheries Management. 14(2):237-261.

California Department of Fish and Game (CDFG). 2002. Status review of California coho salmon north of San Francisco: Report to the California Fish and Game Commission. CDFG. Sacramento, CA. 336 pp.

Cedarholm, C.J., R.E. Bilby, P.A. Bisson, T.W. Bumstead, B.R. Fransen, W.J. Scarlett and J.W. Ward. 1997. Response of Juvenile Coho Salmon and Steelhead to Placement of Large Woody Debris in a Coastal Washington Stream. North American Journal of Fisheries Management. 17:947-963.

Dietrich, W. E., Kirchner, J. W., Ikeda, H. and Iseya, F. 1989. Sediment Supply and the Development of the Coarse Surface-Layer in Gravel-Bedded Rivers. Nature **340**: 215-217.

Dietrich, W.E. and Montgomery, D. 1998. SHALSTAB.
http://ist-socrates.berkeley.edu/~geomorph/shalstab/

Dietrich, W.E. et al. 1998. A validation study of the shallow slope stability model, SHALSTAB, in forested lands of Northern California. Stillwater Ecosystem, Watershed & Riverine Sciences. Berkeley, CA. 59 pp.

Fox, M. 2001. A new look at the quantities and volumes of instream wood in forested basins within Washingtion State. M.S. Thesis, University of Washington.

Graham Matthews and Associates. 1999. Sediment source analysis and preliminary sediment budget for the Noyo River.

Harmon, M.E., J.F. Franklin, F.J. Swanson, P. Sollins, S.V. Gregory, J.D. Lattin, N.H. Anderson, S.P. Cline, N.G. Aumen, J.R. Sedell, G.W. Linkaemper, K. Cromack Jr., and K.W. Cummins. 1986. Ecology of coarse woody debris in temperate ecosystems. Pages 133-302 in A. Macfadyen and E.D. Ford, editors, Advances in ecological research, volume 15. Academic Press, New York.

Hilton, Sue; Lisle, Thomas E. 1993. Measuring the fraction of pool volume filled with fine sediment. Res. Note PSW-RN-414. Albany, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture; 11 p.

Holman, G. and W. Evans. 1964. Noyo River Stream Clearance Projects. California Department of Fish and Game. 12 p.
Kelly, E.A., A. MacDonald, T. Tally and N.J. Merrit. 1995. Effects of Large Organic Debris on Channel Morphology and Sediment Storage in Selected Tributaries of Redwood Creek, Northwestern, California. U.S. Geologic Survey Professional Paper 1454-P, Menlo Park, CA.

Keller, E.A., and Tally, T., 1979, Effects of large organic debris on channel form and fluvial processes in the coastal redwood environment, in Rhodes, D.D., and Williams, G.P., eds., Adjustments of the fluvial system: Annual Geomorphology Symposium, 10th, Binghampton, New York, Kendall Hunt Publications, Dubuque, Iowa, p. 169-198.

Knighton, D. 1998. Fluvial forms and processes. London: Arnold Press.

KRIS 2004a. KRIS Ten Mile: Fisheries Data from Hawthorne Timber Company. Accessed on September 22, 2004. http://www.krisweb.com/kristenmile/krisdb/webbuilder/selecttopic_fish.htm

KRIS 2004b. KRIS: Ten Mile: Hypothesis 1. Accessed on September 22, 2004.
http://www.krisweb.com/kristenmile/krisdb/html/krisweb/analysis/hypoth1_ten.htm

KRIS. 2004c. Big River history: big river was dammed.
http://www.krisweb.com/krisbigriver/krisdb/html/krisweb/history/bigdam.htm

KRIS 2004d. Hatchery information in KRIS Noyo.
http://www.krisweb.com/krisnoyo/krisdb/html/krisweb/noyo_background/hatchkris.htm

KRIS 2004e. Hypothesis 1.
http://www.krisweb.com/krisbigriver/krisdb/html/krisweb/analysis/hypoth1_big.htm

KRIS 2004f. Noyo River: Hypothesis 3.
http://www.krisweb.com/krisnoyo/krisdb/html/krisweb/analysis/hypoth3.htm

KRIS 2004g. Big River: Hypothesis 2.
http://www.krisweb.com/krisbigriver/krisdb/html/krisweb/analysis/hypoth2_big.htm

KRIS 2004h. KRIS Big River: Sediment: Fines <0.85 mm by GMA, 2001.
http://www.krisweb.com/krisbigriver/krisdb/webbuilder/bw_ct21.htm
Accessed on September 27, 2004

KRIS 2004i. KRIS Big River: Sediment: Fines <0.85 mm by GMA, 2001.
http://www.krisweb.com/krisbigriver/krisdb/webbuilder/lb_ct21.htm and
http://www.krisweb.com/krisbigriver/krisdb/webbuilder/mb_ct16.htm

KRIS 2004j. KRIS Big River: Sediment: Fines <0.85mm All MRC Sites Average, 2000. http://www.krisweb.com/krisbigriver/krisdb/webbuilder/bw_ct23.htm

KRIS 2004k. KRIS Big River: Sediment: Gravel Permeability All MRC Sites Average, 2000 http://www.krisweb.com/krisbigriver/krisdb/webbuilder/bw_ct27.htm

KRIS 2004l. KRIS Noyo River: Sediment: Gravel Permeability for the Mainstem Noyo. http://www.krisweb.com/krisnoyo/krisdb/webbuilder/un_ct9.htm

Lisle, T. E., Nelson, J. M., Pitlick, J., Madej, M. A. and Barkett, B. L. 2000. Variability of bed mobility in natural, gravel-bed channels and adjustments to sediment load at local and reach scales. Resources Research **36**: 3743-3755.

Knopp, C. 1993. Testing Indices of Cold Water Fish Habitat. Final Report for Development of Techniques for Measuring Beneficial Use Protection and Inclusion into the North Coast Region's Basin Plan by Amendment of the.....Activities, September 18, 1990. North Coast Regional Water Quality Control Board in cooperation with California Department of Forestry. 57 pp.

Maahs, M. 1996. A salmon spawning survey for portions of Ten Mile, Caspar Creek and Garcia River. 1995-96. Prepared for Humboldt County Resource Conservation District. Salmon Trollers Marketing Association, Inc. Fort Bragg, CA. 31 pp.

McMahon, T., and G. Reeves. 1989. Large woody debris and fish. Paper presented at the COPE workshop “Silvicultural management of riparian areas for multiple resources” held at Salishan Lodge, Gleneden Beach, Oregon on 12-13 December 1989. U. S. Forest Service Pacific Northwest Research Station, Portland and Oregon State University College of Forestry, Corvallis.

Napolitano, M. B. 1998. Persistence of historical logging impacts on channel form in mainstem North Fork Caspar Creek. In: Ziemer, Robert R., technical coordinator. Proceedings of the conference on coastal watersheds: the Caspar Creek story, 1998 May 6; Ukiah, CA. General Tech. Rep. PSW GTR-168. Albany, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture; 97-101.

NCRWQCB. 2004a. Action plan for the Albion River, Big River, Noyo River, and Ten Mile River watersheds sediment TMDLs.

NCRWQCB. 2004b. Preliminary draft basin plan language for the action plan for the Albion River, Big River, Noyo River, and Ten Mile River watersheds sediment TMDLs. .

NCRWQCB. 2001. Assessment of aquatic conditions in the Mendocino coast hydrologic unit.

Stillwater Sciences. 1997. A review of coho salmon life history to assess potentially limiting factors and the implications of historical removal of large woody debris in coastal Mendocino County. Prepared by Stillwater Sciences, Berkeley CA for Louisiana-Pacific Corporation, Wildlife and Fisheries Science Group, Forest Resources & Fiber Procurement Division. May 1997. 55 pp

Surfleet, C.G., and R.R. Ziemer. 1996. Effects of forest harvesting on large organic debris in coastal streams. Pages 134-136 in: LeBlanc, John, ed., Conference on Coast Redwood Forest Ecology and Management, 1996 June 18-20, Humboldt State Univ., Arcata, CA.

Suttle, K.B., M.E. Power, J.M. Levine, and C. McNeely. 2004. How fine sediment in riverbeds impairs growth and survival of juvenile salmonids. Ecological Applications **14**: 969- 974.

Tally, Taz, 1980, The effects of geology and large organic debris on stream channel morphology and processes for streams flowing through old growth redwood forests in northwestern California: Unpublished Ph.D. dissertation, University of California, Santa Barbara, 273 p.

Tappel, P.D., and T.C. Bjornn. 1983. A new method of relating size of spawning gravel to salmonid embryo survival. North American Journal of Fisheries Management 3:123-135.

Taylor, S.N. 1978. The status of salmon populations in California coastal rivers. California Department of Fish and Game. Salmon/Steelhead Program, Anadromous Fisheries Branch. 14 pp.

U.S. EPA. 2001a. Albion River TMDL for sediment.

U.S. EPA. 2001b. Big River TMDL for sediment.

U.S. EPA. 1999. Noyo River TMDL for sediment.

U.S. EPA. 2000. Ten Mile River TMDL for sediment.

Wehren, R. 1996. Coho salmon spawner survey, Albion River and Salmon Creek, Winter 1995-96. Coastal Land trust. November 1996.

STAFF'S RESPONSES TO PEER REVIEWERS' COMMENTS

Problem Statement

For each of the four watersheds, Regional Water Board staff has concluded that excessive inputs of sediment to the four rivers have caused a reduction in the quality and quantity of instream habitat. This has resulted in a situation where the four rivers are not fully supporting their beneficial uses, and water quality objectives for suspended material, settleable material, and sediment are being exceeded.

Questions: Is the above conclusion scientifically valid? Does the rationale described in the draft Staff Report and Basin Plan Language adequately support the conclusion?

(1) Dr. Dietterick: "Beneficial uses are undoubtedly being threatened by excess sediment in North Coast watersheds.

RESPONSE: Regional Water Board staff concur.

(2) Dr. Dietterick: "However, the reliance of salmonid population trends to draw conclusions about the potential adverse effects from current land management activities is controversial. The effect that short-term climatic variability has on oceanic and hydrologic conditions and the relationship on anadromous fisheries and habitat conditions is poorly understood. . . . Although this statement is largely conjecture, this variability arguably plays an important role in population trend analysis. This position suggests that wording in problem statements need to reflect this uncertainty."

RESPONSE: Since Regional Water Board staff are no longer proposing a Basin Plan amendment, there is no longer a Problem Statement section from which this statement was drawn. However, these comments will be taken under consideration when we apply the TMDL Implementation Policy at a watershed-specific level. Staff concur that factors such as climatic variability and oceanic and hydrologic conditions play a role in salmonid population trends. Staff further assert that excessive inputs of sediment to the Albion, Big, Noyo, and Ten Mile Rivers and their tributaries have caused, at least in part, a reduction in the quality and quantity of instream, freshwater habitat.

(3) Dr. Dietterick: "It is also unclear the role that legacy land management activities play on what has been observed over the past decade and what we continue to observe amidst current activities and the short-term climate effects."

RESPONSE: Regional Water Board staff are not attempting to distinguish between anthropogenic sediment waste discharges that occurred in the past versus the discharges that are occurring today. Both types of discharges will be subject to the TMDL Implementation Policy.

(4) Dr. Kirchner: "The problem statement relies heavily on the USEPA TMDL documents for the four rivers. If those TMDL documents are scientifically valid (which this review has not directly assessed) then the problem statement and its conclusion are scientifically reasonable."

RESPONSE: Regional Water Board staff concur. Staff have determined that the TMDL documents are scientifically valid.

(5) Dr. Resh: "In conclusion, based upon available data from streams in coastal Northern California, it appears that (1) LWD/habitat complexity, (2) increased sediment supply, and (3) high temperatures may be limiting salmonid production in the Albion River, Big River, Noyo River, and Ten Mile River watersheds. . . . Data from the four watersheds, combined with evidence from other north coast streams, indicates that salmonid populations have experienced massive declines throughout the 20th century. There is ample evidence that excessive inputs of sediment have resulted in drastically altered aquatic habitat conditions, which have significantly contributed to the decline of salmonid populations in Albion River, Big River, Noyo River, and Ten Mile River watersheds. In addition to sediment, large woody debris and temperature are also important factors that must be considered."

RESPONSE: Regional Water Board staff concur. In addition to primarily focusing on sediment, the TMDL Implementation Policy addresses LWD in the ***Salmonid Freshwater Habitat Targets for Sediment-Related Parameters***. Temperature issues will be addressed through a separate TMDL and/or Basin Plan amendment process.

(6) Dr. Resh: "Combine portions of the four problem statements into an overview section, which discusses commonalities between the watersheds. . . . Add information about potential limiting factors other than sediment, such as wood and temperature. . . . Although temperature and wood water quality targets are included, these factors should be discussed in the problem statement. . . . Add general information about the history of forest and watershed management on the redwood coast. . . . Add estimates of anthropogenic-derived sediment, from the sediment source analyses by Graham Matthews and Associates, to the problem statement . . ."

RESPONSE: Since Regional Water Board staff are no longer proposing a Basin Plan amendment, there is no longer a Problem Statement section. However, these comments will be taken under consideration when we apply the TMDL Implementation Policy at a watershed-specific level.

Water Quality Targets

The TMDL Action Plans contain a suite of instream and upslope water quality targets. The targets are designed to be used as indicators of watershed health and tools for determining the effectiveness and success of the TMDL Action Plans in attaining water quality objectives and protecting beneficial uses. Regional Water Board staff will compare sampling and monitoring data to water quality targets to determine watershed conditions and recovery status.

Questions: Are the proposed targets scientifically valid? For each target, does the rationale described in the draft Staff Report adequately support the proposed target value? If the instream targets are obtained, will the habitat requirements for all freshwater lifestages of chinook salmon, coho salmon, and steelhead trout be present in the water body? If the instream targets are obtained, will the habitat requirements for other aquatic life be present in the water body? Will the proposed parameters show a measurable response from changes in sediment discharges over time? Are the proposed targets appropriate for the local geology? Where an instream target is limited to a specific stream type or reach, is that stream type or reach appropriate, and are there other stream types or reaches that the target should apply to? Are the monitoring and sampling suggestions clear, concise, appropriate, and adequate?

Benthic Macroinvertebrate Assemblage

(7) Dr. Dietterick: "I am also inclined to want to see the evidence that suggests that BMI [benthic macroinvertebrates] can be used to detect smaller improving or declining trends related to the implementation of sediment controls."

RESPONSE: Benthic macroinvertebrates are often adversely affected by excess fine sediment. As stated by Harrington & Born (1999, p. 5-10), ". . . when integrated with physical and chemical assessments, biological assessments . . . provide a more appropriate means for evaluating discharges of non-chemical substances (e.g., sedimentation and habitat destruction)."

(8) Dr. Kirchner: "generally reasonable."

RESPONSE: Regional Water Board staff concur.

(9) Dr. Kirchner: "It is not clear why the target should be a score of 18 rather than, say, 14 or 22, or some other score. If there are specific data that reflect the change in biotic condition -- and specifically the suitability of salmonid habitat -- as the IBI score ranges above and below 18, those data should be shown or referenced."

RESPONSE: According to Harrington & Born[1], the six metrics ". . .were integrated into a single scoring criteria [sic] by producing a histograms [sic] of the values for each of the biological metrics and visually determining breaks in their distribution. The approach of determining scoring criteria was more intuitive and probably most appropriate given the data came from streams that could have been moderately impaired and not actually representative of pristine reference conditions." Regional Water Board staff proposed a conservative target for benthic macroinvertebrate assemblage of 18, which corresponds to a biological integrity rating of good or excellent, in order to err on the side that is the most protective of the beneficial uses associated with the cold water salmonid fishery. Additionally, in response to this comment, the quote from Harrington & Born describing the derivation of the single

[1] Harrington, J., and M. Born. 1999. Measuring the Health of California Streams and Rivers: A Methods Manual for: Water Resources Professionals, Citizen Monitors, and Natural Resources Students. Second Edition. Sustainable Land Stewardship International Institute. Sacramento, CA.

scoring criterion has been added to the text of the ***Salmonid Freshwater Habitat Targets for Sediment-Related Parameters*** document.

(10) Dr. Resh: "There is no evidence that I am aware of (and no reason to believe), however, that these metrics are sensitive to changes in important habitat conditions for salmonids, such as gravel permeability, levels of fine sediment, pool frequency and depth, and increased temperature."

RESPONSE: Regional Water Board staff do not concur. Please see the response to comment number 1.

(11) Dr. Resh: "It is reasonable to expect that a benthic assemblage scoring good or excellent on the RRIBI could exist in a highly embedded riffle unfavorable for salmonid egg development."

RESPONSE: Regional Water Board staff concur that benthic macroinvertebrate assemblage data may score as good or excellent on the Russian River IBI when the water body is otherwise highly sedimented, although such a situation is unlikely. For this reason, Regional Water Board staff are proposing a suite of instream salmonid freshwater habitat conditions as targets. When considered together, the proposed targets are expected to demonstrate trends in water quality related to sediment.

(12) Dr. Resh: "As a recommendation, it may be preferable to use the biological traits of benthic taxa as indicators of substrate conditions. . . . This type of approach could be applied in these four watersheds by developing a database of biological traits specific to the taxa found in the watersheds. . . . a database of these biological traits [body size, mobility, habit, propensity for drift] could be developed specific for local taxa, and be used to infer relative differences in prey availability between and within watersheds."

RESPONSE: Regional Water Board have determined the Russian River IBI to be an effective and applicable measure of benthic macroinvertebrate health. However, staff agrees that it may be possible, and preferable, to develop a target or a suite of targets that is watershed-specific in the future. The use of benthic taxa and specific biological traits as target parameters would be considered at that point.

(13) Dr. Resh: "Additionally, benthic invertebrates are important not only as indicators of stream condition but for their role as a food resource for salmonids"

RESPONSE: Regional Water Board staff concur and have added a discussion on the importance of benthic macroinvertebrates as a salmonid food source to the ***Salmonid Freshwater Habitat Targets for Sediment-Related Parameters*** document. Staff also included a short discussion on the recent study by Suttle et al. (2004). Thank you for the reference.

(14) Dr. Resh: "Finally, I recommend that the name of the target be changed from 'Benthic Macroinvertebrate Production.'"

RESPONSE: Regional Water Board staff concur and have made the recommended change.

Embeddedness

(15) Dr. Kirchner: "generally reasonable."

RESPONSE: Regional Water Board staff concur.

(16) Dr. Kirchner: "It should be recognized that the degree of embeddedness can fluctuate over time, due to fluctuations in both streamflow and sediment supply. See, for example, Dietrich WE, Kirchner JW, Ikeda H, and Iseya F. 1989. . . . Thus the apparent change in embeddedness between two successive surveys may not accurately reflect the long-term trend."

RESPONSE: Regional Water Board staff concur and have added such language to the ***Salmonid Freshwater Habitat Targets for Sediment-Related Parameters*** document.

(17) Dr. Resh: "The RWQCB proposes an embeddedness target of "an increasing trend in the number of locations where gravel and cobbles are <25% embedded." This is an appropriate target, as embeddedness is an important factor affecting substrate suitability for many aquatic organisms."

RESPONSE: Regional Water Board staff concur.

(18) Dr. Resh: "I am wary of asserting that "the long term goal is for all wadeable streams and rivers to have embeddedness values <25%", however. It seems impractical to assume that this is a reasonable target for all streams and rivers, as there is little evidence that this is the "natural" condition of North Coast streams. In general, sustaining stream function requires a range of conditions to be present (Reid and Furniss, 1998)."

RESPONSE: Regional Water Board staff concur and have deleted the long term goal.

Large Woody Debris

(19) Dr. Kirchner: "The LWD volume targets, adopted from Fox (2001), are significantly higher than the LWD volume in ***any*** of the Northern California reference watersheds surveyed by Knopp (1993), and reported in Figure 3-11. The proposed targets correspond to 990-3170 m^3 of wood per 1000m of channel length, whereas the average in Figure 3-11 is less than 250 m^3 of wood per 1000m. It does not seem reasonable to set a

standard that ***none*** of the reference watersheds meet. (Perhaps there is an error here, and the Knopp figures are per 100 meters, rather than 1000 meters?)"

RESPONSE: First, there is not an error in regards to data attributed to Knopp (1993)[2]. Knopp's surveys were conducted on 1000 meter reaches, and data were expressed in such units. Second, it is difficult to compare Knopp's data to the targets included in Fox (2001)[3] since Knopp did not report the size range of LWD surveyed or the bankfull channel width. Please see the response to comment number 23 in regards to Fox's targets being higher than LWD volumes found in Northern California reference watersheds.

(20) Dr. Kirchner: "It also is problematic that the targets apply to channels with bankfull widths of 0 to 6, 0 to 30, and 0 to 10 meters, potentially being applied to very small channels. It does not seem not reasonable to require a channel that is, say, only 1 meter wide to have over 99 m^3 of wood, and over 11 key pieces, per 100m of length. Note, for example, that the 99 m^3 of wood would be sufficient to bury the entire channel roughly 1 meter deep along its 100m length."

RESPONSE: Regional Water Board staff concur and have excluded water bodies with a bankfull channel width of less than 1 meter from the numeric target specified in the ***Salmonid Freshwater Habitat Targets for Sediment-Related Parameters***. The LWD target for such water bodies has been changed to an increasing trend in the volume and frequency of LWD and key pieces of LWD.

(21) Dr. Kirchner: "I agree with the assessment that sufficient data exist to propose numeric targets for LWD, . . ."

RESPONSE: Regional Water Board staff concur.

(22) Dr. Kirchner: ". . . the targets proposed should take better account of differences between small and large channels -- perhaps excluding very small channels or specifying different targets for them -- . . ."

RESPONSE: Please see the response to comment number 20.

(23) Dr. Kirchner: ". . . the targets . . .should be more clearly justified with respect to the reference watersheds."

RESPONSE: Regional Water Board staff concur. The target for LWD volume in water bodies ranging from 1 to 30 meters in bankfull channel width has been

[2] Knopp, C. 1993. Testing Indices of Cold Water Fish Habitat. Final Report for Development of Techniques for Measuring Beneficial Use Protection and Inclusion into the North Coast Region's Basin Plan by Amendment of the "Guidelines for Implementing and Enforcement of Discharge Prohibitions Relating to Logging, Construction and Associated Activities." North Coast Regional Water Quality Control Board in cooperation with the California Department of Forestry.

[3] Fox, M. 2001. A New Look at the Quantities and Volumes of Instream Wood in Forested Basins within Washington State. A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science, University of Washington, College of Forest Resources.

modified so that it is now set at > 72 m^3 per 100 m of channel length. The target included in Fox (2001) for such water bodies is > 99 m^3 per 100 m of channel length. This modification reflects the minimum volume of LWD found in reference streams in Northern California per Keller et al. (1995)[4], and ensures that the LWD targets correspond to local reference conditions. As more data and information becomes available, the LWD volume target may be revised to a value that is based on the average volume of reference water bodies.

(24) Dr. Resh: "The RWQCB is correct to assume that the percentage of stream habitat formed by LWD in Little North Fork of the Ten Mile River does not represent suitable conditions and should not serve as a water quality target."

RESPONSE: Regional Water Board staff concur.

(25) Dr. Resh: ". . . there are several reasons that LWD targets from Washington may not be appropriate for the Mendocino coast."

RESPONSE: Regional Water Board staff do not concur, but have determined that the LWD targets, which are modified from the Washington-based targets included in Fox (2001), are appropriate for water bodies throughout the North Coast Region that drain watersheds predominately composed of redwood and/or Douglas fir forests. Although redwoods and other trees of Northern California may have some differences in density, buoyancy, and subsequent entrainment, it is not likely significant enough to warrant a change in the target values, and the targets are valid for Northern California. Keller and Tally (1979)[5] assumed an average wood density of 500 kg/m^3 for woody debris in Prairie Creek and Little Lost Man Creek (tributaries to Redwood Creek), while Fox relied on an average wood density of 415 kg/m^3 for trees in Washington. Additionally, please see the responses to comments numbered 26 and 27.

(26) Dr. Resh: "Volumes of dead wood in streams draining old growth forests varies greatly both within and between forest/climatic types in northern California (e.g. Coastal Mountains, Sierra Nevada, Klamath Mountains, Cascade Mountains) (Lisle, 2002). Redwood forests have exceptionally high LWD loading levels: the median volume of LWD in streams draining old growth redwood forests is nearly an order of magnitude greater than other coniferous forests (Harmon et al. 1986; Lisle 2002)."

RESPONSE: Regional Water Board staff concur and have limited the applicability of the numeric target specified in the ***Salmonid Freshwater Habitat Target for Sediment-Related Parameters*** to only those water bodies that drain watersheds

[4] Keller, E.A., MacDonald, A., Tally, T., and Merrit, N.J. 1995. Effects of Large Organic Debris on Channel Morphology and Sediment Storage in Selected Tributaries of Redwood Creek, Northwestern California. In Geomorphic Processes and Aquatic Habitat in the Redwood Creek Basin, Northwestern California. Eds. Nolan, K.M., Kelsey, H.M., and Marron, D.C. U.S.

[5] Keller, E.A. and Tally, T. 1979. Effects of Large Organic Debris on Channel Form and Fluvial Processes in the Coastal Redwood Environment. Reprinted from Adjustments of the Fluvial System. Proceedings of the Tenth Annual Geomorphology Symposium. Binghamton, New York.

predominately composed of redwood and/or Douglas fir forests. As described by Keller et al. (1995), "Redwood (***Sequoia sempervirens***), Douglas-fir (***Pseudotsuga menziesii***), Stika spruce (***Picea sitchensis***), western hemlock (***Tsuga heterophylla***), big-leaf maple (***Acer macrophyllum***), and red alder (***Alnus oregonia***) are the main contributors of large organic debris to the streams of the coastal redwood forest" (p. 5).

(27) Dr. Resh: "Whereas redwood dead wood lasts for centuries (Kelly et al. 1995), fir and spruce dead wood decays much faster, occurring on the order of decades (Cedarholm et al., 1997). Even with similar levels of wood recruitment, redwood debris jams can serve as longer-term stabilizing features in channels than wood from other conifers."

RESPONSE: Regional Water Board staff concur. As stated in the ***Salmonid Freshwater Habitat Targets for Sediment-Related Parameters***, ". . . redwoods remain in streams as LWD longer than any other tree species: usually to approximately half the age of the tree." Partly due to this unique quality of redwood, the LWD targets modified from the Washington based targets included in Fox (2001) are limited to water bodies that drain watersheds predominately composed of redwood and/or Douglas fir forests.

(28) Dr. Resh: "The RWQCB should consider that some data on LWD loadings from old-growth redwood forests is available (e.g. Keller and Tally 1979; Harmon et al. 1986)."

RESPONSE: Regional Water Board staff have made adjustments to the numeric LWD targets for water bodies that drain watersheds predominately composed of redwood and/or Douglas fir forests so that the targets correspond to local reference conditions. These adjustments are based on research and data by Keller et al. (1995), which, in turn, relied upon the work of Keller and Tally (1979). Please see the response to comment number 23 for more information.

(29) Dr. Resh: "Given the high natural variability between old-growth streams, it may be more appropriate to specify a frequency distribution of dead wood volumes or frequencies rather than specifying one numeric target (Lisle, 2002)."

RESPONSE: Regional Water Board staff do not concur with the use of a frequency distribution of LWD volumes or frequencies as described in Lisle (2002).[6] Lisle used the cumulative frequency distributions to demonstrate differences in LWD volume between climatic regions of California and Oregon. The frequency distributions do not appear to be intended to express target conditions.

(30) Dr. Resh: "I suggest that two numeric targets could accurately describe optimal conditions: a minimum value and a median value of dead wood volume based on values from old-growth redwood forests. These values could be drawn from the studies of

[6] Lisle, T.E. 2002. How Much Dead Wood in Stream Channels in Enough? USDA Forest Service Gen. Tech. Rep. PSW-GTR-181.

Harmon et al. (1986, in Bilby and Bisson, 1998), who found an average debris loading of 74.2 kg/m^2 in small streams in redwood forests, and Tally (1980; in Napolitano 1998), who observed a range of 12-268 kg/m^2, with a median value of 85 kg/m^2."

RESPONSE: Regional Water Board staff do not, at this point in time, concur with the use of LWD loading data from Harmon et al. (1986, as cited in Bilby and Bisson 1998), Tally (1980), and Napolitano (1998). Although these studies focused on LWD loading in streams draining old growth redwood forests, the data, unfortunately, are expressed in kg/m^2. The use of LWD density is not consistent with the volume (m^3) of wood per 100 m of stream length. Regional Water Board staff have determined that expressing LWD volume in m^3/100 m of stream length is preferred since such units are simple and relatively easy for a layman to measure. However, it may be possible to obtain the original data from the above listed studies and express and analyze the data in the preferred units. Should this occur, the LWD target may be revised.

Pools – Backwater, Lateral Scour, and Primary Pool Distribution Targets

(31) Dr. Kirchner: In relation to the Lateral Scour Pool Distribution Target: "This target appears reasonable."

RESPONSE: Regional Water Board staff concur.

(32) Dr. Kirchner: In relation to the Primary Pool Distribution Target: "This target appears reasonable. I concur that the CDFG objective of >50% pool frequency is desirable, but unattainable in view of the range of pool frequencies measured in reference watersheds."

RESPONSE: Regional Water Board staff concur.

(33) Dr. Resh: ". . . it is advisable to set the targets as "an increasing trend", as variability in natural conditions across spatial and temporal scales should be expected (Reid and Furniss, 1998)."

RESPONSE: Regional Water Board staff concur.

Substrate Composition - % Fines

(34) Dr. Kirchner: In relation to the % Fines < 0.85 mm Target: "This target appears reasonably consistent with the available data in the literature."

RESPONSE: Regional Water Board staff concur.

(35) Dr. Kirchner: In relation to the % Fines < 6.40 mm Target: "The data in Figure 3-16 indicate that this target should be expected to ensure reasonable rates of egg survival."

RESPONSE: Regional Water Board staff concur.

(36) Dr. Resh: "Both of the percent fines targets seem appropriate, as they are empirically correlated with emergence success and significant amounts of data are already available from the four watersheds. The RWQCB should be sure to explicitly specify the methods to be used, as existing data has been collected from different locations (subsurface vs. surface samples; redds vs. pool tail-outs) and using different collection and sieving methods."

RESPONSE: Regional Water Board staff concur. In regards to sampling methods, the ***Salmonid Freshwater Habitat Targets for Sediment-Related Parameters*** document includes monitoring recommendations that specify the preferred monitoring and data analysis methods.

Substrate Composition – D_{50}

(37) Dr. Kirchner: "The proposed water quality target (D50>69.5mm) is one that would not be met by two-thirds (12 of 18) of the reference streams surveyed by Knopp (1993). Unless the streams surveyed by Knopp (1993) are systematically different from these four rivers, it does not appear realistic to expect this target to be attainable. A more complete rationale for this target should be presented, or the target should be revised. The target is based on the average across the streams surveyed by Knopp, but that average is inflated by several very high values (including one that is nearly three times the mean)."

RESPONSE: In response to this comment and those by Dr. Resh on this subject, Regional Water Board staff have removed the D_{50} parameter from the ***Salmonid Freshwater Habitat Targets for Sediment-Related Parameters*** document. It is not appropriate at this point in time for a D_{50} target of > 69.5 mm to be applied across the North Coast Region.

(38) Dr. Resh: "The median grain size of the bed is an important indicator of the suitability of habitat for spawning. As a water quality target for the four watersheds, however, D_{50} is not scientifically valid. Substrate composition is a factor of transport capacity and sediment supply. Reach-scale transport capacity varies with channel gradient, channel roughness, and flow (Knighton, 1998). Local-scale flow perturbations and tributary effects add considerable variability to grain size and transport capacity. Although sediment supply is an important variable affecting surface grain size, even a doubling of sediment supply, which is the maximum increase observed from sediment budget analyses by Graham Matthews and associates, would be very difficult to detect from surface grain size distributions (Lisle, 2000). Despite the RWQCB proposal to restrict application of the target to third-order streams with gradients between 1 and 4%, there is still tremendous variability in transport capacity between this range of streams. In general, transport

capacity will be a more important determinant of surface grain size than sediment supply.

RESPONSE: In response to this comment and the comment by Dr. Kirchner on this subject, Regional Water Board staff have removed the D_{50} parameter from the ***Salmonid Freshwater Habitat Targets for Sediment-Related Parameters*** document. It is not appropriate at this point in time for a D_{50} target of > 69.5 mm to be applied across the North Coast Region.

(39) Dr. Resh: "Instead of D_{50}, other indicators that reflect sediment supply but account for transport capacity, such as Shields stress or Q*, would be more appropriate (see recommendations below for specific targets)."

RESPONSE: Regional Water Board staff will research Shields stress or Q* parameters in the future and add them to the ***Salmonid Freshwater Habitat Targets for Sediment-Related Parameters*** document, if appropriate.

Temperature Target

(40) Dr. Kirchner: "I cannot comment on the validity of this target, which is based on a draft staff report (Zabinsky and Azevedo 2004) that is not yet available."

RESPONSE: Regional Water Board staff have removed the temperature target from the ***Salmonid Freshwater Habitat Targets for Sediment-Related Parameters*** document. Temperature will be addressed through a separate effort of the Regional Water Board. Specifically, staff are currently developing a Basin Plan amendment to revise temperature water quality objectives with values that are protective of salmonid species in the North Coast Region.

(41) Dr. Resh: "The temperature targets are excellent indicators of stressful conditions for salmonids, as they are based on extensive empirical and experimental research. They are much improved from the existing targets in the NCRWQCB Basin Plan, which are qualitative in nature.

RESPONSE: Regional Water Board staff concur, however staff have removed the temperature target from the ***Salmonid Freshwater Habitat Targets for Sediment-Related Parameters*** document. Please see response to comment number 40.

(42) Dr. Resh: "It is problematic that limiting factors for salmonids must be approached from the perspective of sediment. Although wider and shallower channels can cause increased temperatures, riparian shading and stream flow are much more important factors. The effects of historic logging on streamside shading must be tremendous, but these effects are not addressed."

RESPONSE: Please see the response to comment number 40.

(43) Dr. Resh: "The RWQCB should carefully specify where temperature monitoring should occur. Cold-water refugia, as is often found at the mouths of tributaries or in deep pools, plays an important role for salmonids in mainstem rivers. Monitoring should be targeted at a variety of channel locations to assess the range of temperature conditions available."

RESPONSE: Please see the response to comment number 40. This comment has been forwarded to the Regional Water Board staff currently working on revisions to the temperature water quality objective.

Thalweg Profile Target

(44) Dr. Kirchner: "An increasing trend in thalweg profile variability is a reasonable target. If this measurement can be made more quantitative in the future, it may provide an effective tool for quantifying habitat complexity."

RESPONSE: Regional Water Board staff concur.

(45) Dr. Resh: "The thalweg profile target of 'an increasing trend in the variation around the mean thalweg profile slope' is an appropriate target for low gradient streams that are believed to have been simplified as a result of loss of LWD recruitment and increased sediment supply. It should not be applied to steeper streams, however, if those streams do not naturally exhibit a pool-riffle or forced pool-riffle (due to LWD or other obstructions) morphology. Based on data from Washington, there is significant overlap between pool-riffle and plane-bed morphologies (Montgomery and Buffington, 1997). Use of this target in streams steeper than ~2% would first require an evaluation of channel types and morphologies in least-disturbed (e.g. old-growth) forests to document expected conditions for a range of slope classes.

RESPONSE: Regional Water Board staff concur and have revised the thalweg profile target so that it is applicable to water bodies with slopes of 2% or less.

Turbidity Target

(46) Dr. Kirchner: "The turbidity target (less than 20% above "naturally occurring background levels") leaves open the question of what those background levels are. The draft acknowledges that this question is difficult to answer at present. But without some way to specify natural background levels, the turbidity target would appear to be impossible to apply in practice."

RESPONSE: Comment noted. The 20% above background value is the existing water quality objective for turbidity and Regional Water Board staff are not proposing a change to the objective. Nor is staff including a turbidity target in the ***Salmonid Freshwater Habitat Targets for Sediment-Related Parameters*** document.

(47) Dr. Resh: "The existing turbidity target (20% above background) is not appropriate to the biology of salmonids. However, the RWQCB is correct in its conclusion that sufficient studies have not been performed to propose an appropriate numeric target. The 25 NTU or 27 NTU chronic turbidity threshold is appropriate, but it is unclear how many consecutive days or total days above the threshold can occur before beneficial uses are affected. If rates of juvenile growth are found to be a limiting factor for salmonid populations, the RWQCB should consider establishing a target based on the 25 NTU threshold."

RESPONSE: Comment noted.

(48) Dr. Resh: "Turbidity monitoring can either be performed with continuous data collectors, which are quite expensive, or grab sampling. If grab sampling is performed, it is recommended that monitoring should target the days following the peak flow of significant storm events. Post-storm sampling (i.e. 1,2,3,5 days following peak storm flows) should document the length of time turbidity remains elevated above 25 NTU. In addition to providing data about the effects of turbidity on salmonid feeding, this data is also useful for identifying particular sub-basins with chronic sources of fine sediment."

RESPONSE: Regional Water Board staff concur that the turbidity data is a very useful indicator of instream water quality conditions. The monitoring of turbidity can involve a complex methodology, regardless of whether the monitoring uses continuous collectors or grab samples. Regional Water Board staff expect to develop detailed monitoring guidance in the future.

(49) Dr. Resh: "The turbidity target is missing from Table 3-1 and should be added."

RESPONSE: Please see the response to comment number 46. Since staff are not including a target for turbidity, but are only restating the already existing turbidity water quality objective, it is not appropriate for turbidity to be included in the summary table of the ***Salmonid Freshwater Habitat Targets for Sediment-Related Parameters***.

V* Target

(50) Dr. Kirchner: "This target appears reasonable. The deviations from the USEPA TMDL targets are justified, in my view."

RESPONSE: Regional Water Board staff concur.

(51) Dr. Resh: "Based on studies of tributaries to the Trinity River, V* is a good indicator of sediment supply, especially fines (Lisle and Hilton, 1991)."

RESPONSE: Regional Water Board staff concur.

(52) Dr. Resh: "The comparison of V* values from streams in the Klamath Mountains (Little North Fork Salmon River, South Fork Salmon River, Taylor Creek) is inappropriate, as the Action Plan points out. These streams primarily drain granitic watersheds, which produce high amounts of sand and do not represent undisturbed conditions."

RESPONSE: Regional Water Board staff concur.

(53) Dr. Resh: "Numerous unmanaged streams in the Coast Ranges have V* values ranging from 0.21 to 0.27. If the purpose of the target is to set standards representative of relatively undisturbed conditions, a higher target value should be used. Based on data presented in Figure 8 of Knopp (1993), which only includes data from the Franciscan Formation, a value closer to 0.30 might be more appropriate for distinguishing between relative levels of disturbance."

RESPONSE: Regional Water Board staff do not concur. The V* target is based on the research by Knopp (1993), who concluded that the median particle size of instream sediment samples was significantly different at the 95% confidence level between the Index reaches and those of Moderate and High disturbance. The region-wide mean V* value for index reaches was 0.21 of the pool volume filled with fine sediment, which is the value set as the V* target.

(54) Dr. Resh: "Rather than requiring a set number of pools or limiting the reach length to 1000 meters, it would be better to sample consecutive pools until the natural variation has been captured (e.g. the standard deviation is below a predefined target). 'Field computers' used by Lisle and Hilton allow for the input of data in the field and the calculation of average values and standard deviations."

RESPONSE: Regional Water Board staff do not concur. The monitoring recommendation for V* is a minimum of six pools per 1000 meters of stream is based on the methodology used by Knopp (1993), and is necessary in order for future data to be comparable to the target.

Activity in Unstable Areas

(55) Dr. Kirchner: "Reducing sediment inputs from unstable areas will be crucial to reducing overall sediment loads to the four rivers."

RESPONSE: Regional Water Board staff concur, although the target for activity in unstable areas has been removed from the ***Salmonid Freshwater Habitat Requirements for Sediment-Related Parameters*** document. The current targets focus solely on instream habitat and upslope conditions are no longer included. However, staff recognize the importance of addressing unstable areas, disturbed areas, and sediment discharge sites at the source. Actions to reduce sediment discharges are progressing through the TMDL Implementation Policy, Basin Plan amendments, and on-going regulatory actions of the Regional Water Board.

(56) Dr. Kirchner: "USEPA's TMDL documents specify that activities on unstable areas should be avoided or eliminated, whereas the proposed target here is simply that the number of activities should decrease over time. This appears to be a substantially weaker standard, and a rationale should be provided for preferring it over the USEPA standard. Three aspects of the proposed standard raise concern. The first is that it pertains to the "number of activities", without indicating how they should be counted. Second, it does not take account of the scale, scope, or impact of human activities, but only their number. Presumably if one replaces a one-acre garden and a one-acre pasture (two activities) with a 100-acre clearcut (one activity), the number of activities has gone down but the total impact has gone up substantially. Third, the target applies to unstable areas, but without a clear definition of what an "unstable area" is. The factors mentioned are all associated with slope instability, but it would seem difficult to enforce a standard that is based on a potentially subjective assessment of whether enough of these factors are present that a particular area should be determined to be unstable."

RESPONSE: Please see the response to comment number 55.

(57) Dr. Resh: "It is unclear how unstable areas will be defined. . . . I recommend a standardized approach for identifying unstable areas, conducted by the RWQCB across all four watersheds. This first step in the approach would be a GIS-based analysis of hillslope instability. . . . Given the SHALSTAB model's accessibility and efficiency, and the fact that it has already been successfully tested and applied in the region, it would be sensible to use this approach at least as a first approximation of hillsope instability. Rather than proposing a decreasing trend in activity on unstable areas, it would be more appropriate to immediately limit the types of activivties that could be performed on unstable areas. Determination of allowable land use practices should be tailored to the degree of potential instability (log q/T values from SHALSTAB). If a site is believed to be moderately unstable, certain practices could be allowed as long as extra cautions are observed."

RESPONSE: Please see the response to comment number 55.

Disturbed Areas Target

(58) Dr. Kirchner: "The proposed target is that the number of disturbed areas should show a decreasing trend towards zero. In my opinion, the target should take account of the size, scope, and severity of disturbance; a trend from five small, moderately disturbed areas to one large, severely disturbed area (which might even subsume all five of the previous areas) would represent a decrease in the number of disturbed areas, but an overall increase in the negative impact on a watershed."

RESPONSE: The target for disturbed areas has been removed from the ***Salmonid Freshwater Habitat Targets for Sediment-Related Parameters*** document. The

current targets focus solely on instream habitat and upslope conditions are no longer included.

(59) Dr. Resh: "The disturbed areas target does not describe the methodology that will be used to determine disturbed areas. Unless a detailed method for assessing disturbed areas is developed, it is recommended that the RWQCB eliminate this target."

RESPONSE: Please see the response to comment number 58.

(60) Dr. Resh: "The RWQCB correctly points out that the Equivalent Roaded Area method and other disturbance indices are not suitable for predicting the effect of land use on water quality. Because any sediment introduced into a watershed will eventually end up in a sensitive stream reach (spawning or rearing habitat), perhaps a better measure of the potential for disturbance would be the unstable areas target."

RESPONSE: Regional Water Board staff concur in regards to the equivalent roaded area comment. In regards to the unstable area comment, please see the response to comment number 55.

Targets for Roads and Railroads

(61) Dr. Kirchner: "I cannot assess the reasonableness these targets, because the draft does not specify what they are, referring instead to the USEPA TMDL documents."

RESPONSE: The targets for road and railroads have been removed from the ***Salmonid Freshwater Habitat Targets for Sediment-Related Parameters*** document. The current targets focus solely on instream habitat and upslope conditions are no longer included.

(62) Dr. Resh: "An increasing trend in the number of properly functioning roads and railroads is an appropriate target. The guidelines given in Figure 8-3 seem reasonable, provided knowledgeable workers are redesigning or improving the roads. Again, I have concerns about the technical ability or motivation of private landowners to create properly functioning roads. No monitoring recommendations are given. It is important to standardize monitoring and assessment of road condition across the watersheds. Watershed-wide road assessments should be conducted at regular intervals (1-5 years) by professionals trained in road assessments."

RESPONSE: Please see the response to comment number 61.

General Comments on Salmonid Freshwater Habitat Targets

(63) Dr. Dietterick: "I'll begin with a number of general statements about the proposed methods. I do not believe the Staff Report presents a convincing argument that these parameters are capable of discerning improving or declining trends in instream sediment. These methods have been used to show significant changes, but the thresholds of

change detection are not known and need to be evaluated within the context of precision and repeatability of each method."

RESPONSE: Regional Water Board staff do not concur. This statement appears to be an over-arching statement which is expanded upon in comments 64, 65, 66, 67, 68, 69, and 70. Please see the response of Regional Water Board staff to those comments.

(64) Dr. Dietterick: ". . . it is been evident that the timing when these methods are performed can generate very different results. The degree to which watersheds are hydrologically-active, along with storm and stormflow characteristics, can have a confounding effect on sediment delivery and transport. Consequently, most instream measurements will be responsive to these conditions, which can lead to significant variability that may be difficult to separate from any effect associated with land management activities. . . . In California, where rain seasons are clearly defined, instream measurements are most often performed during the summer months. Thus, results are closely linked to the nature of the storm characteristics and the stormflow response of latter events of a season. . . . In short, evidence exists for successfully using instream parameters are used as indications of stream health relative to reference streams or reaches, . . ."

RESPONSE: Regional Water Board staff concur and have added language to the ***Salmonid Freshwater Habitat Targets for Sediment-Related Parameters*** document. The additional language states that in order to address the variability in climatic conditions and storm-flow characteristics, monitoring data for the salmonid freshwater habitat parameters should be compared to reference conditions during the same time period, when possible. Furthermore, the targets are primarily designed to be used as long-term trend monitoring tools. Detecting statistically significant changes in the parameters may take a considerable amount of time, in part because of seasonal and yearly climatic variations.

(65) Dr. Dietterick: "The author of Testing Indices of Cold Water Fish Habitat (Knopp, 1993), did recommend that the influence short-term climatic variation on the indices be evaluated to determine the effect on the range of index values. It was not apparent that an evaluation of inter-season variability was ever done using the original dataset used in that study. Furthermore, the suggestion to also evaluate the effect that intra-season variability has on the response of these indices also appears to have been overlooked."

RESPONSE: Knopp[7] recommended that "State agencies should combine their expertise to define the relationships between structural habitat characteristics discussed [in Knopp's report], and their influence on aquatic productivity. . . . [One

[7] Knopp, C. 1993. Testing Indices of Cold Water Fish Habitat. Final Report for Development of Techniques for Measuring Beneficial Use Protection and Inclusion into the North Coast Region's Basin Plan by Amendment of the "Guidelines for Implementing and Enforcement of Discharge Prohibitions Relating to Logging, Construction and Associated Activities." North Coast Regional Water Quality Control Board in cooperation with the California Department of Forestry.

need was to d]etermine the extent of change that short term climatic variation has had on the range of values measured in this study. (p. 42)" Even in light of this need, which has yet to be addressed, Knopp found that "The results form [sic] this study demonstrate that three aspects of habitat are influenced by upslope disturbance, are quantifiable, and can serve as a basis for assessing habitat conditions. (p. 42)" One of the three aspects of habitat is V*, which is the only target proposed by Regional Water Board staff that is based on Knopp's work. Therefore, Regional Water Board staff are not changing the ***Salmonid Freshwater Habitat Targets for Sediment-Related Parameters*** document based upon this comment.

(66) Dr. Dietterick: "Another point worth considering is that the discharge sites in many cases will be relatively small sediment contributions within the scope of the entire system. The effect of sediment discharges from these sites before or after treatment may or may not influence the local channel habitat features. Adverse impacts of beneficial uses from any one site, may be most impacted a significant distance downstream where suspended sediment may be more likely to be deposited. In short, . . . I have not seen the evidence to suggest these parameters can be successful to detect change resulting from sediment controls implemented on discharge sites."

RESPONSE: The salmonid freshwater habitat targets are most appropriate for comparison to compliance and trend monitoring data. Compliance and trend monitoring is intended to determine, on a watershed scale, the status of and changes in water quality related to sediment. Compliance and trend monitoring is not intended to determine the effect of individual sites, but all activities upstream of the monitoring station. Instream effectiveness monitoring is intended to determine, by assessing instream conditions, if sediment control practices are effective at keeping sediment from being discharged to a water body. Project-specific effectiveness monitoring is necessary, and the salmonid freshwater habitat parameters are useful and applicable tools for such monitoring efforts. However, the target values may not be as appropriate as the comparison of conditions upstream and downstream of a discharge point or of conditions monitored before, during, and after the implementation of a sediment control practice. It is obvious from this comment that staff's discussion of the use of the targets should be expanded. Additional language has been added to the ***Salmonid Freshwater Habitat Targets for Sediment-Related Parameters*** document which describes the most appropriate types of monitoring data for comparison to the targets.

(67) Dr. Dietterick: "Details of how this 'weight of evidence' approach will [be] performed are not evident, nor is there evidence that this approach will be successful in identifying improving or declining trends in sediment delivery and transport."

RESPONSE: The language regarding the weight-of-evidence approach is intentionally imprecise because Regional Water Board staff will not be able to determine the status of, and changes in, water quality related to sediment until a significant amount of data have been analyzed. Until that time, staff are unable to

state how many of the proposed targets must be attained before sediment-related water quality standards are met. Additionally, it is likely that monitoring of the targets, watershed conditions, and beneficial uses in the North Coast Region and throughout Northern California and the Pacific Northwest will result in the future refinement of the targets. Regional Water Board staff intends to update this document in the future as new research, data, and technology become available. However, in response to this comment, staff have revised the language so that it reads "Because of the inherent variability associated with stream channel conditions, and because no single target applies in all situations, attainment of the targets ***should be*** evaluated using a weight-of-evidence approach." Emphasis added.

(68) Dr. Dietterick: "Although there appears to be limited data to guide the setting of the targets, it is logical to assume targets should be adjusted based not only on stream type, but also local geology. The scientific justification for adjusting targets may be increasingly compromised by applying to other watersheds, particularly if the scope is increased to include the entire North Coast as proposed."

RESPONSE: Regional Water Board staff concur and are therefore proposing that most of the targets be limited in some manner to certain streams and/or stream reaches. For example, the target for V* is applicable only to third order streams with slopes between 1% and 4% that drain watersheds geologically composed of the Franciscan Formation.

(69) Dr. Dietterick: "It seems that achieving target values will elevate habitat conditions, and it seems reasonable the biological condition will improve."

RESPONSE: Regional Water Board staff concur.

(70) Dr. Dietterick: "Generally speaking, the monitoring and sampling suggestions are not specific enough."

RESPONSE: The main purpose for the ***Salmonid Freshwater Habitat Targets for Sediment-Related Parameters*** document was to describe the salmonid freshwater habitat conditions that, when considered together, should result in water quality that is free of sediment impairment and supports the beneficial uses associated with the cold water salmonid fishery. The purpose was not to provide a comprehensive guidance document on monitoring and sampling methodologies. However, Regional Water Board staff have taken note of this comment and will attempt to provide more-specific monitoring and sampling suggestions for the target parameters in the future.

(71) Dr. Kirchner: "This of course depends on how much sediment discharges change over time. It is reasonable to expect some of these parameters to show measurable changes over periods ranging from years to decades if average rates of sediment discharge change by factors of two or more."

RESPONSE: Regional Water Board staff concur.

(72) Dr. Kirchner: "The proposed targets are generally appropriate for geological conditions that prevail within the Franciscan Formation."

RESPONSE: Regional Water Board staff concur.

(73) Dr. Kirchner: In regards to limitations of several targets to certain stream types or reaches: "They are generally appropriate. Several of the targets apply to reaches with gradients between 1% and 3%, leaving open the question of what (if any) target should apply to reaches with gradients less than 1%."

RESPONSE: Regional Water Board staff concur that the targets are appropriate. Additionally, staff have determined that several parameters are applicable to water bodies with a gradient of less than 1%, including benthic macroinvertebrate assemblage, embeddedness, LWD, all three pool parameters, % fines, and thalweg profile.

(74) Dr. Kirchner: In regards to monitoring and sampling suggestions: "They are sufficiently clear, and reasonably suited to their purpose."

RESPONSE: Regional Water Board staff concur.

(75) Dr. Resh: "Reduced inputs of sediment, according to the prescriptions of the TMDL for each watershed, should gradually result in improved conditions for at least five proposed in-stream water quality targets: embeddedness, % fines <0.85 mm, % fines <6.4 mm, turbidity, and V*."

RESPONSE: Regional Water Board staff concur.

(76) Dr. Resh: "Other water quality targets, such as large woody debris, backwater pool distribution, lateral scour distribution, primary pool distribution, temperature, will be moderately to minimally affected by reductions in anthropogenic sediment delivery to streams. Rather, the abundance and size of large woody debris and the frequency of stable log jams is the principal factor affecting many of these parameters, including the thalweg profile."

RESPONSE: Regional Water Board staff concur that other factors besides sediment affect the amount of LWD and pools and the characteristics of the thalweg profile (for temperature, please see the response to comment number 40). However, as noted in the comment, sediment is a factor that influences these parameters. Regional Water Board staff have determined that the parameters included in ***Salmonid Freshwater Habitat Targets for Sediment-Related Parameters*** are appropriate as targets.

(77) Dr. Resh: "The lack of definitive studies on the limiting factors of salmonid populations in these watersheds makes it problematic to establish which water quality parameters are most critical. It is unknown whether sediment-related factors, which primarily influence spawning and emergence, or wood and pool related factors, which effect rearing, are the most important reasons for the decline in salmonid populations."

RESPONSE: Regional Water Board staff currently do not know which of the parameters included in ***Salmonid Freshwater Habitat Targets for Sediment-Related Parameters*** are the limiting factors in any particular watershed. Different parameters are likely limiting factors in different watersheds. It is not necessary to know what parameters are the limiting factors, especially considering the regional geographic scope of the targets.

(78) Dr. Resh: "I recommend that a detailed limiting factors analysis should be undertaken, based on the critical freshwater life stages of salmonids. . . . Only after these steps should final numeric water quality targets and management actions be established. . . ."

RESPONSE: Although a detailed limiting factors analysis would provide useful information, existing data and information shows that sediment discharges are impacting the quality and quantity of salmonid freshwater habitat regardless of the factors that limit salmonid production in a particular watershed. In light of such information, including sediment total maximum daily loads (TMDLs), Regional Water Board staff are currently taking steps to control and reduce anthropogenic sediment waste discharges. Such steps include the proposed TMDL Implementation Policy, the Sediment Waste Discharge Prohibitions and Action Plan (currently under development), and other on-going regulatory efforts.

(79) Dr. Resh: "It is highly recommended that Q* or bank-full Shields stress should be used as an indicator of sediment supply and bed mobility instead of D_{50}. . . ."

RESPONSE: Please see the response to comment number 39.

(80) Dr. Resh: "I recommend that a gravel permeability water quality target be added. Gravel permeability is the most important indicator for the emergence success of salmonid eggs, and has been used extensively throughout the watersheds in question."

RESPONSE: Regional Water Board staff will research gravel permeability in the future and add them to the ***Salmonid Freshwater Habitat Targets for Sediment-Related Parameters*** document, as appropriate.

(81) Dr. Resh: "Most channel indicators relating to sediment and channel form respond very slowly to changes in management practices. Additionally, channel conditions often are relatively static until very large flood events reorganize the channel. . . . It should be made clear in the Action Plan that detecting the effects of new management practices will require lengthy time periods (decades or longer)."

RESPONSE: Regional Water Board staff concur and have added language to the ***Salmonid Freshwater Habitat Targets for Sediment-Related Parameters*** stating that detecting statistically significant changes in the parameters in response to changes in upslope practices and sediment discharges could take a lengthy amount of time, perhaps years to decades. However, valuable feedback on water quality trends is likely to occur within shorter periods, perhaps in the order of five to ten years.

Definition – Unstable Areas

The concept of an unstable area is used in the Water Quality Targets and in the Implementation Plan sections of the proposed TMDL Action Plans. The definition is a compilation of definitions found in geology texts, the Forest Practice Rules, and the Garcia River Sediment TMDL Action Plan. In-house Registered Geologists also assisted in developing this definition. The definition of unstable areas can easily be found in the Glossary of the Staff Report.

Questions: Is the definition of unstable areas scientifically valid?

(82) Dr. Dietterick: "Yes, the definition includes multiple perspectives which are appropriate and needed."

RESPONSE: Regional Water Board staff concur.

(83) Dr. Kirchner: "The factors mentioned are associated with slope instability, but the draft does not provide a means to unambiguously determine which areas should be termed 'unstable' and which should not. Identifying sites with a 'high risk of slope failure' is a judgment call, made somewhat more difficult by the subjectivity of judging what constitutes a 'high risk'. It would seem difficult to enforce a standard that is based on a potentially subjective assessment of whether a particular area should be determined to be unstable."

RESPONSE: Regional Water Board staff concur that the in-field determination of unstable areas is subjective. Staff are working with the California Department of Forestry and Fire Protection and the California Geological Survey to develop a more determinate means for identifying unstable areas. Additionally, staff intend to minimize the differences in judgment calls through education of staff, landowners, and other resource professionals.

Implementation Plan - Road Management Plan

In all four watersheds, it is the proposed policy that new road construction, maintenance, and decommissioning shall retain natural hydrologic function. Regional Water Board staff have developed examples of road management practices consistent with this policy. The examples are based on the experience and professional judgment of staff.

Questions: In the majority of situations, will the example road management practices result in roads that retain natural hydrologic function? Are the example practices clear, concise, appropriate, and adequate?

(84) Dr. Dietterick: "For the most part, the recommended practices offer a guideline that will promote natural hydrologic function as much as can be expected with a road. . . . There are specifics not included in the list of practices, but reference is made to the Weaver and Hagans text, and that should be adequate. Reference could also be made to the California Forest Practice Rules which provide similar road drainage guidelines, which are consistent with the Handbook for Forest and Ranch Roads."

RESPONSE: Regional Water Board staff concur. Reference to the Forest Practice Rules will be made in the road management section of the guidance document for the control of sediment waste discharges, which is currently being developed.

(85) Dr. Kirchner: "They will help, but natural hydrologic function cannot be guaranteed. Roads are intrinsically less permeable than undisturbed terrain, and thus their hydrological function is inherently unnatural to some degree."

RESPONSE: Regional Water Board staff concur.

(86) Dr. Kirchner: In regards to the road management practices being clear, concise, appropriate and adequate: "Generally yes."

RESPONSE: Regional Water Board staff concur.

(87) Dr. Kirchner: "The way that slopes are referred to is confusing. For example, a fill slope that is presumably two units of horizontal distance per unit of vertical distance is called a 200% slope, but in common language a 200% slope is one in which the vertical distance is twice the horizontal (i.e., a 63 degree slope!). This would exceed the angle of repose for all common non-cohesive materials. By contrast, the draft refers to hillslopes of "40% slope", which presumably means a 22 degree slope, in agreement with the common usage of the term."

RESPONSE: Regional Water Board staff concur and have revised this language so that the slopes are correctly described.

(88) Dr. Resh: "The example road management practices are clear and appropriate. However, these examples are inadequate preparation for inexperienced workers performing road management. Perhaps landowners performing road management activities, who do not do so under the guidance of trained professionals, should be required to take a training session."

RESPONSE: Regional Water Board staff concur on both points. Outreach and education of all stakeholders on sediment control practices and issues is a high priority for staff.

Implementation Plan – Sediment Discharge Site Volume Thresholds

The TMDL Action Plans propose that dischargers inventory, repair, and possibly compensate those sediment discharge sites that discharge or threaten to discharge ≥ 1 yd^3/yr or ≥ 10 yd^3/10yrs.

Questions: Is the volume of 1 yd^3/yr or 10 yd^3/10yrs a significant sediment source? If discharged, does the proposed volume result in an adverse impact to anadromous salmonids and other beneficial uses? Is the volume of 1 yd^3/yr or 10 yd^3/10yrs easily recognizable? Please answer these questions while considering cumulative impacts and the persistent nature of sediment in a stream system.

(89) Dr. Dietterick: "One cubic yard seems too small for many fluvial sources whether or not it is originating from a natural or anthropogenic source. We have developed the Near-Stream Sediment Source Survey for the Little Creek Watershed Study. . . . It may be advantageous in some watersheds to establish the threshold, or minimum volume higher to more realistically address those sites that have the greater impact toward improving beneficial uses.

RESPONSE: Requirements related to the 1 yd^3/yr or 10 yd^3/10yrs volume threshold have been removed from the TMDL Implementation Policy. However, Regional Water Board staff will take this comment and the data from Akers' research into consideration when developing the guidance document for the control of sediment waste discharges.

(90) Dr. Dietterick: "Additionally, I suspect that the sediment source estimates for the Big, Albion, and Ten Mile Rivers underestimated the contributions from fluvial erosion, and that has also exaggerated the percent contributions of all sources originating from road sources. That's not to say that road sources are not important; road sources are arguably the most significant anthropogenic source associated with current land management activities."

RESPONSE: Comment noted.

(91) Dr. Kirchner: "This is all a question of scale and of timing. A single discharge of 1 yd^3/yr is quantitatively insignificant compared to the average sediment load of tens of thousands of tons per year. But if it is highly localized, and particularly if it occurs during low flows, it could have a significant local effect."

RESPONSE: Regional Water Board staff concur.

(92) Dr. Kirchner: "It will be recognizable if it is highly localized (such as a localized mass failure, or rilling and sheetwash associated with drainage on a short length of road surface). If it is spread over a large area, it will not be recognizable against the background erosion rate of hundreds of tons per square mile per year."

RESPONSE: Regional Water Board staff concur and will take this comment into consideration when developing the guidance document for the control of sediment waste discharges.

(93) Dr. Resh: "The one cubic yard and ten cubic yards/ten years volumes are significant and easily recognizable by a trained professional. The difficulty comes in predicting future sources of sediment. Because increased sediment supply is a cumulative watershed effect, any amount of sediment adds to the adverse impacts to salmonids."

RESPONSE: Regional Water Board staff concur.

Implementation Plan – Inventory Requirements

In order to address existing sediment discharges, the proposed TMDL Action Plans include a requirement for dischargers to inventory sediment discharge sites, roads, stream crossings, and unstable areas.

Questions: Are the inventory requirements adequate to allow the thorough review and analysis of sediment discharge sites, roads, stream crossings, and unstable areas and their threat to water quality? Are the requirements clear, concise, appropriate, and adequate?

(94) Dr. Dietterick: "With the exception of the 1 yd^3 minimum volume, the requirements appear to be reasonable. I am supportive of this type of ground-based approach. It can be effective in identifying and treating significant sediment sources. The other benefit of this approach over other more scientific approaches is that it can be performed by most landowners with very little training."

RESPONSE: Regional Water Board staff concur. In regards to the $1yd^3$ minimum volume, please see the response to comment number 89.

(95) Dr. Kirchner: "The inventory requirements will, if conscientiously followed, generate an adequate database of existing and potential sediment sources."

RESPONSE: Regional Water Board staff concur.

Implementation Plan – Sediment Control Threshold

In order to address existing sediment discharges, the TMDL Action Plans include a requirement for dischargers to control at least 75% of the volume of sediment discharge sites under Phase I and Phase II in a five year time frame. This proposal is based on several studies and staff's professional judgment.

Questions: Is the proposal to require the control of at least 75% of the volume of sediment discharge sites scientifically valid? Does the rationale described in the draft Staff Report adequately support the proposal? Will the most significant sediment discharge sites be addressed under the proposal?

(96) Dr. Dietterick: "If the question is, will a 75% reduction in sediment sources under Phase 1 and 2, result in improving habitat conditions and increase the likelihood that water quality objectives will be met, the answer is yes. I am not aware of the Madej study documenting the 75% reduction, nor the practices implemented to achieve the reduction, but it seems reasonable. The removal of the remaining 25% under Phase 3 may be problematic to resolve under many circumstances. I would recommend that a set of reasonable sediment control techniques or offset compensation be accepted for this remaining amount. It will also be very difficult, if not impossible, to evaluate effectiveness of a practice(s) in controlling the remaining 25 percent. However, ground-based observations following storm events could still be effective."

RESPONSE: Requirements related to the sediment control threshold and the phased approach have been removed from the TMDL Implementation Policy. However, Regional Water Board staff will take this comment into consideration when developing the guidance document for the control of sediment waste discharges and when requiring sediment control of dischargers.

Implementation Plan – Sediment Control Requirements

The TMDL Action Plans also include a requirement for dischargers to develop a Sediment Control Plan. The Sediment Control Plan will contain a description of the selected sediment control practices, an estimate of the volume of sediment that will be kept from discharging to a water body, an estimate of the volume of sediment that will continue to discharge to a water body after prevention and minimization efforts, and a description of the inspection and maintenance activities.

Questions: Are the requirements of the Sediment Control Plan adequate to allow the thorough review and analysis of the sediment control practices and any remaining discharge? Are the requirements clear, concise, appropriate, and adequate?

(97) Dr. Dietterick: "The three-phased approach seems reasonable and should allow for all significant sources to be treated. I also recommend that means by which effectiveness of the control measures is predicted be reconsidered. Eliminating this requirement would allow the landowner to comply without incurring additional expenses from hiring a consultant to predict effectiveness using methods that are gross approximations at best. A palette of acceptable methods can be made available, the landowner proposes treatment, and the plan accepted or declined following review by Board staff."

RESPONSE: Requirements related to the sediment control requirements and the effectiveness of sediment control practices have been removed from the TMDL Implementation Policy. However, Regional Water Board staff will take this comment into consideration when developing the guidance document for the control of sediment waste discharges and when requiring sediment control of dischargers.

(98) Dr. Kirchner: "The control plan requirements should allow adequate review of the planned control practices and expected sediment discharges."

RESPONSE: Requirements related to the sediment control requirements have been removed from the TMDL Implementation Policy. However, Regional Water Board staff concur that review of sediment control practices and sediment waste discharge sites will be necessary.

(99) Dr. Kirchner: "The requirements are generally clear, except in point #2, which requires '(1) an estimate of the total volume of sediment waste that will be kept from discharging to a water body, and (2) an estimate of the volume of sediment waste per year that will be kept from discharging to a water body by the sediment control practice(s).' It is unclear whether the distinction that is being drawn is between the amount per year and the total amount over all time, or between discharges prevented by sediment control practices and the total discharges prevented by all means."

RESPONSE: The intention was to distinguish between the total amount discharged and the amount discharged per year. Clarity will be added should this issue remains in the guidance document for the control of sediment waste discharge, which is currently being developed.

Implementation Plan – Storm Period Inspection Frequency

In regards to the Sediment Control Plan, the TMDL Action Plans contain a suggestion to inspect sediment discharge sites after the first four inch rain event of the winter season and after any significant storm over two inches thereafter the same season until the sediment discharge site is 100% vegetated and the drainage is functioning as designed.

Questions: Will the above suggestion result in inspection and maintenance activities necessary for the short and long term upkeep and integrity of sediment control practices? Is this suggestion clear, concise, appropriate, and adequate?

(100) Dr. Dietterick: "Language regarding the development and retention of the Inventory and Sediment Control Plan places responsibility on the landowner for identification and compliance. This is encouraging landowners to be responsible stewards, yet I anticipate opportunities for landowners to not achieve compliance either from negligence or from not having the appropriate level of feedback from Board staff (even with the outreach training as proposed). In short, there are indications that

on-ground inspections will be lacking due to Board staffing limitations and this could be a detriment to achieving sediment control and improving beneficial uses."

RESPONSE: Comment noted. Regional Water Board staff recognize the potential problems that could arise due to lack of resources. The TMDL Implementation Policy addresses this issue, at least in part, by directing the Executive Officer of the Regional Water Board to pursue new funding and staffing resources to address sediment waste discharges across the North Coast Region.

(101) Dr. Kirchner: "For clarity, the inspection requirements should specify what constitutes a 'rain event'. Four inches of rain falling in a week is probably not a rain event, whereas four inches in a day is definitely one."

RESPONSE: Regional Water Board staff concur that clarification of a "rain event" is needed and will include a definition in the guidance document for the control of sediment waste discharges, which is currently being developed.

Implementation Plan – Offset Compensation
(This question was asked of Dr. Kirchner and Dr. Resh, but not of Dr. Dietterick)

Offset compensation is sediment control work, often of natural sources, that compensates for the adverse effects of a discharge of anthropogenic sediment. Offset compensation is only required in certain circumstances as stated in the draft Basin Plan Language and Staff Report. If offset compensation is required, dischargers shall prepare an Offset Compensation Plan.

Questions: Do sound scientific knowledge, methods, and principles support the remediation of natural sediment discharge sites as compensation for anthropogenic sediment waste discharges? Do the proposed TMDL Action Plans require sufficient information to adequately characterize the volume of sediment that is discharged or that is prevented from being discharged? Are the offset compensation requirements clear, concise, appropriate, and adequate?

(102) Dr. Kirchner: "The principle of offset compensation is generally sound, to the extent that the impairment of the water body results from the overall load of sediment, and to the extent that natural and anthropogenic sediment present similar risks to water quality. Thus an important component of the offset compensation guidelines is the requirement that offset sites should match the discharge sites in sediment composition and sediment delivery timing. It is difficult to accurately estimate the volume of sediment discharge that will be prevented by any particular offset compensation actions. Thus it is appropriate that proposers of offset compensation actions should have the "burden of proof" of justifying their projections of sediment discharge that will be prevented."

RESPONSE: Regional Water Board staff concur. However, the concept of offset compensation has been recently removed from the TMDL Implementation Policy.

Implementation Plan - Implementation & Upslope Effectiveness Monitoring

The proposed TMDL Action Plans include requirements that dischargers photograph sediment discharge sites from the same location on an annual basis (i.e., photo-point monitoring).

Questions: Are the proposed requirements to conduct photo-point monitoring adequate to allow the thorough review and analysis of sediment control efforts over time? Is this monitoring component adequate to determine if there is a trend in the amount of sediment being discharged to water bodies? Are the implementation and upslope effectiveness monitoring requirements clear, concise, appropriate, and adequate?

(103) Dr. Dietterick: "The photo-point monitoring requirements are well-stated and relatively easy for a landowner to implement. As stated, the ability for photo point monitoring to ensure sediment-control efforts are effective may be difficult for some discharge sites. Combining photo documentation with additional post-storm observations would provide additional assurance that measures are effective. Post-storm observations could be similar to step 4 in the requirements for the Sediment Control Plan."

RESPONSE: Regional Water Board staff concur.

(104) Dr. Kirchner: "Photo-point monitoring is well-suited to this task because it is relatively quick, simple, repeatable, and versatile. Photo-point monitoring will not provide a quantitative measure of changes in sediment discharge rates, but it will qualitatively indicate changes in the condition of sediment source areas."

RESPONSE: Regional Water Board staff concur.

(105) Dr. Kirchner: "It would be appropriate to include a requirement that the coordinates of each photo-point should be recorded using GPS."

RESPONSE: Regional Water Board staff do not concur. Currently, a GPS device is not a piece of equipment available to owned by most landowners, and staff have determined that is would be an unnecessary expense.

(106) Dr. Kirchner: "It would also be appropriate to require that when a photo-point is first established, the monitoring log should also include a photograph showing the location of the photo-point itself, in relation to nearby landmarks."

RESPONSE: Regional Water Board staff concur. This comment will be added, as a suggestion, to the guidance document for the control of sediment waste discharges.

(107) Dr. Kirchner: "On point 5, the wording should be changed to make clear that successive photos for any individual photo-point should be made at the same time of day, not that

every site should be photographed at the same time of day (which would be infeasible)."

RESPONSE: Regional Water Board staff concur and this change will be made to the guidance document for the control of sediment waste discharges.

Implementation Plan – Sediment Assessment Methods

There are several requirements throughout the proposed TMDL Action Plans to quantify the volume of sediment that as been discharged, has the potential to be discharged, or will be kept from discharging sediment to a water body in the four watersheds. A separate section in the Implementation Plan discusses recommended sediment assessment methods and models.

Questions: Are the recommended models and methods scientifically valid? Are there other models that should be used instead of, or in addition to, the recommended models and methods? Is it possible to quantify the uncertainty associated with the recommended sediment models and methods?

(108) Dr. Dietterick: "Twenty years of working with hydrologic models have convinced me that most watershed-scale models do not have the precision to detect change. Model parameter sets can be selected within acceptable ranges and yield order of magnitude differences in output responses when. The application to predict effectieveness pre- and post-treatment can show significant change, when in fact, no change in conditions has occurred. This is a broad generalization, but estimating representative parameter values, that are spatial averages at best for most watershed-scale models, introduces error and uncertainty in the model output. . . . I have little confidence in WEPP or RUSLE except for making predictions on a gross scale – not to the level of change detection that is scientifically defensible for documenting the expected change or effectiveness of a particular sediment control practice."

RESPONSE: The specific requirements to quantify sediment waste discharges has been removed from the TMDL Implementation Policy, but will be included in the guidance document for the control of sediment waste discharges, which is currently under development. Due to this comment and comments numbered 109, 110, and 111, staff will recommend that sediment assessments primarily be conducted using direct measurements, instead of models. However, models are reasonable and appropriate tools for estimating volumes, comparing discharges that may be released under various alternatives (especially when direct measurements are possible), and prioritizing sediment discharge control. In recognition of the disadvantages of models, dischargers will be required to provide information on calibration, validation, and sources of error for models that are used.

(109) Dr. Kirchner: "The recommended models and methods represent the best available science at present. Direct measurements (of eroded void volumes, for example) are much more reliable than model-based estimates. Thus it is appropriate to require those

using model-based estimates of sediment discharges to justify the basis for those estimates and to quantify the uncertainties involved."

RESPONSE: Please see the response to comment number 108.

(110) Dr. Kirchner: "In some cases (i.e., RUSLE), the accuracy of the erosion predictions has been assessed by comparison to experimental data. Those using such models should at least be aware of the likely uncertainties. If the uncertainties are unknown, one is not entitled to assume that they are small; thus it is helpful to stipulate, as part of the requirements for assessment methods, that the uncertainties must be quantified."

RESPONSE: Please see the response to comment number 108.

(111) Dr. Resh: "Sediment assessment methods should be based upon field-based surveys of erosion and sediment delivery. Although predictive models (RUSLE, WEPP, SEDMODL2) may be useful for identifying problem areas, they should not be used as methods to quantify sediment delivery."

RESPONSE: Please see the response to comment number 108.

Monitoring Plan

The proposed TMDL Action Plans contain instream effectiveness monitoring and compliance monitoring requirements.

Questions: Are instream effectiveness monitoring requirements adequate to determine if sediment control practices are effective at keeping sediment from being discharged to a water body? Are compliance monitoring requirements adequate to determine if sediment related water quality objectives and water quality targets are being met? Are the monitoring and sampling suggestions clear, concise, appropriate, and adequate?

Effectiveness Monitoring

(112) Dr. Dietterick: "There are instances where effectiveness monitoring can be successful in determining the effectiveness of sediment control practices, but by and large I see this effort generating a lot of meaningless data."

RESPONSE: Regional Water Board staff concur that effectiveness monitoring can be successful, but do not concur that such monitoring will generate a lot of meaningless data. Data collected under the auspices of effectiveness monitoring will be used to determine if sediment control practices are effective at keeping sediment from being discharged to a water body. Such information is necessary for adaptive management and to determine the success of the TMDL Implementation Policy.

(113) Dr. Dietterick:"There is the variability in climatic conditions and the characteristics of stormflow conditions in any one season, that can that can affect the response of instream parameters, such as V* and percent fines."

RESPONSE: In order to negate variable climatic conditions and stormflows, instream effectiveness monitoring is likely to be conducted upstream and downstream of a sediment discharge point or before, during, and after the implementation of sediment control practices. Data from such monitoring will, therefore, be compared to conditions that are not impacted by a particular discharge versus the target values found in the ***Freshwater Habitat Targets for Sediment-Related Parameters*** document. Please see the response to comment number 66 for more information.

(114) Dr. Dietterick:"I also think that it is unlikely that remedying smaller discharge sites will change most instream parameters, such as pool distribution and percent fines, to the extent that can be detected and attributed to the restorative strategy."

RESPONSE: Regional Water Board staff do not concur, but expect that the remediation of many sediment waste discharge sites will have a cumulative effect on downstream water quality to the point that changes in the parameters included in the ***Freshwater Habitat Targets for Sediment-Related Parameters*** document will be evident. Please see the responses to comments numbered 66 and 113 for a discussion on instream effectiveness monitoring and the targets.

(115) Dr. Dietterick:"I am supportive of visual observations, supported by photo monitoring, before and after sediment control implementation, as well as this type of ground-based monitoring immediately following significant storm events."

RESPONSE: Regional Water Board staff concur.

(116) Dr. Dietterick:"I think it would be unwise and a futile effort to recommend turbidity monitoring for most sites. I think if there is an instance where an increase in turbidity is evident to the eye, that the sediment source can be determined from visual observations and remedied more efficiently."

RESPONSE: Regional Water Board staff do not concur, but have determined that turbidity is a useful parameter when conducting instream effectiveness monitoring. For such monitoring, turbidity would likely be monitored by collecting grab samples or by making visual observations upstream and downstream of a sediment discharge point or before, during, and after the implementation of sediment control practices. Staff concur that using visual observations of turbidity is often more efficient than taking grab samples.

(117) Dr. Dietterick:"I would also question the statement regarding being able to detect a 20% increase in turbidity over background levels."

RESPONSE: It has been the experience of Regional Water Board staff that a difference of 20% in turbidity levels is visible to the naked eye in most cases.

(118) Dr. Kirchner: "The instream effectiveness monitoring requirements are not spelled out; instead, the draft simply states that specific monitoring activities may be required. The most important issue is that the monitoring activities must encompass the hydrologic conditions of interest (high flow? low flow? spawning conditions?) and those conditions must be consistent each time the measurements are made. Otherwise spurious trends may appear as a result of differences in hydrologic conditions from one measurement period to the next."

RESPONSE: Regional Water Board staff concur and will take this comment into consideration when developing instream effectiveness monitoring strategies. Please see the responses to comments numbered 66 and 113 for a discussion on how instream effectiveness monitoring will likely be conducted.

(119) Dr. Resh: "Effectiveness monitoring should be focused on hillslope activities, the "first links of the cause-effect chain" (Reid and Furniss, 1998). Because the implementation plan is geared towards road management and hillslope stability, the best measure of the effectiveness of the prescribed management actions is sediment discharge from hillslope activities. It may take years or even decades to observe a channel response to changes in sediment supply. If adaptive management is to be used in the TMDL Implementation Plan, monitoring sediment delivery resulting from land-use activities must allow for an immediate assessment of the effectiveness of sediment controls, and information must be made available quickly enough that steps can be taken to reduce the impact of sediment delivery (Reid and Furniss, 1998).

RESPONSE: Regional Water Board staff concur. Monitoring will take several different forms: upslope effectiveness monitoring, instream effectiveness monitoring, and instream compliance and trend monitoring. While it may take years or even decades to observe a statistically significant channel response to increased sediment supply (through compliance and trend monitoring), upslope effectiveness monitoring will allow for more immediate assessments of sediment controls.

(120) Dr. Resh: "In conjunction with hillslope monitoring, turbidity (or suspended sediment concentration) responds rapidly enough to be a useful indicator of effectiveness. Turbidity grab samples following storm events would be useful for identifying tributaries with higher fine sediment loads, which could indicate previously unknown upslope sediment sources."

RESPONSE: Regional Water Board staff concur.

(121) Dr. Resh: "Rather than strictly relying upon photographic analysis of existing problem areas, effectiveness monitoring should target potential future sources of sediment.

Potential areas could be prioritized by topographic and hydrologic conditions using a hillslope stability model such as SHALSTAB (Dietrich and Montgomery, 1998), and by time since previous land use disturbance (timber harvest)."

RESPONSE: Regional Water Board staff do not concur. Potential future sources of sediment will be addressed through instream compliance and trend monitoring efforts and through visual observations of turbidity during rain events by Regional Water Board staff (using aerial surveillance when possible). Additionally, staff are hesitant to use hillslope stability models, such as SHALSTAB, for such a purpose, as explained in the response to comment number 108.

Compliance and Trend Monitoring

(122) Dr. Dietterick: "Turbidity monitoring is a complex and expensive venture . . ."

RESPONSE: Regional Water Board staff concur and are aware of the many issues raised by this comment in regards to the high levels of technical expertise, time, effort, and cost associated with constant turbidity and suspended sediment monitoring. Due to such issues, constant turbidity and suspended sediment monitoring will be selectively used. However, the usefulness of turbidity and suspended sediment data, its sensitivity of the effects of land use, and its ability to take into account variable climatic conditions are worth the time, effort, and cost.

(123) Dr. Dietterick: "If the Board has the intention to fund such [turbidity and suspended sediment] monitoring efforts, the money may be better spent on ground-based surveys that more effective to ensuring sediment controls are being effective and beneficial uses will improve."

RESPONSE: Regional Water Board staff have determined that several different types of monitoring will be necessary, including both ground-based surveys (upslope effectiveness monitoring) and turbidity and suspended sediment monitoring.

(124) Dr. Kirchner: "The monitoring provisions are appropriate, and are necessary to determine how sediment fluxes in the river systems are changing through time. As such they are essential to determining whether sediment discharges are being reduced as intended. It is essential to monitor discharge, turbidity, and suspended sediment quasi-continuously, because the majority of sediment discharge can occur during rare, brief storm episodes. These would likely be missed under a protocol of periodic grab samples . . . ."

RESPONSE: Regional Water Board staff concur.

General Questions

As a reviewer, you are not limited to only addressing the issues and questions of particular concern that are listed above. We also invite consideration of the following "big picture" questions:

Questions: In reading the technical Staff Report and proposed amendment language, are there any additional scientific issues that are part of the scientific portion of the proposed rule not described below? Taken as a whole, is the scientific portion of the proposed rule based upon sound scientific knowledge, methods, and practices?

(125) Dr. Kirchner: ". . . on page 2 of the draft basin plan language, the Albion River watershed is said to comprise '43 square miles, or 47,520 acres...'. Since there are 640 acres in a square mile, at least one of these two numbers must be wrong."

RESPONSE: Thank you for catching this typographical error. The correct size of the Albion River Watershed is 43 square miles, or 27,520 acres.

(126) Dr. Kirchner: "To my knowledge, the proposed rule is based on the best available science at present. The science of erosion, sedimentation, and fluvial geomorphology is continually evolving and significant uncertainties remain. It is likely that significant advancements will be made in the science within the next 5 to 10 years. Therefore the provision for periodic reassessment is an important component of the action plan."

RESPONSE: Regional Water Board staff concur.

(127) Dr. Resh: "The RWQCB has done a commendable job outlining a plan for assessing sediment sources and problem areas, but I am worried that landowners will use inconsistent monitoring and assessment methods, resulting in analyses that are incomplete or not comparable. I recommend that the RWQCB do as much as possible to encourage landowners to pool their resources in order to finance a single, standardized approach to monitoring and sediment source analyses."

RESPONSE: Comment noted. Thank you.